Technical
Report
Series

CENTER FOR TECHNOLOGY IN EDUCATION

Technical Report No. 17

Girls and Design: Exploring the Question of Technological Imagination

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August 1991

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Introduction

The research presented here began several years ago when a group of us at Bank Street's Center for Children and Technology set out to investigate a range of issues around gender and technology. As part of that research, we speculated that the activity of *design* was a promising way to support alternative pathways for girls into the world of technology (Brunner, Hawkins, & Honey, 1988). The developmental and educational psychology literatures offer robust evidence that a richer understanding of a task is developed when children actively construct their own knowledge (Dewey, 1933; Piaget, 1972). In his book, *Knowledge as Design*, David Perkins (1986) suggests that the act of designing facilitates the constructive and creative use of knowledge by the designer. The work that Seymour Papert and his colleagues at M.I.T. have undertaken on LEGO/Logo indicates that design is a powerful way to engage learners in making deep "cognitive connections with the mathematical and scientific concepts that underlie the domain in which they are designing" (Resnick & Ocko, 1990, p. 122). The LEGO/Logo researchers also found that, as an activity, design has the added benefit of helping students acquire a rich sense of achievement and purpose. At the start of our research, we hypothesized that through the activity of design, "it may be possible to develop situations in which technology comes alive for girls, where they are invited to engage in a new kind of conversation with materials and ideas in constructing artifacts" (Brunner, Hawkins, & Honey, 1988, p. 11).

Our gender research also began with certain suppositions about the nature of technology. In our view, there are specific discursive practices that have grown up around technology that need to be unpacked if we are to understand the social and psychological dimensions of engaging with technological objects. For example, there is a world of culturally produced meaning associated with technology. A recent article by Paul Edwards (1990) makes the point that "computer work is more than just a job. It is a major cultural practice, a large scale social form that has created and reinforced modes of thinking, systems of interaction,

The research and development work for the Imagine *project was originally funded by the Spencer Foundation (Women and Technology: A New Basis for Understanding). The research for this study was supported by the Center for Technology in Education under Grant No. 1-135562167-A1 from the Office of Educational Research and Improvement, U.S. Department of Education. This paper appeared in* Transformations, *2(2), Fall 1991.*

and ideologies of social control" (p. 102). There are also psychological meanings that we, as users, bring to the technology. For example, a common fantasy shared by women is that when something goes wrong with a technological device, it will blow up. These two meaning domains do not, however, exist independently of each other, and there are numerous ways in which personal fantasies or desires mesh with culturally produced meanings. Sherry Turkle's (1984, 1988, 1990) work has shown us that, in many respects, the cultural apparatus that surrounds technology is sustained by the ways in which gender operates as a social and psychological phenomenon. Her notion of "computational reticence" documents exactly this phenomenon—women are reluctant to engage with computers because, for a variety of complex social and psychological reasons, they experience this technology as threatening (1988, p. 42).

Background Research

With this perspective in mind, we collected baseline information that would help us to elaborate our hypothesis about design (Hawkins et al., 1990). We devised a paper-and-pencil projective task in which men and women and boys and girls were asked to imagine futuristic technological devices. Our purpose was to explore the symbolic aspects of technology by asking individuals to elaborate on their less-than-conscious associations to technology. Specifically, the adults were asked to write a reply to the following scenario: *If you were writing a science fiction story in which the perfect instrument (a future version of your own) is described, what would it be like?* The task was modified slightly for the adolescents, and read as follows: *If you were writing a science fiction story about the perfect school computer (a fabulous machine), what would it be like*?

The sample for these studies consisted of 24 adult technology experts (13 women and 11 men) and 80 early adolescents (41 girls and 39 boys) who were not particularly sophisticated about technology. While we found evidence suggesting an overlap between the genders, there was a definite and characteristic difference in the way adult men and women in our sample fantasized about the relationship between humans and machines (Brunner et al., 1990). Women commonly saw technological instruments as people connectors, communication, and collaboration devices. Their technological fantasies were often embedded in human relationships, and they served to integrate their public and private lives. For example, one woman, an industrial engineer, described a futuristic instrument in the following terms:

> The "keyboard" would be the size of a medallion, formed into a beautiful piece of platinum sculptured jewelry, worn around one's neck. The medallion could be purchased in many shapes and sizes. The keyed input would operate all day-to-day necessities to communicate and transport people (including replacements to today's automobile). The fiber optic network that linked operations would have no dangerous side effect or by-product that harmed people or the environment.

The men, in contrast, tended to envision technology as extensions of their power over the physical universe. Their fantasies were often about absolute control, tremendous speed, and unlimited knowledge. Consider this fantasy, written by a male computer scientist:

> A direct brain-to-machine link. Plug it into the socket in the back of your head and you can begin communications with it. All information from other users is available, and all of the history of mankind is also available. By selecting any time period, the computer can impress directly on the user's brain images and background information for that time. In essence, a time-machine. The user would not be able to discern the difference between dreams and reality and information placed there by the machine. (Perhaps this is all a nightmare.)

The results of our studies with adolescents were congruent with the results of the adult subjects (Brunner et al., 1990). The difference in technological imagination points in the same direction as the adult fantasy material. Girls' technological fantasies tended to be more about household helpers, contact bringers, machines that offer companionship, or devices with which they could broaden their social and personal networks. On the other hand, boys fantasized about extensions of instrumental power, often thinking up tools that could make other technological objects overpower natural constraints.

These differences between boys and girls were more concretely evident in another task in which we had another group of early adolescents blueprint designs of fantasy machines (Brunner et al., 1990). The boys often illustrated fantastic cars or vehicles for flight that ventured through rocky terrain or adventuresome landscapes propelled by powerful devices, such as rocket boosters and turbo jets. Some went as far as describing the voltage of the batteries or motors that their inventions included. The girls generally illustrated robots and devices with human-like qualities (e.g., smiles, eyes) that could help with everyday chores, and they tended to embed their inventions in social or real-life contexts, such as hospitals, bedrooms, or shopping malls. They were less concerned with describing the internal mechanical parts of their machines. Instead they often chose to include luxury features, such as sensory devices (which one girl named "synergistic relaxation") or external buttons and switches that would magically operate their inventions.

We gather from this that girls think about technology, when invited to do so, as embedded in and facilitating human interaction. Clearly, such an attitude toward technology should be encouraged and valued. However, if we consider the cultural and social discourse in which technology is embedded, the obstacles girls may face in having their fantasies realized become apparent. Margaret Lowe Benston (1988) suggests that

> part of the technical world view is the belief in one's right to control the material world. Part of successful socialization as a man in our society involves gathering confidence in one's actual *ability* to exercise that control. (p. 20)

The male fantasy material in our studies reflects exactly this phenomenon. In addition, the kinds of design features that girls want to build into their machines are not necessarily accorded the same privileged status as the features of power, speed, and efficiency that boys emphasize. As the writings of Cheris Kramarae (1988) and Cynthia Cockburn (1988) suggest, women's desire for communication, collaboration, and integration are not central to the masculine technological world view, which is increasingly accepted as the only legitimate model for discussing, developing, and evaluating technology.

Finally, there is a great deal of evidence that confirms the fact that gender-specific social expectations play a role in limiting girls' capacity to be creators, shapers, and producers of technology (Berner, 1984; Carter & Kirkup, 1990; Cockburn, 1988; Kramarae, 1988; Kramer & Lehman, 1990; Lewis, 1987; Weinberg, 1987). From a very early age, boys are expected and encouraged to learn about machines, tools, and how things work, and are given many opportunities to dismantle technological objects and toys. Girls, in contrast, are not expected to know about technical matters, and are often encouraged to be merely consumers and users of the technology.

The Design Tool

Our preliminary investigation into the question of girls and design led us to develop a computer-based design tool that enables girls to create machines by starting from their own imaginative vantage points. *Imagine* is intended to function as a legitimating environment in which girls are encouraged to think of themselves as designers and inventors of machines, without the traditional bottleneck imposed by math and science. *Imagine* is a graphics program that contains basic draw and paint tools as well as animation capabilities. After designing and drawing an object of their own, students can animate it by using a series of link procedures that are analogous to flip animation or the kind used in animated films. Sound and visual effects, such as a fade or black swipe across the screen, can be added to this type of animation. In addition, students can label the individual components of their machines and describe in as much detail as they wish what each component does and how it works.

The Research Context

To test the use and effectiveness of this program for encouraging girls' technological imaginations, an elective course in design based on *Imagine* was offered in an alternative junior high school in New York City.[1] The goal of the pilot research was to conduct a small-scale, qualitative investigation into the ways in which girls used *Imagine* in the context of a supportive but relatively unstructured classroom environment. In other words, we wanted to gather baseline information on how girls would make use of *Imagine* without the aid of a directive curriculum.

Six girls (five seventh graders and one eighth grader) met with the instructor once a week for an hour and twenty minutes. Because all of the girls were novice Macintosh users, the first two classes were devoted to an introduction to the computer. The girls learned such basics as using a mouse, the difference between the hard disk and a floppy disk, and file management. The skills needed to design and animate an object using Imag*ine* were taught in the following order: draw tools, paint tools, animation, and labeling. Each session was organized so that the first 20 or 30 minutes were spent learning a new feature of the program, and the remaining time was spent working on projects. Once all of the important features of *Imagine* were introduced, students spent the entire period working on their projects, while the instructor traveled from student to student offering assistance where it was needed. The instructor spoke regularly with each student and encouraged her to articulate what she was working on and what she wanted to accomplish during the class.

Because we are ultimately interested in developing a more directive curriculum that will encourage girls to proceed from their own interpretive vantage points *and* think systematically about the mechanisms that make machines work, we analyzed students' inventions for the following information: (1) the kinds of machines they designed; (2) the range of functions they had their machines perform; and (3) the extent to which they posited a universal operating mechanism, and the extent to which they posited individual operating mechanisms for each discrete function through the use of *Imagine's* labeling capabilities.

Findings

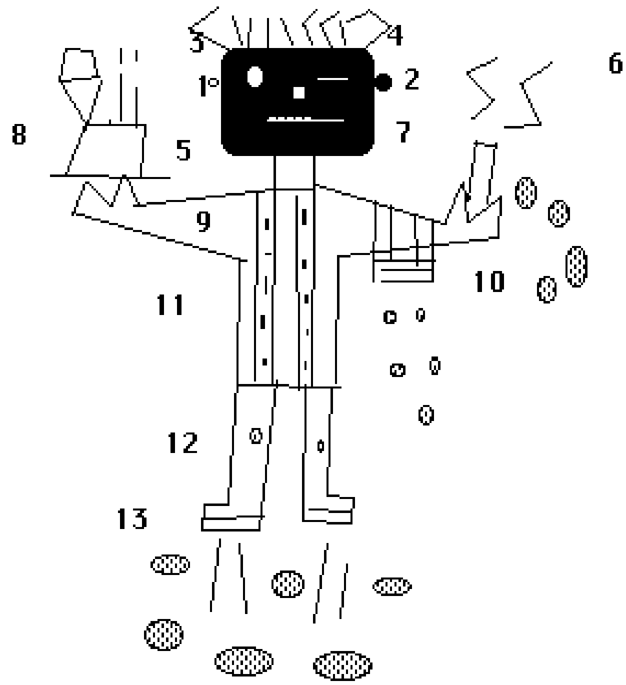
Of the six girls who took the elective, four became deeply involved in designing highly imaginative devices. The remaining two girls had less success using this environment for reasons that we will speculate about below. The nature of the imagining that girls did in this context was similar in many ways to the kind of imagining we found in our background research. The machines they designed often featured human-like qualities or emphasized solutions to real-life dilemmas. Three of the girls made extensive use of *Imagine's* labeling capabilities. However, they tended to vary in terms of whether they specified a mechanism or set of mechanisms that made their devices work. The projects are briefly described below.

Beth, a seventh grader, designed a robot that was able to anticipate as well as fulfill a variety of human needs, including waking you up, serving breakfast in bed, and telling you the answers to homework problems. Beth's robot consisted of a drawing of a "creature who came from another planet." Figure 1 shows Beth's drawing and label descriptions for her robot.

Although she had a well-developed sense of the overall capabilities of her invention and had her robot performing a wide range of discrete tasks (she used a total of 13 labels to describe how the different parts of the robot functioned), she did not develop an explanation for an integrated mechanism that would enable the tasks to be carried out. For three of the robot's discrete functions, she alluded to biological mechanisms (e.g., brain, legs) and for another function, she made reference to a quasi-mechanical clip. Even though Beth had her robot performing complex tasks, there was no integrated mechanism that made the robot as a whole able to function. This device appeared to work magically—something like a fantasy caretaker who knows what you want even before the need has arisen.

Another student, Jessy, designed an improved subway car that made less noise, was more beautiful, had larger windows and a sunroof, more room to sit, and contained sensors for anything that could harm the subway or anybody in it. The project consisted of a relatively elaborate drawing and seven labels describing the improvements she envisioned. Figure 2 shows Jessy's drawing and label descriptions for her subway car.

Jessy differed from Beth insofar as she began to speculate about the mechanisms that allowed for certain improvements to be realized. She borrowed from the world of computer technology and defined information-based mechanisms that made these parts work. For example, she described a window-washer that performed its function at midnight because it had been programmed to do so, and she described the door of the train as having extra sensitive microchips that could detect graffiti, guns, knives, and other harmful weapons. Jessy, thus, appeared to be leaning in the direction of thinking about the mechanism that allowed a device to carry out its task.



1: This is one half of the robot's brain. It sends messages to the robot and the robot will understand everything you say!

2: This is the other half of its brain. It knows when you want something to eat, drink, or just to rest or go to sleep, so it can tell you a bedtime story.

3: This helps the robot see where it's going, just like a human.

4: This also helps it see where it's going.

5: This helps the robot sense where.

6: This is a piece of soap they used in the robot's land before he landed on Earth. It's excellent for your face and wakes you up even more.

7: This is the mouth. It helps the robot to talk just like humans do. It also helps you if you want to watch a movie. You tell it which movie you want and it comes out of its mouth. The best part of all is that it tells you the answers to your homework if you need help.

8: This is a tray full of food for breakfast. It's brought to my bed every morning.

9: This is an arm that clips on to things. Every morning it picks me up by my shirt and carries me into the bathroom.

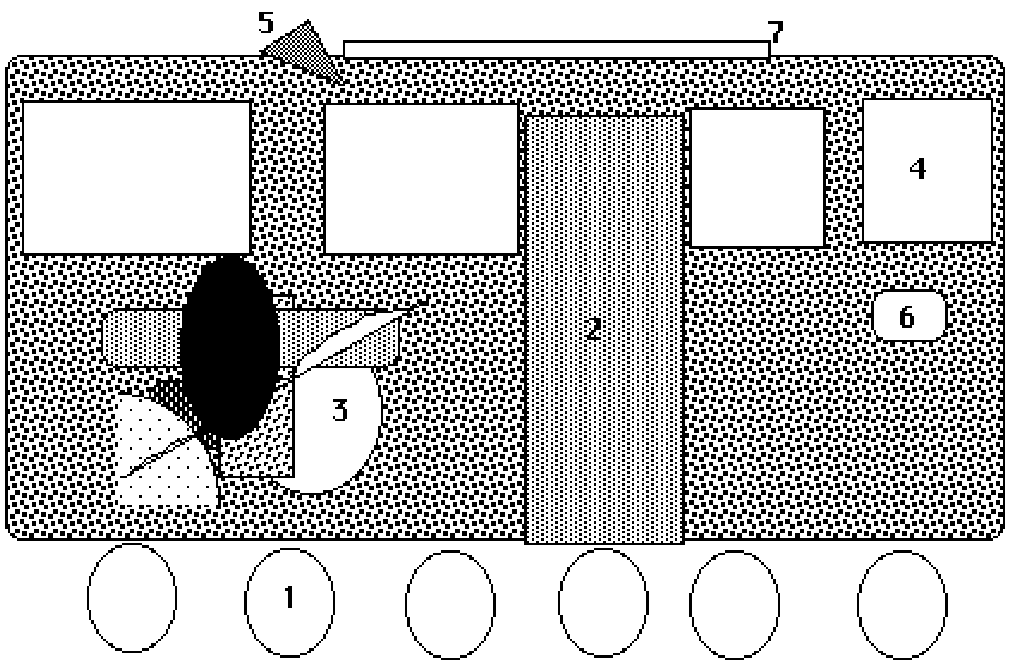
10: This is the towel that wakes me up every morning -- but when it wakes me up, it's freezing cold!!!!

11: These are his suspenders from his old planet. They control all of his actions and sayings. Almost everything he does revolves around his suspenders.

12: These are his legs. They help him walk. The little buttons in the middle help all of his legs' actions.

13: These are pumps. They help him jump to all my needs.

Figure 1. Beth’s robot and label descriptions.



1: These are the new wheels for the improved train. New and improved, it doesn't make a screeching sound when it puts on the brakes. It also doesn't send sparks flying when the train stops.

2: This is the door of the train. It has extra sensitive microchips that can sense graffiti cans, guns, knives, and any other weapon or object that can hurt the train or any person or thing on the train.

3: Are you tired of the old, boring, plain trains? Well, this piece of "art" makes the train nice to look at. Each and every train has an abstract painting on each side. These pieces of art have bright colors, and for once, you'll be riding in a train that looks good and NOT a train that looks like it had been through the city dump.

4: With the new and improved trains, you can finally have sunshine and fresh air. We have put in more windows than ever. Now, on the trains that run above ground, you can see out and love the scenery you never saw before. On the trains that run under ground, unfortunately, there is no such things as "beautiful scenery" but you can get fresh air and in the summers you won't have to suffocate. Windows are always needed.

5: With all these windows, how can a bird stop from doing its thing? This is the window washer that cleans not only bird makings, but also dirt and other things that keep the windows crystal clear. It cleans daily because it is programmed to at 12 o'clock midnight.

6: Finally, the body of the train. This is much bigger so everyone can have room to sit and not to stand. The special design has a secret spray on it that makes any dirt that comes near to go away. Its design urges people to come ride on the train. Each train has a different design. Isn't it beautiful?

7: Sun roof. See #4.

Figure 2. Jessy's subway car and label descriptions.

A third student, Pauline, designed an intelligent television that performed such tasks as serving food and answering mother when you really wanted to avoid her. Like the others, she imagined a wide range of different functions (eight altogether) that her machine performed. Figure 3 shows Pauline's drawing and label descriptions for her intelligent television.

Unlike Beth and Jessy, Pauline integrated the different components of her machine by making them responsive to a central processing unit known as the "central intelligence service." In her design, the CIS received and interpreted messages, provided feedback to the user. and was responsive to the different components of the machine. Of the three girls who concentrated on labeling, defining, and describing the functions of their devices, Pauline was the only student to conceptualize an operating mechanism.

Kathy, an eighth grader, was unique in that she was the only student to concentrate exclusively on using the animation component of the program to illustrate her design. She created a self-cleaning bathtub, that featured a rotating brush and a button that released soapy water. Kathy's animation was composed of a series of twelve screens that illustrated the cleaning motion of the brush in the bathtub. Although she successfully showed how her machine functioned, she did not make reference to a mechanism that would underlie the operation of the brush. Figure 4 shows the drawings that Kathy used in her animation sequence.

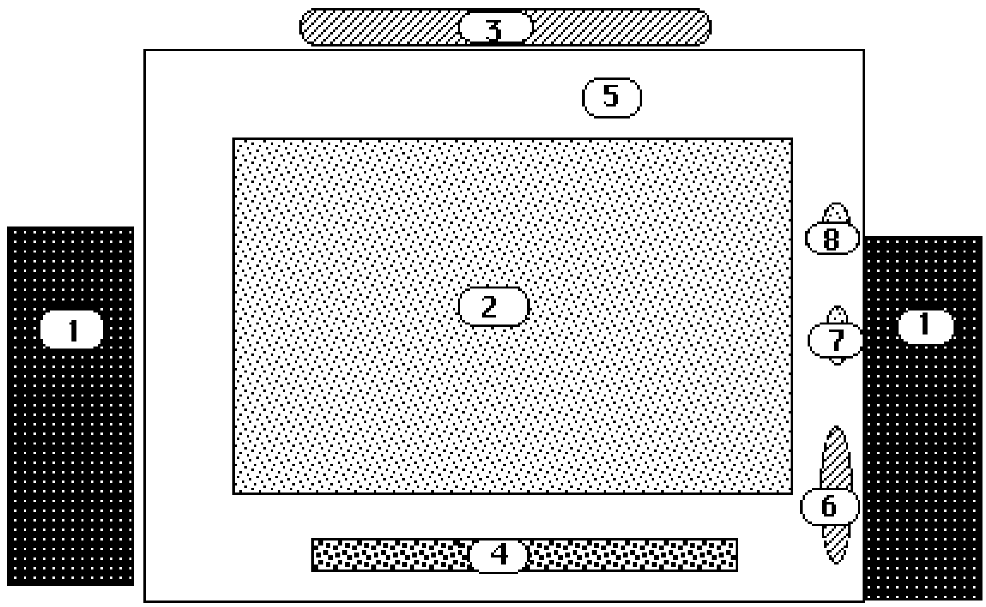
The two girls who had difficulty using the program spent the majority of the course working together as partners. Although they came up with ideas for devices (e.g., a wristwatch that was also a VCR and Nintendo machine, a flying skateboard), they were never satisfied with the drawings they made. They spent class after class drawing and redrawing the object they wanted to design. Undoubtedly, both girls would have benefited from a version of *Imagine* that provided canned shapes and objects.

It was only toward the end of the course, when they began working independently of each other, that they started to make some progress. Hilda designed a flying bed. Her project consisted of a schematic drawing of a bed with pillows, a headboard, and controllers. However, the quality of Hilda's drawing suggested that she was struggling with the use of the tools. She identified five functions that the bed performed, but did not describe any mechanisms that made it work. Figure 5 shows Hilda's drawing and label descriptions for her flying bed.

The other student, Iris, with a great deal of support and guidance from the instructor, began to think through an animation sequence for a pinball machine. However, she was unable to put her plan into operation. Despite her difficulties in using the software, Iris was not discouraged and asked the instructor if she could take the class again the following semester.

Concluding Remarks

There is a growing body of psychological and sociological research which suggests that women and girls do indeed approach, interpret, and understand various facets of life differently from men. For example, Carol Gilligan's (1982) work on women's reasoning suggests that women tend to view the world in terms of interpersonal dynamics, and base their decisions, particularly in the moral realm, on an ethic of care and responsibility toward others. The work of Evelyn Keller (1985) suggests that the ways in which the mainstream scientific community represents its enterprise as an attempt to dominate nature, penetrate its secrets, and wrest knowledge from it runs counter to the ways in which women think about the scientific enterprise. In her work on the life of the molecular biologist Barbara McClintock, Keller found that the vocabulary McClintock used to describe her work was "consistently a vocabulary of affection, of kinship, of empathy" (p. 164). In the technological domain, sociologist Sherry Turkle (1988) has identified two different styles of computing: the *risk-taking style* (mostly male), which is preoccupied with testing the limits of both machine and self through mastery and manipulation of the computer environment, and the *relational style* (mostly female), which is "marked by an artistic, almost tactile style of identification with computational objects, a desire to 'play with them' as though they were physical objects in a collage" (p. 50). Our own research (Hawkins et al., 1990) suggests that gender is an important factor in the interpretation of engineered objects, understanding their symbolic significance, and exercising technological imagination. All of these findings have tremendous implications for creating alternative teaching and learning strategies, that make room for differential patterns of understanding and interpretation employed by women and girls.



1: These are the TV's speakers. If you want an ice cream float, just speak into the speakers and your words will be sent to the TV's central intelligence system. The TV's brain will make sense of your words and carry out your order.

2: This is the TV screen. You watch the screen, and your favorite shows are displayed on the screen and you just enjoy .

3: This is the TV's central intelligence. When you talk to the TV, your words are sent to the CI, and there they are made sense of.

4: This is the TV videotape player. You just pop your tape into the slot and tell the TV to rewind/forward wind or start wherever you want.

5: This is the TV's frame. It doesn't really have a purpose but without it, the TV would look kind of bare. It is supposed to be made of wood.

6: This is the TV push button which you push when you suspect that something is wrong with your TV's central intelligence system.

7: This is the TV's "Shut down button." If you are really sick and tired of your TV's cheerful and bright conversation, just press this button and you will be rid of all the annoyance your TV's CI brings to you.

8: This is the TV's duplicate button. If your mother is calling you and you don't want to answer, just activate the "DB" and (if you have your voice recorded in the CI) the TV will play your voice and it will seem like you are really talking.

Figure 3. Pauline's intelligent television and label descriptions.

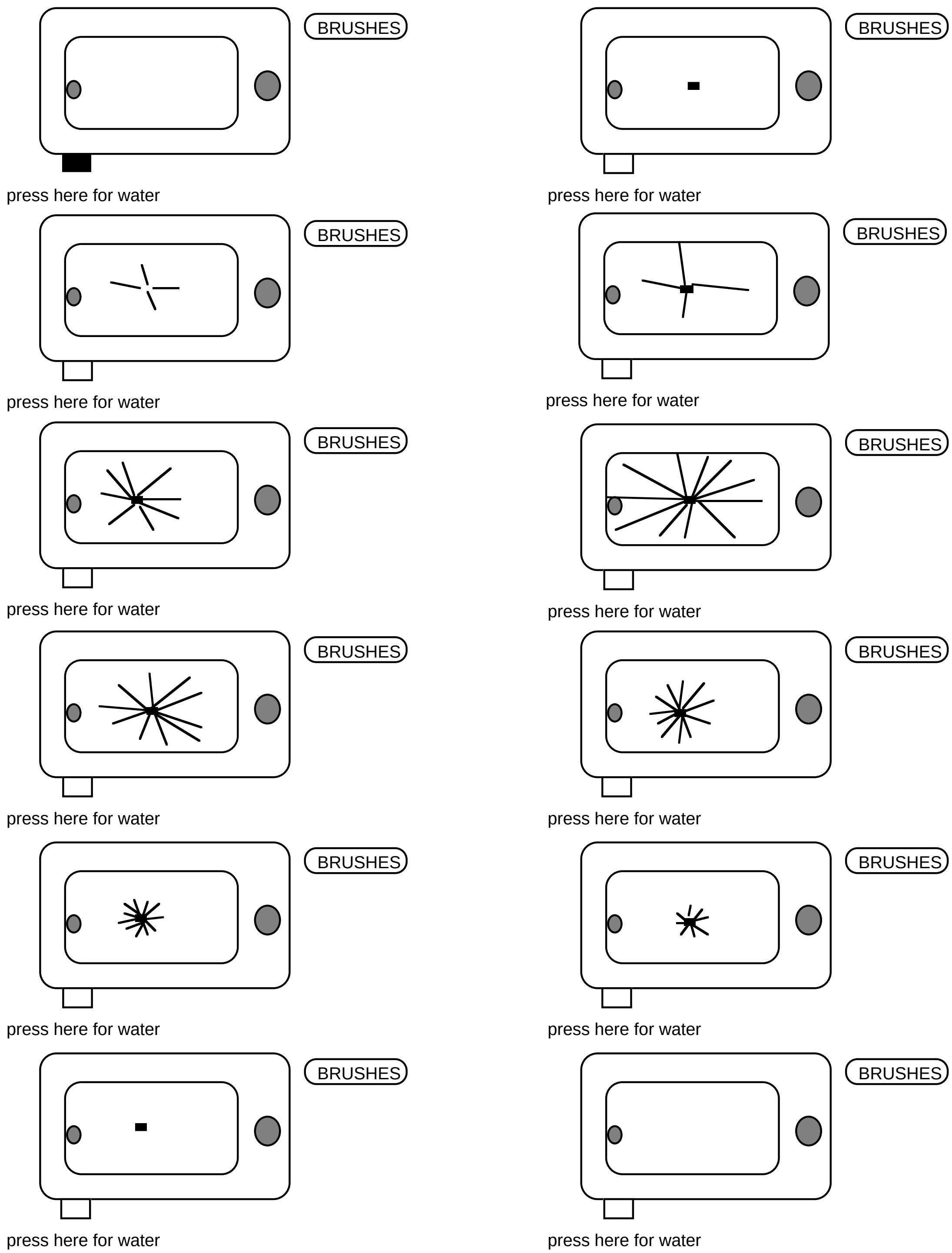
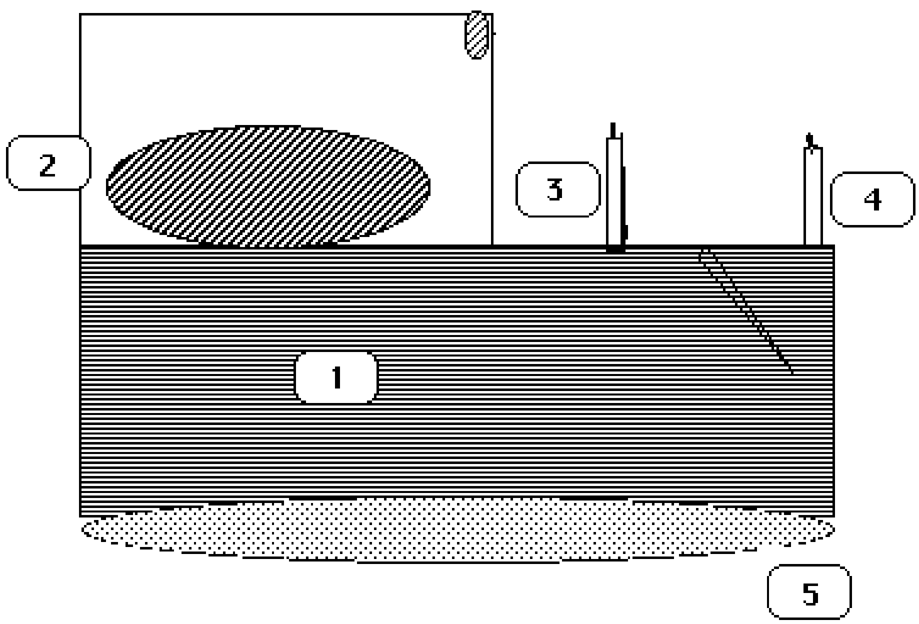


Figure 4. Kathy's animation sequence.

Based on the work that the girls in this study did during the course of a semester, it is clear that *Imagine* is effective in serving as a conceptual space where girls are encouraged to create and elaborate design ideas for technological devices. With minimal encouragement, the majority of these girls were able to develop imaginative devices that performed a range of creative functions. *Imagine* appeared to facilitate a process of mental and graphic tinkering. In the absence of a well-defined and rigorous design curriculum, what *Imagine* appears capable of doing is legitimating the *psychological* experience of thinking of oneself as an inventor. This, in and of itself, is an important first step in legitimating and affirming girls' technological imaginations.



1: Headboard made to protect you while the bed is in motion!!!

2: Pillow for you to rest while you enjoy the moving bed!!!

3: Controllers used to steer the bed.

4: Nick! Nick! Controllers used to control the speed of it!!!

5: Bump......Y! Bounces the bed up and down!!!!!!!! Fun?!!!!!?

Figure 5. Hilda's flying bed and label descriptions.

Notes

1. The students who attend this school are described as alternatively gifted. These are students who do not necessarily score exceptionally well on standardized tests, but are considered to be highly motivated and display a deep interest in one or more area of study. In addition, the school's curriculum is organized around project-based work and inquiry activities.

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