1. Introduction: MOOSE Crossing

1.1 An Evening at The Crossing

It's early evening on a Thursday in September, 1996. Hermes[1] (boy, age 9) is working on his Magic Subway Station. Miranda (girl, age 11)[2] is in her room.

Miranda sees:
```
You sense that Hermes is looking for you in Magic Subway Station.
Hermes pages, 'Hi! can i come over?'
```

Hermes sees:
```
All of a sudden, you hear a clap of lightning and a rumble of
   thunder.  You look into the sky, and see Miranda's message written
   in the stars!
Miranda pages, 'Ok '
```

Hermes types: `join Miranda`
He sees:
```
Miranda's room
A bright room in what look[3] like the center of the sun, all around
you there is a bright yellow light.  A green hand emerges from the
wall and shoves a pair of sunglasses on your face.  The sun glasses
turn the bright light into a dull glow.  You can barely make out a
arm chair and sofa.  The floor is covered in a gold rug.
   Obvious exits: ..crazy........Miranda's Crazy Gadgets shop
                  ..fly..........Travel Agency
                  ..fortune......The Fortune Tellers Caravan
                  ..in...........< Paradise Island >
                  ..stroll.......The GreenHouse
   You see Juju, Huey, and Duey here.
   Miranda is here.
```

They both see:
```
Hermes shatters the air with his explosive arrival.
Google arrives, following Hermes.
Miranda says, 'Hi!'
Miranda says, 'How old are you?'
Hermes says, '9'
Hermes says, 'you?'
Miranda says, 'oh, I'm 11, I'm Mouse's sister'
```

---

[1] I have changed the children's character names to protect their identities. Although their character names are already aliases, changing them gives an added level of privacy. I tried to pick names which convey the same flavor as the original, but are not obviously identifiable as the same person. People who work in and around the area of The Media Lab known as "The Pond" contributed many creative name suggestions.

[2] Miranda started participating in MOOSE Crossing when she was ten years old. At the time of this writing, she is still an active member and is now twelve. Many children have participated for more than a year. I will indicate their age with a range when I am refering to their participation in general terms. When I quote a specific incident or completed project, I will list their age at the time the event took place or the project was created. As a result, some children's ages will be listed differently in different sections of this thesis.

[3] Miranda presumably meant to use the word "looks" here. The children's conversations and descriptions of their creations are presented unedited and uncorrected (except where otherwise noted, and where editing was necessary to protect their privacy.)

Miranda types: `become Athena`

```
Miranda waves her hand over her entire body.  Every place her hand
   passes, changes into a new person!
Hermes says, 'mind having the magic subway connected to paradise
   island?'
```

Miranda has built a vacation resort called Paradise Island where you can swim and build a summer home. She also made a travel agency and car rental agency to arrange trips there.

Hermes types: `become Cloudstreamer`

```
Hermes suddenly floats up in the air and is engulfed in light.  The
   old form melts away and is magically transfomed into an eagle.
   It's Cloudstreamer!
Athena says, 'Fine with me, but would you mind connecting it to my
   Travel Agency? you don't have to'
Cloudstreamer says, 'ok, but you have to help connect it.'
```

Miranda/Athena and Hermes/Cloudstreamer work to connect his magic subway station to her travel agency. While they are working, he notices that a new member, Scribbles (girl, age 13), has connected.

Scribbles sees:

```
You sense that Cloudstreamer is looking for you in Magic Subway
   Station.
Cloudstreamer pages, 'hi! i'm new too'
```

Cloudstreamer sees:

```
You sense that Scribbles is looking for you in MOOSE Crossing.
Scribbles pages, 'hi! can I join you? Love the name!'
```

Cloudstreamer has to go to dinner, but says he'll be back in half an hour. Not long after:

```
Cloudstreamer pages Scribbles, 'im baaack!!come on over!'
```

Scribbles types: `join Cloudstreamer`
She sees:

```
Magic Subway Station
Welcome to The Magic Subway Station!  Please select your destination
and step through the magic portal!
   Obvious exits: ..CR...........Crossroads
                  ..EA...........Emerald Apartments
                  ..HC...........Home in the Clouds
                  ..NM...........North Main Street
                  ..PI...........< Paradise Island >
                  ..RF...........Redwood Forest
                  ..TA...........Travel Agency
   You see Google here.
   Cloudstreamer is here.

Scribbles teleports in.
```

```
Scribbles says, 'Hi there!'
Cloudstreamer says, 'hi'

Cloudstreamer types:  look Scribbles
He sees:
You see a brand new MOOSE Crossing member.
She is awake and looks alert.

Scribbles grins
Cloudstreamer says, 'wach this'
Scribbles says, 'this is my very first time on.  How about you?'
Cloudstreamer says, 'probably my 10th'

Cloudstreamer types:  become Widget

Cloudstreamer is suddenly covered by robot mechanics the size of mice
   carrying wrenches and drills and screwdrivers.  Body parts fly
   everywhere!  (Grownups, don't read this!)  Yikes!  Duck!  There
   goes an eyeball!  The metal mice vanish, and before you now stands
   ... drumroll, please! ... the one and only Widget!!!
Widget says, 'good. huh'
Scribbles jumps up and down.
Scribbles says, 'Yes.  AWESOME!'
Scribbles says, 'how'd you do it?'
Widget says, 'wanna do it?'
Scribbles says, 'it might be kinda fun.'
```

Hermes/Cloudstreamer/Widget shows Scribbles how to describe herself, and how to have multiple personas. He's just built a home for himself on Sparky II, a mobile community made by Rufus (boy, age 12). He shows her how to build a home there too. Soon he has to go to bed. After he leaves, Scribbles works more on her description:

```
A small, cinnamon-colored ball of short, fluffy fur and green
splendor stares up at you with twinkling eyes and a vivacious smile.
A mouse, you realize after a moment - a mouse wearing a tiny, white
silk shirt and close fitting green velvet breeches.  She bows deeply
and doffs a triangular, green hat with a bobbing golden plume pinned
to the side.  You can't help wondering where she obtained this odd
attire in such a minute size.  There is no doubt that it is of the
finest make.  Graceful vines, embroidered in thread-of-gold, climb up
the sides of her breeches and adorn the neck and cuffs of her shirt.
Tiny boots of a soft brown velvet lace up to her fuzzy knees.  Her
hat, which she has now returned to her head, is a perfect miniature
of those you have seen in full size.  Yet there is something else
about her something that draws your attention more than her odd dress
or her tiny size.  It is something in the way she carries herself,
the way she looks expectantly up at you with her paws on her hips and
her booted feet set slightly apart.  She looks like someone who has
been through a great deal, and always come out on top.  Like someone
who knows their destiny
```

In real life, Miranda is in Massachusetts, Hermes is in Florida, and Scribbles is in Maryland. They have never met face to face. They are participating in a text-based virtual world (or "MUD") for kids called MOOSE Crossing. They

are imagining new places and objects, and creating them with words and programs. In their spare time for fun they are reading, doing creative writing, and writing computer programs. Through these activities, they are learning in a self-motivated, self-directed, peer-supported fashion.

This research examines how the Internet can be used not just as a conduit for information, but as a context for learning through community-supported collaborative construction. In *Mindstorms*, Seymour Papert has a vision of a "technological samba school." At samba schools in Brazil, a community of people of all ages gather together to prepare a presentation for carnival. "Members of the school range in age from children to grandparents and in ability from novice to professional. But 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). People go to samba schools not just to work on their presentations, but also to socialize and be with one another. Learning is spontaneous, self-motivated, and richly connected to popular culture. Papert imagines a kind of technological samba school where people of all ages gather together to work on creative projects using computers. MOOSE Crossing is an attempt to realize that vision.

1.2 Construction and Community

The central claim of this thesis is that community and construction activities are mutually reinforcing. Working within a community helps people to become better dancers/programmers/designers and better learners. Conversely, working on design and construction projects together helps to form a strong, supportive community.

This interdisciplinary thesis is addressed to several overlapping communities: computer scientists, educators, educational researchers, researchers in computer-supported cooperative work (CSCW), designers of virtual communities, and members of virtual communities. The underlying research draws ideas from each of these communities, and is also strongly influenced by concepts from anthropology, cultural studies, gender studies, psychology, and sociology. Different facets of this central theme about construction and community need to be highlighted for each of these communities.

From an education perspective, MOOSE Crossing shows how constructionism can be supported by community. "Constructionism" is a term first coined by Seymour Papert as an expansion of Jean Piaget's "constructivism." Papert writes:

> We understand "constructionism" as including, but going beyond, what Piaget would call "constructivism." The word with the v

> expresses the theory that knowledge is built by the learner, not supplied by the teacher. The word with the n expresses the further idea that this happens especially felicitously when the learner is engaged in the construction of something external or at least shareable... a sand castle, a machine, a computer program, a book. This leads us to a model of using a cycle of internalization of what is outside, then externalization of what is inside. (Papert 1991)

Mitchel Resnick expands on this notion, writing "They might be constructing sand castles, LEGO machines, or computer programs. What's important is that they are actively engaged in creating something that is meaningful to themselves or to others around them" (Resnick 1994). This thesis gives new attention to those "others around them" and the essential role they play in the learning process.

While the term "constructionism" was only coined in the 1980s, research in this spirit to design computerized tools to help children learn by making things began in the 1960s. However, tools alone are not enough. All too often, tools designed to empower learners end up being used in the same old disempowering ways. The educational philosophy and spirit in which the tools were designed needs to be distributed together with the software or hardware. It's not possible to communicate these ideas through a software interface, or through a manual no one will read. Tools can be effectively constructionist only when they are embedded in a constructionist culture. Constructionism works best when it is situated in a supportive community context. A kind of constructionist culture often emerges when the tool's designer is present to help grow a community of users, but this spirit usually fails when dissemination is tried on a larger scale. Computer networks can be used to help create and spread constructionist cultures.

Papert imagined his technological samba school as a physical place. Virtual communities can be used to create such a "place" on the Internet. Both real and virtual places can help to create a supportive context for human activity and social interaction. You can also get the best of both worlds by using a virtual community to link many small face to face communities (such as after-school programs) into a larger whole.

At the time of this writing, an increasing number of educators are coming to realize that The Net is not an educational panacea. The process of getting computers hooked up to the Internet has been increasingly politicized—on Net Day in California in 1996, the President and Vice President of the United States themselves rolled up their sleeves and pulled red, white, and blue cable through a school. The day after Net Day, however, many educators found themselves wondering: Now we have net connections, but what exactly are we supposed to do with them? What is the real educational potential of this technology? I hope classroom educators will find this research to be one

useful model. Chapter Two, "The Day After Net Day: Approaches to Educational Use of the Internet," reviews various approaches to using the net as an educational tool. Most applications focus on information—receiving it, retrieving it, or sharing it. MOOSE Crossing focuses on seeing the Net as a place for learning through community-supported collaborative construction.

From a computer science perspective, MOOSE Crossing demonstrates the viability of end-user programming, and the value of community support for learning to program. As technologies increasingly surround the every day lives of ordinary people, it remains an open question how much control people will have over those technologies. On MOOSE Crossing, children as young as seven years old have been able to write simple computer programs; thirteen-year-olds have been able to write moderately complex ones. I designed the MOOSE programming language and MacMOOSE client interface to help make this possible. Chapter Three, "Designing Enabling Technologies: The MOOSE Language and the MacMOOSE Client," reviews their design. MOOSE is a special-purpose language designed for only one application: helping kids to make creative, cute objects in a text-based virtual reality environment.

While good, expressive tools are essential, I believe the real key to expanding what users can accomplish is community support. Computer networks can enable that essential support. Researchers in computer-supported cooperative work (CSCW) have long recognized this potential. Readers from a CSCW background will be most interested in Chapter Four, "Collaborative Learning Strategies: Storm's Weekend with Rachael" and Chapter Five, "Community Support for Construction." The detailed data collected on children's learning experiences on MOOSE Crossing sheds new light on the ways in which community support can help motivate and support an individual's work.

From a virtual communities perspective, MOOSE Crossing and MediaMOO (an earlier community I designed) demonstrate the benefits of letting users be creators, not just inhabitants, of virtual worlds. Cyberspace is not Disneyland—it's not a place for people to obediently wait on line, and then sit strapped into a seat viewing what is presented. It's a place for people to participate and create (Bruckman 1995). It's essential to view users as creators, not merely recipients, of content. Constructionist ideas are of central importance to the design of virtual communities. Chapter Six, "Constructionist Culture," argues that constructing things together helps to create a particularly special, supportive sort of community.

At the intersection of these various communities are educators designing applications of virtual communities. To that community I would like to plead: please don't have virtual classes where students sit behind virtual desks and teachers write on virtual blackboards. To do so combines some of

the worst aspects of both traditional pedagogy and virtual worlds. Children learn better by working on personally meaningful projects than by being lectured to. This is even more true in the virtual world than in face to face classrooms. A constructionist pedagogy makes better use of the affordances of MUDs. Like any medium, MUDs have affordances and limitations: things they are good for and things they are not good for. They should not be used for every application. They are lousy places to conduct traditional classroom-like education. They are superb places for constructionist learning.

1.3 What is a MUD?

1.3.1 MUD History

MOOSE Crossing is a "MUD." For historical reasons, "MUD" stands for "Multi-User Dungeon." The first MUDs were networked multi-player dungeons and dragons games. Since many current applications of MUD technology have moved far from their origins as violent games, some people prefer to say that the "D" stands for some other word such as "Domain" or "Dimension." I prefer to use the historically correct word.

MUDs have their origins in text-based adventure games. The first such game, "ADVENT," was written by Will Crowther and Don Woods around 1967 (Crowther 1992). In the late 1970s, Roy Trubshaw and Richard Bartle at Essex University in Great Britain put a multi-user text-based world up on the Arpanet and called it "MUD" (Bartle 1990). (It's commonly referred to now as "MUD1" to avoid confusion with the generic use of the term.) At around the same time, Alan Klietz made a similar program called "*E*M*P*I*R*E*," which was soon renamed "Scepter of Goth" (Klietz 1992). All MUDs for the next ten years would be modeled on Dungeons and Dragons games where players try to kill monsters and find magic treasure.

In 1989, a graduate student at Carnegie Mellon University named James Aspnes decided to see what would happen if he removed the monsters and the magic swords. In most MUDs up until this time, extending the virtual world was a privilege reserved for either the owners of the computer the game ran on, or those who had dedicated hundreds of hours of playing time and succeeded in winning the game by completing all of its quests. Aspnes decided to let everyone extend the virtual world. He removed many of the combat-oriented commands from the MUD software he was modifying, and the resulting code was much more compact. Consequently, he called his software "TinyMUD." The choice of names is ironic, because TinyMUD soon became huge. With few controls on who could build how many rooms, the database grew out of control. Students from several universities built detailed replicas of their campuses. The model of MIT included a detailed copy of The Media Lab. In the lab's cube auditorium was the set of a play then being performed there, and a negative review of the play was posted on the

wall. The original TinyMUD soon got too big for the computer it was running on, and was shut down.

TinyMUD was a more egalitarian and pacifist community than its predecessors. I asked James Aspnes if those ideals came from himself and the community's founders. What had been his design goals? He replied:

> You raise an interesting question about the ideals of the TinyMUD community coming from the few founding members. Most adventure-style games and earlier MUDs had some sort of scoring system which translated into rank and often special privileges; I didn't want such a system not because of any strong egalitarian ideals (although I think that there are good egalitarian arguments against it) but because I wanted the game to be open-ended, and any scoring system would have the problem that eventually each player would hit the maximum rank or level of advancement and have to either abandon the game as finished or come up with new reasons to play it. This approach attracted people who liked everybody being equal and drove away people who didn't like a game where you didn't score points and beat out other players (I did put in a "score" command early on since almost everybody tried it, but most players soon realized that it was a joke). I think that this effect created a kind of natural selection which eventually led to the current egalitarian ideals. I like the egalitarianism, but it wasn't my original goal. (Aspnes 1992; Bruckman 1992)

Somewhat inadvertently, Aspnes had created a more egalitarian community, and a new kind of learning environment. It's a remarkable fact that at any given moment there are tens of thousands of people doing creative writing and computer programming in their spare time just for fun on MUDs.

The rest of this section describes what a MUD is by analyzing its three primary components: personas, rooms, and objects.

1.3.2 Personas

When you first connect to a MUD, you must pick a name. You may also chose your gender and describe what you look like. If we are in the same room on MOOSE Crossing and you type "look at Amy," you will see:

```
Amy is 5'8 with shoulder-length wavy brown hair, and a mischievous
grin which seems to say "Can you believe I get paid to do this?"
She is awake and looks alert.
Carrying:
  randomizer                              Generic Returning Object
  A Carrot Cake                           Amy's card
  generic business card                   frob
```

On some MUDs (including MOOSE Crossing), participants may have more than one persona and may switch between them, as Hermes demonstrated in Section 1.1 by becoming Cloudstreamer and Widget, and Miranda demonstrated by becoming Athena. Each persona has a different description and gender. Rachael (girl, age 12) extended the software on MOOSE Crossing so each persona can also have different clothes. MUDders often work through issues of personal identity through the activity of constructing and role playing different personas (Bruckman 1992; Turkle 1995).

Sometimes MUD players are explicitly taking on fictional roles, pretending to be someone else; however, at most communities most of the time, participants are primarily just being themselves—it's more like a costume party than an actor's workshop. On MOOSE Crossing, only small amounts of real role playing take place. Notably, Rachael organized a sub-community she calls "The Nest" for medieval role playing. Nest members have homes at The Nest Gathering Grounds, and special nest personas who pretend to be living in medieval times and not to know about things like telephones and computers. Different MUD communities vary in what percentage of the time players typically are playing a role versus simply being themselves. People tend to stay "in character" more of the time on MUDs with themes taken from popular culture such as Star Trek or Anne McCaffrey's *Dragonriders of Pern* series of books. However, on most MUDs most of the time, people may have fanciful names and descriptions, but they are primarily talking about issues of real-world concern to them.

This is certainly true on MOOSE Crossing. For example, Miranda's alter-ego SuperMiranda talks in all capital letters and jokes about being a super hero. However, she usually changes into this persona very briefly, and then changes back. This is the only one of her several personas which behaves at all different from the others. Whichever name she is using, she is primarily just being herself. She talks to the other children on MOOSE Crossing about the things she's making there, and about elements of her real life (her new braces, her friends, the first day of the new school year). Similarly, Hermes, Cloudstreamer, and Widget don't behave observably different. Jo (girl, age 12-13) tries to behave differently when she is her gothic alter-ego Rowena, but she doesn't entirely succeed. Here is Rowena's description:

```
You see a tall girl of about 16. Her hair is died black and she is
wearing a long black dress. Her complexion is very light, almost
white, as if she has never seen the light of day. Her face never
smiles, though she's really quite friendly.
```

In one conversation, she talks about how successful this persona is with Scribbles and Werdna (boy, age 9). Werdna is in another room, but is talking to the others through his puppet "hawk":

```
Rowena says, 'scrib, on a scale of one to 10, 10 being a total goth,
   how gothic is my character?  You too werdna'
hawk [Werdna] says, '8 and a half'
Rowena says, 'better than I expected, but what's missing'
Scribbles says, 'your character looks gothic, but she doesn't act
   like it.  She acts like my Stacey:)'
```
[Stacey is Rowena's real name.]
```
hawk [Werdna] says, 'well i couldn't say'
Scribbles says, 'and htat would sound odd to the outsider...'
Scribbles says, 'but that's ok.'
Rowena says, 'I'm still trying to get into it, its hard being
   depressed when your pale purple'
```

Despite the fact that the children rarely explicitly role play, the way a child (or adult) chooses to describe himself or herself is still a window onto that child's sense of self. It's not an accident that Miranda's younger sister chose the character name "Mouse." As the younger child in the family, Mouse (girl, age 8-10) has an acute sense of being small and not able to do all the things her big sister can do. Her self confidence (and her writing ability) have grown over the last year. Contrast the description she made the day she joined MOOSE Crossing to one made more recently:

```
a blown up, purple mouse.  She has a weel on her butt.
```
[November 1995]

```
A little baby tulip. She is Red and very cute. She has blue eyes and
a small mouth. She is the cutest tulip you've ever seen.
```
[September 1996]

The earlier description conveys a sense of being small, unattractive, and trapped. (How would a mouse get around with a wheel stuck to its behind?)[4] The more recent description in contrast is attractive and confident. She's still small, but she's proud of being small, and feels good about herself. Describing a fictional persona provides people with an unusual opportunity to express how they feel about themselves, and potentially to reflect on that expression.

1.3.3 Places

The virtual world of MUDs is structured into different "rooms." When you "say" something, it is heard by others in the same room. If I type:

```
--> say hi
```

I see:

```
You say, 'hi'
```

[4]In November 1996, I asked Mouse to describe her very first MOOSE Crossing description (written a year before), and she remembered it clearly. Asked why she chose that particular description, she laughed and said she had *no* idea. She said she had imagined the wheel not as being something the mouse could ride on but as something just stuck there. It was not the sort of wheel a mouse runs on, but a regular wheel.

Everyone else in the room sees:

```
Amy says, ‘hi’
```

You can also “emote” to take actions. If I type:

```
--> emote laughs
```

Everyone in the room (including me) sees:

```
Amy laughs
```

If you want to talk to someone not in the same room, you can “page” them. Hermes began his conversation with Miranda in Section 1.1 by paging her asking if it was OK for him to come over. It’s considered good manners to page someone before barging into their room.

Places provide contexts for social interaction. On MediaMOO (see Section 1.4), people behave differently if they are in my office than if they are in a café or the ballroom. On MOOSE Crossing, kids behave differently if they are swimming at Miranda’s Paradise Island or Jack’s swimming pool than if they are standing in the library. Here’s a transcript of Rufus and Hermes going for a swim in Jack’s pool. Jack is a thirteen-year-old boy who is not connected at the time of this log, but his pool is still there for others to enjoy. Jack has programmed the pool so that you can do lots of things there including dive, surface, splash someone, dunk someone, and swim laps. Rufus drives Hermes there in Sparky II, his bus with homes in the back:

```
Rufus says, 'We are here!!'
Rufus says, 'Just type exit.'
```

As they each get out of the bus, they see:

```
You are in a nice pool,  with clear blue water.  YOu can set the
tempiture of the pool, and you can dive and swim under water.  You
can also dunk peoples, splash, lap, check underwater, talk
underwater, and surface from underwater!
You see fluffey and Sparky II here.
Austina [*sleeping*], Alexander [*sleeping*], and Jack [*sleeping*]
are here.
```

Hermes changes into his dolphin personality, Flipper. Rufus says, 'Watch this!' and types “dive.” Jack’s dive program prompts him “Describe your dive. Put it in the form of an emote,” and then asks him for the name of the dive. It puts these two things together and prints the performance of the dive to everyone in the room:

```
Rufus climbs up onto the diveing board and takes the form of a
  Rufusflop.  Then, Rufus flips off the board and emote flips into
  the air five and a half times before doing a bellyflop.!
```

Jack's program's instructions are a little confusing—Rufus didn't need to proceed his description of what he does with the word "emote." Hermes/Flipper types "splash Rufus," but Jack's program tells him "you can't splash someone who is below the surface of the water..." Jack's pool keeps track of who is underwater, at the surface of the water, and by the side of the pool. Rufus types "surface" and they both see, "Rufus comes back out of the water!" Flipper tries "splash Rufus" again, and this time it works:

```
Flipper splashs Rufus!  Rufus is all wet!
Rufus says, 'How was it?'
Rufus says, 'Hey!'
```

Rufus types, "dunk Flipper" in revenge for being splashed. They see:

```
Rufus dunks Flipper!  Flipper comes up sputtering!
Flipper says, 'a 10'
Rufus says, 'Thanks. Go ahead and try it!'
Flipper says, 'ok'
```

Rufus looks at Flipper. He sees:

```
An 8 foot long bottle nosed dolphin with a mischievous grin. He sees
you looking at him and splashes you with his powerful tail. You are
thoroughly drenched!!! Flipper winks at you and then dries you off
with a mighty blast of air from his blowhole.
He is awake and looks alert.
Flipper is wearing a moose-crossing uniform.
```

Flipper types "dive" and describes his dive to Jack's program. They see:

```
Flipper climbs up onto the diveing board and takes the form of a
   tripl tail dance.  Then, Flipper flips off the board and :erupts
   from the water and does a tail dance 3 times!
Rufus says, 'WOW!! A 25'
```

MUDs are more than chat rooms. The metaphor of being at a pool gives Rufus and Hermes/Flipper a context for creative play. The pool is a project completed by another child, Jack. Many children have told Jack how much they like his pool, and this provides him with positive reinforcement. The MOOSE programs that make up Jack's pool are available for the other children to use as coding examples. Furthermore, the simple knowledge that a peer made something like the pool can help inspire other children to attempt significant projects of their own.

1.3.4 Objects

In addition to people and places, MUDs are filled with objects. On MOOSE Crossing, the most popular kind of object are pets. It's possible to make pets follow you through the virtual world. Most members have at least one pet following them, and some have several. For example, Cindy (girl, age 10) was initially followed by quite a noisy menagerie. Here are the messages generated by her arrival in a room:

```
Hoover waddles in, following after you.
Kanga arrives, following after you.
Sandy arrives, following after you.
Peggy arrives, following after you.
Sandy sniffs Peggy curiously.
Peggy says, 'HiKanga'
Peggy says, 'HiSandy'
Peggy says, 'GreetingsHoover'
```

Cindy would later leave some of her pets in her home, but for a month after she made them she had them all follow her. MOOSE (and the MOO software on which it is based) are "object-oriented" (see Chapter 3). Hoover is a penguin. Cindy made this by making an object which inherits from generic penguin, a program that Rachael wrote. It immediately had all the abilities Rachael designed for it, including reacting differently to six kinds of food and automatically keeping track of how hungry it is based on how long it's been since it last ate. Later, Cindy would add six new programs to Hoover, making it possible for her to kiss it, hug it, dress it up, make it greet people, and make it eat additional kinds of food. Examining any object gives you a list of commands that work with that object, so you don't need to guess. One of the scripts Rachael wrote on generic penguin lets you feed it shrimp. Here's an example:

```
--> feed Hoover shrimp
You can't feed Hoover shrimp today because Hoover is on a diet.

--> diet Hoover
Hoover is no longer on a diet!!!

--> feed Hoover shrimp
You feed Hoover a ton of shrimp!
Hoover gobbles the shrimp down in seconds.
```

Here is what five of the programs Cindy added to Hoover do:

```
--> hug Hoover
Hoover snuggles into your arms

--> kiss Hoover
Hoover kisses your nose tenderly

--> feed Hoover green eggs
```

```
Hoover jumps a few feet in the air flapping his wings franticly, then
   he calms down by bowing politely to you

--> undress Hoover
Hoover blushes bright red.

--> hi Hoover
Hoover bows shyly, and then tries to hide in Cindy's pants
```

Kanga is a kangaroo. Cindy started making Kanga by doing a tutorial which helps you to make a dog and changing it to be more kangaroo-like. She then added several new abilities not in the tutorial, including making it ticklish, and making it eat daisies. Peggy is a pet pig that Cindy bought at Byron's Pet Shop. When you buy a pig, Byron's storekeeper will make you an object which inherits from his generic greeting creature object. Greeting creatures say hello to every object which comes into the room. As Cindy wanders around the world, Peggy says hello to Cindy's other pets as they arrive in the room, following Cindy! After she bought Peggy, Cindy added five new programs to her. She decided that Peggy wasn't really a pig but a piggy bank, and wrote a program to let you feed Peggy pennies. Cindy made Sandy by making an object which inherits from generic smart dog, a program that I wrote. She then added seven new programs to Sandy to make it do other dog-like things. The programs on the parent object make Sandy sniff new things that come into the room. Sandy sniffs Peggy in the transcript above because Peggy arrived in the room after Sandy did.

Objects can serve a variety of functions. They can perform useful functions like the research directory on MediaMOO, or the object transfer station on many MOOs and on MOOSE Crossing which lets you change who owns an object. They can also be conversation starters. In real life, one doesn't normally talk to strangers on the street. However, there is an unwritten rule in many cultures that it's acceptable to begin talking to a stranger who has a dog. Admiring the dog and asking questions about it opens the door to conversation on other topics. The same happens in the virtual world with virtual dogs, and other kinds of objects.

Making objects gives individuals opportunities for creative expression. The ways in which making things together helps to strengthen a community are discussed in detail in Chapter 6, "Constructionist Culture." Finally, objects can be as much an expression of self as personas. Arjun Appadurai writes about how much you can tell about a family by the objects in their home (Appadurai 1986). The same is true in the virtual world. You can tell a lot about a person by the things they chose to buy in the real world, and even more by the things they chose to make in the virtual world. Creating objects provides opportunities for self expression, creative play, and learning through design.

1.4 Prior Work: MediaMOO

MOOSE Crossing is the second virtual community I have designed/founded. The first, MediaMOO, is a MUD designed to be a professional community for media researchers. MediaMOO opened to the public in January 1993, and as of October 1996 had 1000 members from 35 countries. From the start, MediaMOO was intended as a kind of rehearsal for MOOSE Crossing. It was my first experience applying constructionist ideas to the design of a virtual community. Throughout this thesis, I will occasionally refer to MediaMOO and design principles learned through the MediaMOO project. I will very briefly introduce that project in this section.

Most MUDs are populated by random collections of people with little in common. As a result, the conversation often sinks down to the least common denominator of discourse. On MediaMOO, I decided to see what would happen if I brought together a community of people with shared interests—in this case, the design of new media technologies. To become a member of MediaMOO, you must be doing some sort of "media research." In evaluating applications, I try to be loose on the definition of media and more strict about the definition of research. Everyone on MediaMOO "wears" a description of his or her research interests, and is identified by his or her real name and email address. It's rather like an endless reception for a conference on media studies.

In the initial design of MediaMOO, I tried to maximize opportunities for individuals to extend the virtual world. On most MUDs, you must ask to be allowed to program new objects. On MediaMOO, everyone automatically has that privilege. I constructed very little of the virtual world, but instead tried to maximize opportunities for people to build their own spaces. The world that has emerged reflects the rich diversity of its inhabitants. A more detailed discussion of MediaMOO appears in "The MediaMOO Project: Constructionism and Professional Community" (Bruckman and Resnick 1995).

1.5 The MOOSE Crossing Project

The MOOSE Crossing Project has three major components: the development of new technologies, the use of that technology with children (including a weekly after-school program at the Media Lab), and the analysis of the children's activities and learning.

- **Tools**

If kids are to work on significant projects in a MUD, they need access to quality tools designed specifically for their needs. The MOOSE Crossing project began with the realization that they would need both a new programming language and a new client interface. Work on the design and

development of the MacMOOSE client began in September 1992. Work on the MOOSE language began in September 1993. Previous MUD languages were designed for adults; MOOSE is the first to be designed explicitly for children. The client and language were first used by children in October 1995. Chapter 3, "Designing Enabling Technologies: The MOOSE Language and the MacMOOSE Client," describes the design of these new technologies in detail.

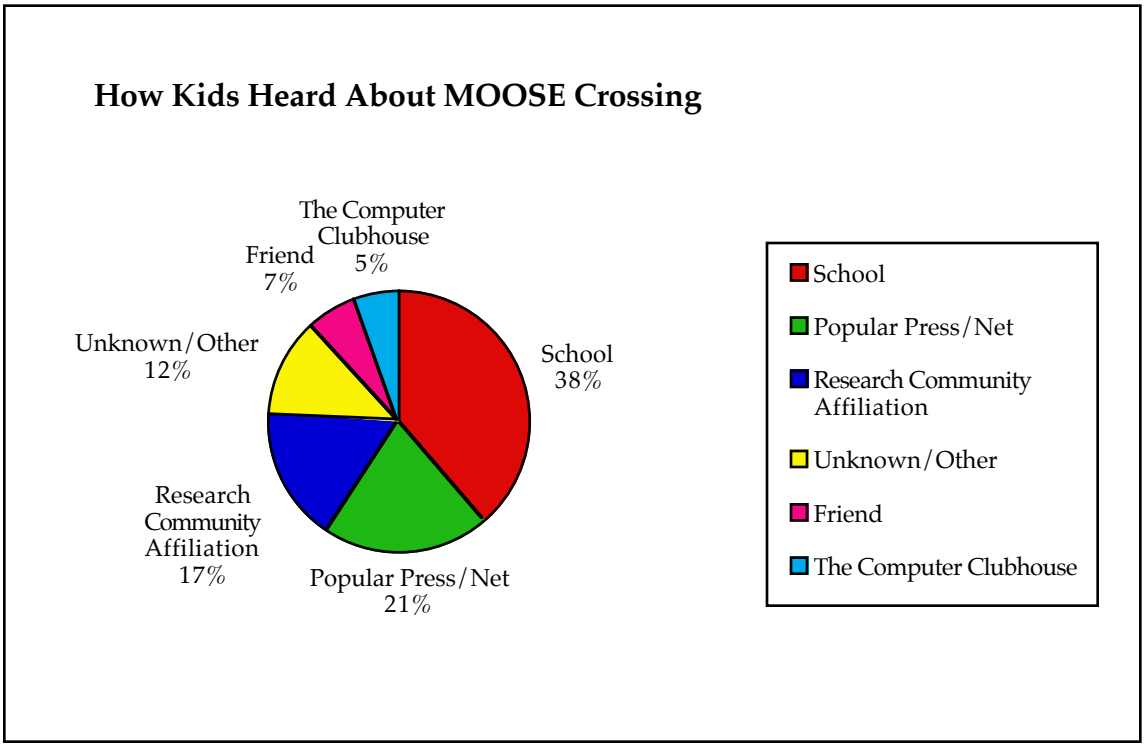

Figure 1.1: How Kids Heard About MOOSE Crossing

- **Use By Kids**

MOOSE Crossing is used by children from home, in after-school programs, and as part of regular school activities. From October 1995 through February 1997, a group of approximately six children came to The Media Lab once per week to participate in a regular MOOSE Crossing after-school program. The main purpose of the program was to give me the opportunity to study a group of children using MOOSE Crossing closely. Exact membership in the group changed occasionally (particularly over the summer), but remained largely the same over the course of the year. Each session lasted approximately two hours. While we originally intended for MOOSE Crossing to be used by kids nine years of age and older, several as young as seven have participated successfully. As of March 1997, over 160 children had participated. While home users form the largest group, the fastest-growing group is children using MOOSE Crossing from in-school programs. Figure 1.1 shows how kids heard about MOOSE Crossing, and Figure 1.2 shows where

they connect to MOOSE Crossing from. This data is compiled from the questionnaire participants complete on registering. Some children start off participating from school or an after-school program and add additional home access later. The data in Figure 1.2 represents their initial answer to the question "From where do you plan to connect to MOOSE Crossing? (home, school, community center, friend's house, or something else)."

The population is more gender-balanced than many other communities on the Internet. Boys make up 56% of the population, and girls are 43%. See Section 7.1.3 for more on gender issues.

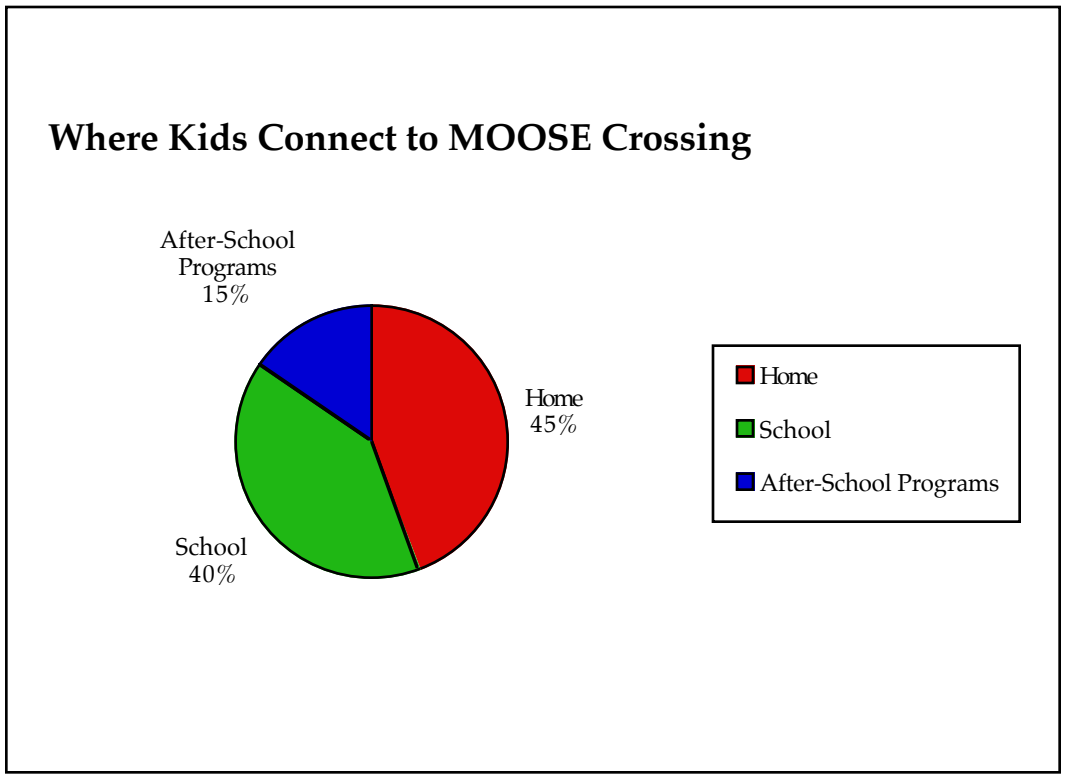

Figure 1.2: Where Kids Connect to MOOSE Crossing

- **Analysis of Children's Activities and Learning**

The after-school program at the Media Lab gave me the opportunity to get to know the children and follow their progress closely, using an ethnographic methodology. After each session, I took detailed field notes. I also interviewed them periodically on video, using a clinical interview style.

Everything typed on MOOSE Crossing is recorded, with written informed consent from the parents and children. This has given me an opportunity to study individual children's learning experiences in detail. The total amount of data recorded is staggering—over 700 Mb as of March, 1997. It's impossible

for one person to review even a small fraction of it; however, it is possible to study selected individuals, places, or objects in great detail.

Recording this data is somewhat of an invasion of the children's privacy. Privacy rights are an issue I'm concerned about (and volunteer some of my spare time lobbying for), and this was not a decision I took lightly. However, after giving the issue serious consideration, I decided that the benefits outweighed the problems. MIT's Committee on the Use of Humans as Experimental Subjects (COUHES) subjected the plans for MOOSE Crossing to careful review before approval. Every MOOSE Crossing member signs a permission/code of conduct form on paper and mails or faxes it to MIT before they are allowed to participate. Minors must also have their parents sign a parental permission form. These forms explain what data is being recorded and why. The formal nature of this process makes me feel more comfortable that the consent being obtained is informed consent—members didn't just click "OK" to a screen of fine print, but signed a statement on paper that spells things out. Children are unlikely to understand the significance of this fact, but their parents are empowered to make this decision on their behalf. It's unclear to what extent the existence of log files has changed the social atmosphere on MOOSE Crossing.

In writing about the children's experiences, I chose to change their character names and names of some of their objects and pets. Some people believe that since MUD names are already pseudonyms, no further disguise is necessary. I disagree. People invest a great deal in their virtual identities. Even if those are not directly traceable to their real identities, the virtual persona itself merits protection. Unfortunately, in a community as small as MOOSE Crossing, it's impossible to disguise individuals in such a way that insiders won't recognize them. Many researchers give their subjects added protection by hiding the community name, but that was clearly not possible in this case. As a result, since the subjects might be identified by some readers, I have edited out unnecessary details in a few unusual places where I am concerned those details might embarrass the child in question. For example, information about a particular child's difficulties getting along with his or her parents or siblings might indirectly shed some light on that child's learning experiences; however, that information is not essential. The focus of this work—on learning, construction activities, and community—has made it possible to eliminate such details without damaging the intellectual integrity of the thesis. A more sensitive topic (such as the work I did with Sherry Turkle on conceptions of the self in MUDs) would be impossible to study in this situation and still protect the subjects adequately.

1.6 Outline

This thesis is divided into seven chapters. It was designed to be readable in any order; consequently, some basic facts are repeated in multiple places. This

first chapter serves as an introduction to the project and the motivations behind it. Chapter 2, "The Day After Net Day: Educational Approaches to Using the Net" reviews educational approaches to using the Internet. Applications which focus on using the net to deliver, retrieve, or share information are separated from those which see the network as a place to create a "technological samba school." Chapter 3, "Designing Enabling Technologies: The MOOSE Language and the MacMOOSE Client," introduces the new technologies designed as part of this project, and examines the ideas underlying their design. Chapter 4, "Collaborative Learning Strategies: Storm's Weekend with Rachael," is a "thick description" (Geertz 1973) of a weekend on which one twelve-year-old girl taught another twelve-year-old girl how to program. It analyzes the learning strategies children typically use on MOOSE Crossing. Chapter 5, "Community Support for Construction," examines in detail the ways that the community motivates and supports individual children's learning experiences. Chapter 6, "Constructionist Culture," examines the converse—the ways in which building things together helps to create a particularly felicitous kind of community. Chapter 7 presents a number of open questions for further research, and then examines what conclusions can be drawn from this work about construction, community, computers, and learning. The Appendix lists all the programs and descriptions of six randomly-selected children who participated in MOOSE Crossing in a variety of settings.