

Pearls of Wisdom:
Technology for Intentional Reflection and Learning
in Constructionist Cooperatives

by

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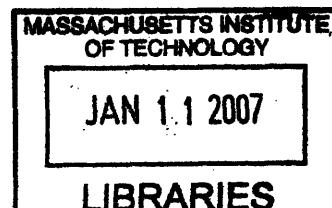
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ABSTRACT

At the core of the constructionist learning paradigm is the idea that people learn through design experiences. However, in most settings, learners rarely revisit their work to reflect on design and learning processes. The practice of reflection is not integrated into regular community practice. That omission results in lost opportunities for deeper learning because reflection plays an important role in knowledge integration. In order to leverage the benefits of constructionist learning, learners must go beyond the activities of construction and reflect on their learning. This involves examining and gaining a deeper understanding of the how and why of their design process, including learning strategies. The conceptual framework of this dissertation, Cooperative Constructionism, establishes a design approach to reflection with a set of tools and methods that support reflection on learning. A Constructionist Cooperative is a community of learners where articulating and sharing of learning experiences is a regular practice. A goal of this dissertation is to explore the computational tools and practices that promote and support such activities. Using these tools, learners construct intentional-reflective artifacts, which embody their reflection on their design and learning experiences.

There were two learning scaffolds developed to promote emergence of a Constructionist Cooperative. The first is a computational scaffold, a software toolkit called Pearls of Wisdom. The software is used to design, edit, and share intentional-reflective artifacts, called Pearls. Pearls are the concrete instantiation of learner reflection on the design and learning process. The second scaffold, called the Reflective Mentor Model, is social in nature. This scaffold promotes a regular practice of intentional reflection within the learning environment by building a mentor community of practice around supporting learner reflection.

A range of empirical studies were conducted, which combined theory and practice to identify connections between grounded theory, existing practices, and the proposed framework. Theory-based indicators were the basis of analysis of the study data. The study site was the Flagship Computer Clubhouse, an after-school technology center for 10- to 18-year-olds, where learners work on design projects of their own interest as part of their learning process. The one-year study explored how learner and mentor intentional-reflection practices promoted growth of a Constructionist Cooperative at the Computer Clubhouse.

Over the course of the study, 78 Pearls were created and 2,764 Pearl pages were viewed. Three treatment groups achieved different levels of reflective practice. All three groups received the Pearls of Wisdom software training. Group 1 mentors conducted regular meetings to reflect on productive strategies for better supporting members in making their Pearls. They became a functioning reflective-mentor team based on the Reflective Mentor Model. Group 1 members produced 74 Pearls (95%) and viewed 2,341 Pearl pages (85%) over the course of the study. Group 2 mentors did not promote Pearl software or practices and held no mentor meetings. Group 2 members produced 0 Pearls (0%) and viewed 58 Pearl pages (2%) over the course of the study. Group 3 mentors promoted Pearls of Wisdom, but did not establish a mentor team. Group 3 members produced 4 Pearls (5%) and viewed 365 Pearl pages (13%).

Members engaged in higher-order thinking when constructing their Pearls and during subsequent Pearl-related discussions. According to member and mentor perspectives, making and using Pearls positively influenced their approach to project design and development by engaging them in more complex learning activities. Pearl creators and users negotiated meaningful roles for Pearls within the Computer Clubhouse community.

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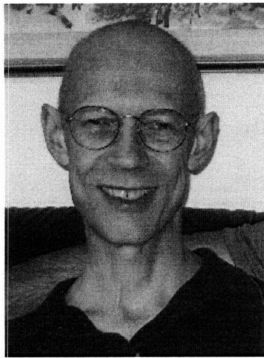
The past and present members of the Lifelong Kindergarten group, my Media Lab Colleagues, Black Graduate Student Association, Academy of Courageous Minority Engineers, and Color Creations.

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If I have forgotten to mention anyone, please know that it is only on paper, but you are in my heart.



Verlina Edwards,
Beloved Sister



Lawren Daltroy,
Dear Friend

*You started this journey with me.
I never imagined reaching my destination without you.
You are deeply loved and sorely missed.*

*In honor of my ancestors who endured much so I could be here.
I fell asleep and dreamed I was in Africa – again.*

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“Baby, all the people in the world are like pearls in a basket.
You need to hold them up to the light to see how they will shine.
You can show somebody how you shine by
telling your story about what you know.”

Mary Ella Pritchett,
Chapman Family Elder

Prologue: Inspirations

I enjoyed an early childhood curiosity in the different ways people went about learning new things. That early interest, and ultimately the name of the Pearls of Wisdom intentional reflection toolkit, was further inspired by my grandma, Mary Ella Pritchett. When I was nine years old, I asked her a question that had vexed me for some time. “*Grandma, why do different people think different and how come I figure out stuff different from everybody else?*” I remember how she chuckled knowingly, “*Baby, all the people in the world are like pearls in a basket. Those pearls may seem the same, but they still all special. You need to hold them up to the light to see how they will shine. People may look the same, but our minds all shine different. You can show somebody how you shine by telling your story about what you know.*” This profound lesson

of the diversity of human mindfulness captivated my nine-year-old imagination. I have never forgotten it. Our conversation solidified what has become a lifelong fascination and relationship with thinking about thinking. My hope is that all learners who participated in this study develop a closer relationship with how they think and learn, how others think and learn, and how we all connect and grow through the sharing of our learning stories.

A second point of inspiration for my research interest grew out of my years of volunteer work at a number of after-school centers. I was constantly amazed at how kids would watch, completely engrossed, as a mentor verbalized their thinking process. I remember one instance, where a group of kids hung onto every word as a volunteer explained her thinking around the debugging of a software program. The kids were bursting with questions, however, not about the software but about the mentor's "thinking choices." Kids want the secret to becoming better thinkers. For them, understanding the "mentor way of thinking" provides a backdrop for them to better differentiate their own learning processes. My volunteer experiences and my grandma's lessons have given me a deeper appreciation of diverse ways of thinking and learning. I want to understand better what young people needed to improve lifelong learning success. That desire, and a lot of hard work, laid the foundation for this research.

"Learning is not separate from reality."
Seymour Papert (1993), *The Children's Machine*

1 The Promise of Intentional Reflection

The constructionism learning paradigm (Papert, 1980; 1993) posits that people learn best through designing, building, and sharing projects based on their own interests. An important part of this process is for learners to reflect on and make sense of their design experiences. However, finding the right balance of reflection within the constructionist paradigm has been problematic. While constructionism has been very successful in promoting learning by design, it has not supported reflection well. As a result, constructionism has not yet lived up to its fullest potential. The challenge is how to strengthen constructionism by

explicitly supporting reflection in a way that does not violate the spirit of the learning model.

Within learning environments, computers and other computational tools offer a platform from which people can make sense of their learning experiences. Engineering computer technologies and learning environments to scaffold reflective aspects of constructionist learning, however, remains a challenge in education and computer science research. This thesis proposes and studies a framework for transforming reflection into a design activity, in which learners design artifacts that represent and support their reflection on their learning. This framework, called Cooperative Constructionism, supports and sustains reflection on learning at the individual and community level. In this framework, a “Constructionist Cooperative” is a community of learners engaging in intentional reflection on their design and learning experiences.

Scaffolding describes the supports that encourage thoughtful engagement in new learning tasks. There is traditionally, however, a tension between the openness of constructionist learning environments and the more structured nature of learning scaffolds. Coherent scaffolds, therefore, must facilitate learners actively participating in and learning about the underlying concepts and processes. A system design challenge, therefore, is how to provide adequate scaffolding while maintaining the integrity of the constructionist activity. In this thesis, I describe the design and use of a computational toolkit for scaffolding reflection on constructionist design activities. I explore the nature of this and other complex learning scaffolds. I describe further development of

constructionism by incorporating intentional reflection into the learning model. Finally, I describe how intentional reflection on design involves the learner in more complex learning activities.

1.1 Designing Minds

Design activities promote various forms of learning by engaging learners in a cycle of designing, evaluating, and redesigning. Through that process they gain understanding of concepts related to achieving their design objectives (Kolodner, 2002; Kafai, 1994; Harel 1991; Perkins, 1986). Design activities tend to be authentic and ill-structured, requiring learners to interact with a variety of materials, tools, and ideas. Also, designing occurs over extended periods of time which gives learners the chance to practice self-regulation of their design activities. In section 1.1.1, learning by design is discussed as grounding for a new design activity for promoting reflection, called reflection by design. In section 1.1.2, reflection by design is introduced with a discussion of its role in facilitating complex learning.

1.1.1 Learning by Design

Seymour Papert's (1983) constructionist learning model states that people learn best through designing and building artifacts of their own interest that they share with others. During the process of designing and building their artifacts learners are employing important learning mechanisms. Learning by design is a core learning activity that involves thinking, doing, and making new connections to what is already known (Kolodner, 2002, Perkins, 1986). Cross (1995; 2001)

argues for a *designerly* way of knowing, which is fueled by the inherent situatedness and authenticity of the design process. Within that context, the designer's attention focuses on the meaning, structure, and construction of their artifact.

Papert and Perkins both agree that learning by design moves the learner through deeper levels of learning. In spite of the fact that reflection is a part of the theory of constructionism, it has rarely been emphasized. There is insufficient support for this critical mode of learning to become fully developed. I argue that reflection must take on a bigger role in constructionist learning, both in theory and in practice. This dissertation addresses that challenge with new theory and associated practices for fostering intentional reflection in constructionist learning environments.

1.1.2 A New Paradigm: Reflection by Design

Reflection provides knowledge integration opportunities for learners; however, without explicit support, most learners don't engage in reflection (Jonassen, 1991; Salomon & Perkins, 1998; Duckworth, 2001). Although constructionist activities afford opportunities for reflection, occurrences mostly are incidental and deeper learning opportunities are lost. These episodes of incidental reflection are transient and generally focus on performance enhancement, for example settling an immediate design issue. Conversely, intentional reflection is a thoughtful, focused reexamination of both positive and negative aspects of the design experience. Intentional reflection attributes

include reasoning about the learning experience and requires planning, organization, and time investment. As with project design, those attributes connect the learner more deeply to their activity.

The prior discussion of learning by design provides a backdrop for my proposal of reflection by design. Earlier, I described learning by design as a dialogue between a learner's design process and the world. Analogously, reflection by design is a dialogue between the learner's reflective processes and the world. This reflective dialogue becomes integrated into the thinking, doing, and knowing inherent in the design activity. Bruner (1996) identifies reflection as more than simply thinking, but additionally as making sense of the learning. He argues that making sense of learning connects learners more deeply with their learning experiences.

Intentional reflection is most effective with appropriate computational and social scaffolds in place to facilitate its regular practice. Bereiter and Scardamalia (1996), in their work of building communities that support critical inquiry, argue for concrete communication as important to critical inquiry. I argue not only for concrete representation of reflection, but construction of specific kinds of representations via design-based activity. The outcome is design-embedded reflection that motivates interactions between the learner, her reflective artifacts, other learners, and the learning environment (Barab, Squire, & Dueber, 2000; Chapman, 2004). Learning by design can be thought of as learning embedded in the design process. Analogously, reflection by design can be thought of as reflection embedded in the design process.

1.2 Cooperative Constructionism: Expanding the Constructionist Learning Space

Cooperative Constructionism represents an expansion of the constructionism learning model. The addition of intentional reflection as a constructionist learning activity deepens the already considerable benefits of constructionist learning. The construction of intentional-reflective artifacts represents an authentic activity situated within the learning environment. This implies the practice of intentional reflection activities must be meaningful to learners and valued within the community. Cooperative Constructionism, with its focus on reflection by design, offers learners the opportunity to deepen their insight into what and how they know, develop more complex relationships with their knowledge, and more clearly articulate their thinking process.

1.2.1 Constructionist Cooperative Scaffolds

The Cooperative Constructionism framework establishes scaffolds necessary for supporting community-wide intentional reflection. Scaffolds, whether computational or social, should promote creative production of ideas, problem solving, debugging, and as importantly, an awareness of these activities.

1.2.1.1 Pearls of Wisdom: A Computational Scaffold for Intentional Reflection

The Pearls of Wisdom software is an intentional reflection toolkit that scaffolds learner construction, sharing, and use of intentional-reflective artifacts,

called Pearls. A Pearl includes the learner's project ideas and motivations, and comments about her learning experiences. It also includes instructions for making the project. The process of designing Pearls affords learners the opportunity to improve their organization and articulation of ideas. Pearl design engages the learner in a process of identifying and revisiting key learning experiences as she considers what she knows, how old ideas link to new, and what and how she should share with others. See Figure 1 for an example of a Pearl. The Pearls of Wisdom toolkit is necessary, but not sufficient, for reflection by design to occur. Also necessary is a mechanism for providing social scaffolds to support development of Constructionist Cooperatives.

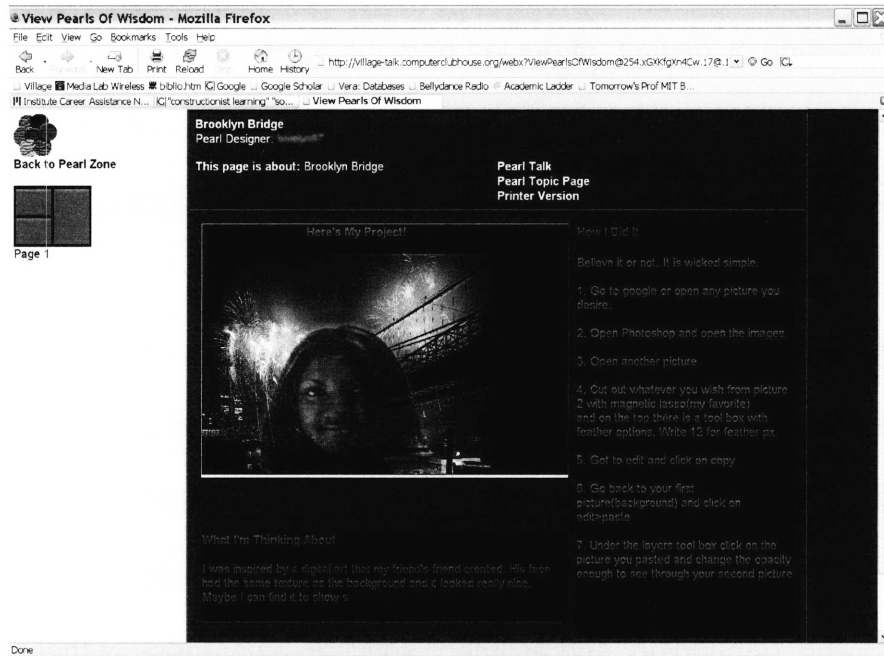


Figure 1. Pearl about an image-layering graphics project.

1.2.1.2 *Reflective Mentor Model: A Social Scaffold for Intentional Reflection*

The Reflective Mentor Model (RMM) is a vital component of the Cooperative Constructionism framework. It provides social support for engaging and sustaining learner interest in intentional reflection practices. RMM is grounded in the medical, education, and business literature on effectiveness of reflecting on work practice. The RMM is organized into two operational phases based on Schön's framework (1983; 1987) for Reflection-in-Action and Reflection-on-Action. Reflection-in-Action occurs while the mentor is working with a learner to directly support intentional reflection and project design activities. Reflection-on-Action occurs afterwards when the learner is no longer present and mentors share their own reflections on mentoring with the aim of deriving new relevant and situated mentoring strategies.

Both the RMM and Pearls of Wisdom toolkit were designed specifically to support emergence of a Constructionist Cooperative within a constructionist learning environment. The act of constructing reflection expands the current constructionist learning space by adding concrete instantiations of reflection to the range of objects designers can build. Constructionism emphasizes how designing projects can deepen learner connections to what they know. Cooperative Constructionism emphasizes how designing projects and IRAs can deepen learner connections to how they think about what they know.

1.3 Research Objectives

The research objectives are to characterize how learners make sense of their intentional reflection and how intentional-reflection practices emerge, at both the community and individual levels. This suggests a two-dimensional research approach. The first is refinement of the theoretical framework that describes the process of change for learners. The goal is to have a well-articulated framework for design of learning environments that promote intentional reflection as a pathway to more complex learning. The second is identification of corresponding practices to implement the framework through a process of community-of-practice building. This work is significant because it explores how embedding reflection in design activity impacts learning and thinking about learning at the individual and group levels. The expectation is that learners will develop their own models of intentional-reflective practice.

1.4 Research Questions Addressed By Study

The study addresses two core research questions, each exploring specific affordances of Constructionist Cooperative learning environments.

Question One:

How does construction of reflective artifacts enhance the ways people reflect on their learning processes?

This question addresses several important aspects of learning through reflection including how construction of reflection artifacts impacts learner experiences.

Question Two:

*What scaffolds are most important for
engaging a community in reflective practice?*

This question addresses the process of emergence of a community of reflective practice.

Answering these questions will prove important to both constructionist theory and practice. The addition of intentional reflection practices to constructionist learning theory opens the door to identifying future complex learning practices that may be explored by learners. Lessons learned about supporting Constructionist Cooperative emergence can provide practical approaches for educators and technologists to consider when fostering intentional reflection in constructionist learning communities.

1.5 Dissertation Map

This dissertation is organized in eight chapters including this introduction. Chapter 2, *Background*, reviews relevant literature that provides the theoretical grounding for the study and highlights related research projects. Chapter 3, *Cooperative Constructionism*, describes the new conceptual framework grounded in constructionism, situated learning, and communities of practice research. Chapter 4, *Pearls of Wisdom: Technologies for Cooperative Constructionism*, provides an overview of the software tool developed for the study. The software design rationale is provided to contextualize learner

outcomes reported in the case studies in Chapter 6 and subsequent findings and discussion in Chapter 7. Chapter 5, *Research Design and Methodology*, describes the research methods for the study design, implementation, and subsequent data analysis. Chapter 6, *Empirical Studies*, presents three case studies, each focused on a different unit of analysis. Chapter 7, *Cooperative Constructionism, Revisited*, includes a synthesis of the empirical data and discussions tying those findings to the larger research context laid out in the conceptual framework presented in Chapter 3. Chapter 8, *Epilogue*, presents challenges to intentional reflection and recommendations for future research.

2 Background

The purpose of this chapter is to establish a foundation for the discussion of the proposed Cooperative Constructionism framework. The study to test this framework will explore how computational and social scaffolds impact the emergence of intentional-reflective practice within a constructionist-learning community. Such a learning community is called a Constructionist Cooperative.

Reflection is recognized as an important component of learning (Dewey, 1933; Gardner, 1991). By thinking about our thinking, we can make meaningful connections between current knowledge and new learning experiences. A regular practice of reflection can lead to new understandings about how we learn best. With these insights, new strategies for learning better in the future can be explored.

Section 2.1 presents a discussion of various theoretical perspectives on reflection that are relevant to this research. I define intentional reflection, the particular type of reflection being investigated in this study. Section 2.2 is a discussion of learning theories that inform the computational and social scaffolds for reflection. In Section 2.3, I detail strategies for promoting intentional reflection and present related work on developing computational learning scaffolds. Finally, in Section 2.4, there is a discussion of three constructionist-based learning communities that provided a context for examining ways of expanding the affordances of the constructionist learning model and inform development of theory in this dissertation. I then position my Cooperative Constructionism framework as a critical expansion of the constructionism learning paradigm.

2.1 Perspectives on Reflection

This section examines the nature of reflection from the perspectives of four important learning theorists, John Dewey, Lev Vygotsky, David Kolb, and Donald Schön. Each focuses our attention on a particular critical aspect of how reflection happens best in the service of learning. Together, their work provides the philosophical underpinnings for this research.

2.1.1 John Dewey

Dewey (1933) introduces reflection in his book, *How We Think*, where he focuses on the nature of reflection. Dewey defines reflection as special form of

thinking that occurs when a learner encounters uncertainty or difficulty within some situation. Under the right conditions, this confusion could lead to purposeful inquiry and reflective thinking. Dewey views reflection as an intentional act and reflective thought as deliberate and persistent.

In his book, How We Think, Dewey planted the seeds for examining the reflective process and its impact on learning. His focus was on the individual and his perspective provided a valuable lens for examination of the individual's reflection process.

2.1.2 Lev Vygotsky

Vygotsky (1978) argued that higher cognitive functions, like reflection, however, must originate within a meaningful, social context. He proposed three objectives for reflection: 1) negotiating a zone of proximal development, 2) learning through mediated artifacts, and 3) promoting social cognition.

Vygotsky's zone of proximal development (ZPD) is the distance between a learner's independent problem-solving ability and his increased ability obtained under the guidance of more capable peers (Wertsch, 1985). Figure 2 below demonstrates how the ZPD is situated between what the learner can achieve on her own and her ZPD, the area of her potential growth with the support of more capable peers.

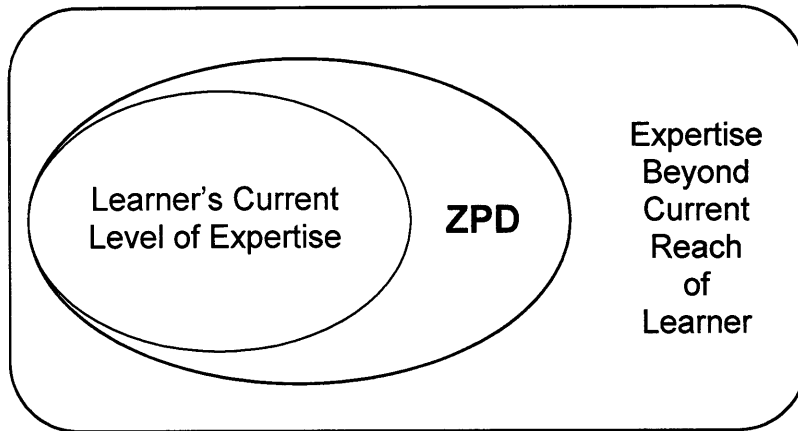


Figure 2. Vygotsky's Zone of Proximal Development.

This firmly situates the ZPD within the socially-mediated space created through a learner's relationships with others. Mediating artifacts include those objects that represent either the learner's internal mental models or external tools and artifacts (Engeström, 1999). Vygotsky hypothesized that such artifacts expand thinking when provided within a learner's ZPD. Social cognition represents the individual's cognition as influenced through her contact with others.

I bring Vygotsky's perspective to my work by utilizing intentional-reflective artifacts to mediate learner reflection and promote interactions around those reflective activities. Reflection for social cognition can then be positioned as individual intentional-reflective activity that is influenced by interactions with and intentional-reflective activities of others. Also, I employ both computational and social scaffolds to promote ZPD formation as a product of the interactions between learners, mentors, and artifacts involved in intentional reflection activities.

2.1.3 Kolb's Model of Experiential Learning

Kolb (1984) proposes a model of experiential learning where learning occurs as a continuous cycle of learning experiences and reflection on those experiences as the mechanism for constructing knowledge and developing new ways of thinking. Experiential learning can be viewed as learning by doing. The transformation of the doing into knowledge occurs in four stages: 1) concrete experience, 2) reflective observation, 3) abstract conceptualization, and 4) active experimentation.

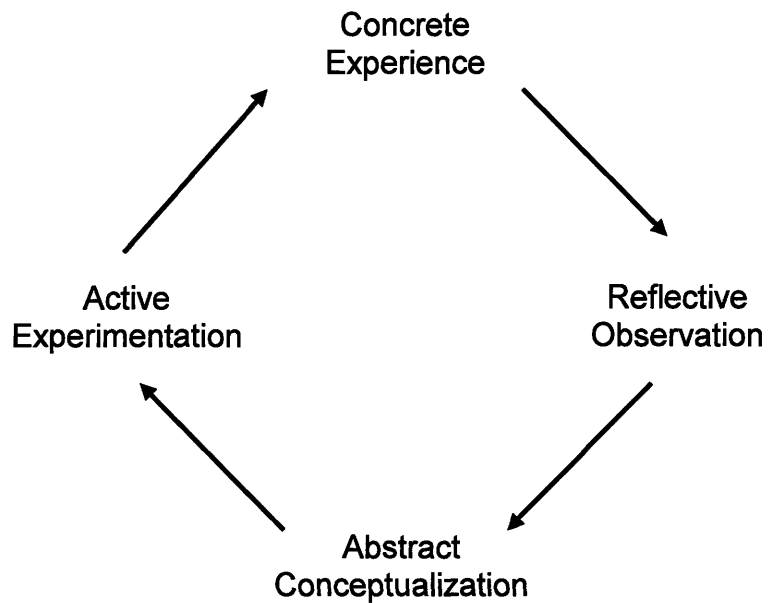


Figure 3. The Kolb Model of Experiential Learning.

Concrete experience happens while the learner is present in the experience. Reflective observation involves the learner reflecting in order to interpret, analyze, or assess his experience. Abstract conceptualization is the formation of abstract concepts and generalizations. In this stage the learner engages in the imagining, planning, and designing motivated by the reflective observation stage.

In the active experimentation stage, the learner implements and tests his newly formed concepts in new learning situations. Even more complex learning happens as this cycle repeats, which results in increasingly complex learning experiences. Kolb's premise is that effective learners employ all four stages and have competence in each. A goal of this research is to enable learners, within a constructionist-learning context, to effectively engage in reflection.

2.1.4 Donald Schön

Schön (1983) presents a model of reflective practice that involves the comparative examination of theory and practice in order to mindfully achieve specific teaching goals. He introduces the "reflective practitioner" as the educator who engages in reflective practice at both the individual and group levels. Schön's theory is especially relevant for promotion of a learning community of educators engaging in individual and group reflective processes to improve their teaching practice. The reflective practitioner cycles through two kinds of reflection:

- Reflection-in-Action, which involves the practitioner entering a cycle of reflection and experimentation while teaching activities are underway.
- Reflection-on-Action, which involves the practitioner entering a cycle of reflection after teaching activities are complete. Reflection-on-Action is retrospective and occurs when the practitioner can look back over events to access outcomes and plan new strategies and next steps.

Schön's model provides a mechanism for thoughtful and responsive support of specific types of learning.

I am proposing a social scaffolding model for supporting intentional reflection that is based on Schön's work. By questioning and reasoning about their mentoring experiences, mentors are better able to scaffold learner experiences and remain responsive to changing learner needs. Mentors can also gain new insights, leading to more effective mentoring strategies for encouraging intentional-reflection practices.

2.1.5 Revisiting Intentional Reflection

A goal of this study is to examine emergence of a particular kind of reflection, called intentional reflection. As introduced in Section 1.1.2, intentional reflection is a thoughtful, focused re-examination of both positive and negative aspects of the learning experience. For both the learner and mentor, their intentional reflection represents an important learning practice. Diverse perspectives on reflective thinking were explored in this section. Within those perspectives, intentional reflection as purposeful engagement was grounded in Dewey's individual and Vygotsky's social models of reflection. Kolb's learning model and Schön's reflective practitioner model both provide a starting point for thinking about appropriate scaffolds for intentional reflection.

2.2 Learning Frameworks

The learning framework informing this research is constructionism, a form of learning-by-design as described in Chapter 1. Section 2.2.1 describes constructionism in more detail. In Section 2.2.2, I include a discussion of situated

learning theory to further ground my proposed expansion model for constructionist learning theory.

2.2.1 Constructionism

Constructionism is an approach to learning that centers on the idea of learning through design experiences. Papert (1991, 1983) argues that people learn particularly well when actively engaging in constructing meaningful artifacts to share with and have been critiqued by others. His constructionism theory builds on Piaget's constructivist learning theory that stated people learn by constructing their own cognitive structures in the context of their previous knowledge and environment (Piaget, 1977).

Piaget viewed the learner as an investigator or scientist searching for *meaning* by constructing ideas about the world. Papert then positioned constructionism in opposition to instructionism, the primary pedagogy in most public schools. While instructionism focuses on new ways for teachers to deliver instruction, constructionism focuses on ways for learners to construct knowledge.

Constructionism emphasizes interactions between learners, their artifacts, and the learning environment. Within constructionist learning environments, learning and *ideas about learning* are distributed throughout the learning community. Those ideas are then available for accommodation by other learners (Bereiter and Scardamalia, 1996).

The constructionist view of learning through experimentation with objects is an important mechanism for reflecting on learning. Constructed objects mediate connections with other learners and with new ideas. Papert defines

such artifacts as “objects-to-think-with” that embody those learning and design choices important to the learner. In this research, I explore the use of intentional-reflective artifacts not only as “objects-to-think-with” but as “objects-to-reflect-with.”

2.2.2 Situated Learning

Situated learning theory (Lave, 1988) describes reflection and deep learning activities in the context of interactions between learners and their learning environments. Through these interactions, knowledge is continually re-constructed and learning can not be separated from social activities.

The concept of "community of practice" is grounded in situated learning theory (Lave & Wenger, 1991). The community of practice (CoP) model emphasizes sharing and doing as a way of constructing meaning in the context of a social unit. This implies all CoP activities are authentic, taking place in the “real-life” of the community. Lave & Wenger use the term "legitimate peripheral participation" to describe a learner’s journey from the periphery of the community toward the center as they become more actively engaged in community culture and norms. Within a CoP, legitimate peripheral participation fuels the emergence of new practices.

I apply the CoP framework to a constructionist community with the intention of seeding an intentional-reflective CoP. Learner participation is realized through construction and sharing of intentional-reflective artifacts. These artifacts help mediate connections between learners and aid their journey from the periphery to more central roles in the community.

2.3 Strategies for Promoting Reflection

In this section, various strategies for scaffolding reflective thinking are reviewed. Specifically, journaling, prompts for self-explanation and self-evaluation, and computational tools for supporting reflection are discussed.

2.3.1 Journaling: The Power of Expression

Journaling is a form of exploratory writing that encourages reflection (Moon, 1999). Reflective journaling is a natural tool for exploring ideas, asking and answering questions, and re-formulating new ways of thinking. In this study, a form of journaling is used in which the learner construction materials are not restricted to text media. Instead, the entire palette of digital media, from audio to video to text, is available to learners for reflection on their learning.

2.3.2 Prompting Reflection

Prompting self-explanation has been used extensively in a variety of educational settings. The purpose of prompts is to guide the learner into asking herself questions that may elicit meaningful reflection. Cognitive prompts focus learner attention on domain-specific ways of thinking (Chi, 1994). Prompting can support learner articulation of her steps to learning and her decisions along the way.

2.3.3 Computational Tools for Reflection

Computational tools for learning can support specific kinds of learning activity. For example, inquiry-based learning (IBL) tools help scaffold learner

exploration of the scientific investigative process. Reflecting on those investigations is an important component of the inquiry process. As a result, a sub-goal of many computational tools for IBL is to support learner reflection on their observations.

I present three IBL systems that offer insight into computational tools for intentional reflection: the Progress Portfolio, the Knowledge Integration Environment, and the Computer Supported Intentional Learning Environment. Each focuses on particular challenges associated with designing scaffolds for reflection.

2.3.3.1 Progress Portfolio

Progress Portfolio (PP) (Kyza, 2002) is software for promoting critical thinking via a highly-structured series of software prompts. These prompts ask students to 1) identify important information, 2) plan and monitor of investigations, 3) synthesize, interpret, and analyze their data, and 4) communicate their findings. The PP helps students learn to do inquiry by encouraging an activity of annotating images that track the progress of their investigations. In essence, students create portfolios to document and reflect on their scientific inquiry process. The software additionally supports note taking and this feature is utilized to post questions and enter personal reflections on PP activities.

The software utilizes a rigid hierarchal structure which organizes portfolio-building activities by pages and templates. For example, a portfolio may have

several pages, each containing related sets of annotated images. Templates are pre-designed page types that determine the layout of page content. For example, a template can determine the amount, type, and arrangement of portfolio content on a page.

Although the name, Progress Portfolio, implies a certain amount of design freedom in portfolio construction, studies revealed students felt constrained by the rigid template structure imposed by the software. Another constraint was the read-only prompts teachers could add to the portfolio template. The initial design rationale was students would waste valuable time focusing on their portfolio layouts rather than on the task of documenting and reflecting on their work. However, study results indicate students were frustrated with their inability to change the portfolio structure, and as a result, this rigid structure hampers their work.

I adopt the PP use of a default “layout” to help novices organize their intentional-reflection artifacts. In my Pearls of Wisdom software all initial layouts, from reflective prompts to page structure, are editable by the learner. A goal of this design approach is to provide organizational structure, while maintaining an open-ended design environment for the learner. The study presented in this dissertation investigates how well the combination of organizational structure and design freedom was able to scaffold construction of reflective artifacts.

2.3.3.2 Knowledge Integration Environment

Knowledge Integration Environment (KIE) (Bell, et al, 1995; Linn, 1995) is software tool for use in the science classroom that makes extensive use of

procedural prompts to scaffold the investigative process. KIE allows users to create one of three project types which are prepared by the teacher: critique projects, collaborative debate projects, or design projects. Critique projects promote development of critical evaluation of evidence and supporting arguments. Collaborative projects permit multiple perspectives on a topic to be viewed by others. Design projects require student to make decisions based upon their evaluation of scientific data.

The goal of KIE is to engage students in reasoning about their science projects. This is accomplished using an extensive software prompting mechanism. Students are led, step-by-step, through the scientific-inquiry process. This detailed prompting may be suitable for instructional-learning environments; however, within a constructionist-learning environment, over prompting may would disrupt the learning and design flow. The KIE research team decreased prompt frequency in later versions of the KIE software.

Important to my study is a particular class of KIE prompts, known as the “stop and think” variety. This class of prompts requires students to suspend their current activities and think about what has recently transpired. In some cases, students are asked to make notes about their thinking. A software challenge for the computational scaffold developed for my study, therefore, is to prompt learners to share their reflections on their design experiences without disrupting the design process.

2.3.3.3 Computer Supported Intentional Learning Environment

A successful, well-established IBL is the Computer Supported Intentional Learning Environment (CSILE), one of the earliest networked systems to provide across-the-curriculum support for collaborative inquiry-based learning (Scardamalia & Bereiter, 1991; Scardamalia *et al.*, 1989).¹ The CSILE software supports problem definition, hypothesizing, data collection, and data analysis. As a research tool, a goal of CSILE is to examination new ways to *design* productive classroom environments. Teachers create a communal database in which students could enter text and graphic notes that could be shared. Using CSILE, learners can engage in a structured, documented discussion about some topic being investigated (Scardamalia and Bereiter, 1996) by contributing notes and images to a communal repository.

The computational scaffolds reviewed here were designed to support more structured discourse than the intentional reflection tools presented in this dissertation. While these IBL systems aim to help students become reflective *inquirers*, this dissertation explores how learners become reflective *designers*. Reflection by design borrows concepts of prompts for guiding the learner through an unfamiliar domain task, in this case reflection. However, the software does not require the rigidity of discourse as that in the IBL systems discussed here. Instead, the prompts and structural layout help guide the learner through the *designing* of their reflective artifacts.

¹ Knowledge Forum, released in 1997, was the commercial version of CSILE.

2.4 Building Constructionist Learning Communities

In this section, I provide a discussion of three constructionist-based studies aimed at extending various aspects of Papert's constructionist learning model. All three projects, Multi-User Sessions in Community (Shaw, 1995), They Have Their Own Thoughts (Hooper, 1998), and Creating Community Connections (Pinkett, 2001) inform the Cooperative Constructionism framework presented in this dissertation.

As detailed in Section 2.2.1, constructionism emphasizes learning through construction of personally meaningful artifacts that are shared with others. Additionally, constructionist learning communities are groups of learners with a common goal of learning through their design experiences and social interactions.

2.4.1 Social Constructionism

Shaw's (1995) community-based software, Multi-User Sessions in Community (MUSIC), is a network environment that uses various multimedia tools to support activities that advance the local neighborhood. For example, community members use MUSIC to create newsletters and schedule community events. Shaw argues that social constructionism supports individual development through his community connections and construction of artifacts that support community development.

An important contribution of Shaw's work is his positioning of the community as an evolving entity. His social constructionism framework is important for advancing community interests and demonstrating how

computational tools could be appropriated for that purpose. Like Shaw, I will be examining how individual construction activities can support individual reflection and also support emergence of intentional reflection at the community level.

2.4.2 Cultural Constructionism

In her dissertation, Hooper (1998) examines how learning happens when learners construct objects expressive of their cultural identity within the context of their culture. Hooper's study takes place at an African-centered community school and focuses on the role of cultural identity in learning, especially when constructing computational artifacts rooted in African-American ways of knowing. Hooper also demonstrates the role computation can play in support of cultural constructionism. She argues that children can take control of their own learning and development, and school environments should support and legitimize children's personal ways of thinking and knowing.

I agree with Hooper's argument that children are able to take control of their learning. Additionally, I argue that children can take control of their reflections on their learning. By embedding reflection into personally, meaningful design activities, learners are able to design intentional-reflective artifacts that represent their diverse ways of reflecting.

2.4.3 Socio-Cultural Constructionism

Pinkett positions his sociocultural constructionism framework as a synthesis of Shaw's social constructionism and Hooper's cultural constructionism. He argues that individual and community growth are mutually

enhanced by emphasizing both individual and shared constructive activities. Pinkett developed the Creating Community Connections (C3) system as an asset-based approach to community technology. He argues for residents as creators of their own community content not just consumers on external content.

The emphasis on individual as well as community-level growth is important to building robust, sustainable practices within a community. In the case of a Constructionist Cooperative, individual intentional-reflective activities fuel community intentional-reflective practices which in turn re-fuel the individual.

The work of Shaw, Hooper, and Pinkett provides valuable examples of how culturally and socially meaningful activity can bring changes in community practice and impact learning. Their projects create a constructionist bridge between cognition, community, and culture, and challenge our assumptions about the boundaries of constructionism.

Summary

The discussion of theory and practice in this chapter highlights the variety of perspectives on reflection, scaffolds for supporting reflection, and vital aspects of supporting emergence of community practice. These views provide a useful foundation for the theory and methods, proposed in this dissertation, for encouraging intentional reflection at the individual and community levels as a means of expanding and improving the constructionism learning model.

“To reflect is to look back over what has been done so as to extract the next meanings which are the capital stock for intelligent dealing with further experiences. It is the heart of the intellectual organization and of the disciplined mind.”

John Dewey (1938), *Experience and Education*

3 Cooperative Constructionism

Cooperative Constructionism is a framework for reflecting on learning experiences by designing artifacts that embody the reflective process. Artifact construction is an authentic activity well situated within the constructionist learning domain. Cooperative Constructionism promotes emergence of a community of practice around intentional reflection by supporting learner construction of reflective artifacts. These reflective artifacts spark a re-examination of learning and design experiences, so learners may obtain deeper insight into their design and learning strategies. The Cooperative Constructionism framework, with its intentional reflection activities, fills a

reflective-practice gap that currently exists within constructionism learning paradigm. Section 3.1 presents details of the Cooperative Constructionism framework. Section 3.2 introduces Cooperative Constructionism scaffolds, which include intentional reflective artifacts and the reflective mentor model. Finally, section 3.3 provides a list of Cooperative Constructionism indicators that provide quality measures for the resultant Constructionist Cooperative community.

3.1 De-Constructing Cooperative Constructionism

The Cooperative Constructionism framework is grounded by three functional pillars: construction, connection, and intentional reflection. The construction and connection pillars represent established constructionist learning principles of learning by design and learning within a social context (Papert, 1983; Perkins, 1986). The construction pillar emphasizes active project construction in accordance with Papert's notion of learning by construction of meaningful artifacts. The connection pillar emphasizes learner interactions with others, particularly the sharing of constructed projects. Figure 4 illustrates the cyclic relationship between the construction and connection pillars. The remainder of this section includes a detailed discussion of the construction and connection pillars, followed by presentation of the intentional reflection pillar. The intentional reflection pillar is an addition to the current suite of constructionist learning activities.

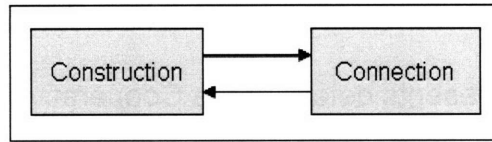


Figure 4. The cyclic relationship that exists between the construction and connection pillars of Constructionism facilitate learning through construction and sharing of meaningful artifacts.

3.1.1 The Construction Pillar

The construction pillar emphasizes the hands-on, experiential aspects of learning through building objects that are meaningful to the learner. Constructing tangible, shareable artifacts is a generative activity leading to higher-level, complex thinking.

Constructionism is a learning paradigm that exploits the benefits of learning through meaningful, construction experiences. Learning becomes a process of active knowledge construction rather than passive knowledge absorption. The term constructionism was coined by Seymour Papert, building on Jean Piaget's constructivist theory of learning that states that people learn by constructing their own cognitive structures in the context of their previous knowledge and environment (Piaget, 1977; Papert, 1983). Papert extends Piaget's ideas on learning by arguing that people learn best when engaged in actively constructing external artifacts to share with and for critique by others (Papert, 1991; Resnick 1996). Papert's constructionism focuses on learning to learn, in particular on how making things relates to learning. People learn through creating, interacting, and experimenting with constructed artifacts.

Being out in the world, these artifacts provide a point-of-reference for sharing ideas within the community. Papert defines “objects-to-think-with” as objects that embody meaningful and important concepts, enabling a learner to make contact with new ideas through her interactions with the objects. For example, Papert’s childhood experiences playing with gears and cogs transformed those concrete objects into objects-to-think-with. His play with gears led to his developing mental models for thinking about ratios, differentials, and other powerful mathematical ideas. Papert’s interest has always been how learners engage each other through their artifacts and how those interactions promote self-directed learning, the construction of new knowledge, and new ideas.

Papert also emphasizes the importance of tools, particularly computation tools, in learning development. Papert’s constructionism provides a context for understanding how ideas are generated and transformed through use of expressive media. Constructionism also provides a context for understanding how learner engagement in authentic activities helps them make meaning of their artifacts. Making ideas concrete and therefore shareable can transform and deepen ideas that are the focal point of learning interactions with others.

3.1.2 The Connection Pillar

The connection pillar emphasizes the socio-cultural aspects of learning and is grounded in the situated learning and community of practice paradigms. It focuses on how the enculturation process functions as a learning pathway (Young, 1993; Jonassen, 1991; Vygotsky, 1978). Situated learning describes

reflection, problem-solving, and other complex learning activities in terms of ongoing interactions between learners and their environment. People learn through their interactions and their knowledge is constantly constructed and re-negotiated. This places their learning firmly within the social sphere (Pea, 1994; Lave, 1988). Situated learning grounds the connection pillar because the connections are part of authentic activities taking place within a social context. The communities of practice paradigm (Wenger, 1998) hypothesizes that learning and meaning are constructed, negotiated, and re-constructed within a given community of practitioners. The activities are those relevant to community membership and objects as well as abstract ideas and norms shape the learning that takes place (Wenger, 1998; Barab & Duffy, 2000). Within a community of practice, practice represents meaningful action. Community of practice research further grounds the connection pillar with its emphasis on how enculturation draws the learner into more complex, reflection-based interactions with others in her community.

3.1.3 The Intentional-Reflection Pillar

As mentioned earlier, constructionist learning activities include opportunities for reflection as one of its side products (Papert, 1980; Resnick, 1999). However, reflection does not always occur. The intentional reflection pillar adds another dimension to Papert's constructionism by including concrete instantiations of a learner's reflection as a constructible object-to-think-with.

Figure 5 illustrates the intentional reflection pillar with the construction and connection pillars.

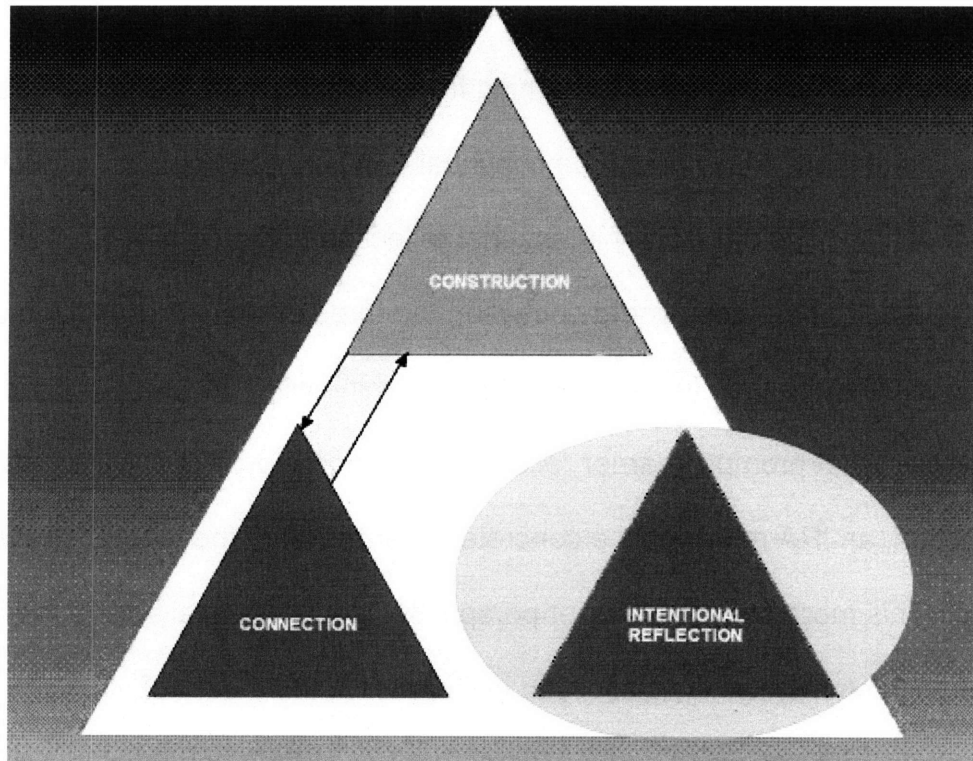


Figure 5. The addition of Intentional Reflection to Constructionism brings reflection embedded in the construction and sharing of meaningful artifacts to the palette of constructionist learning activities.

The addition of intentional reflection to constructionism brings more complex ways for learners to engage with their artifacts and with each other. Intentional reflection brings not only reflection, but reflection embedded in the constructing of artifacts with all the learning benefits discussed in section 1.1.1. These artifacts are called intentional-reflective artifacts or IRAs. At the individual level, IRAs and associated intentional reflection activities facilitate development of learner fluency around reflection and other meta-cognitive activities. At the group level, intentional-reflective artifacts and associated intentional reflection activities

provide the social lubricant for more complex learning interactions and connections.

3.1.4 Learning Synergies

Within the constructionism learning framework, construction of artifacts and the connections they motivate a continual cycle of meaningful construction and connection. The addition of intentional reflection to the constructionist learning paradigm creates synergy between the three pillars. The addition of IRA construction is more than just another object-to-think-with. IRAs are a special kind of object that prompts learner reflective thinking on projects. During its construction, an IRA represents a concrete instantiation of the learner's reflective process. This more complex learner perspective becomes available to the rest of the learning community. As discussed in Chapter 2, the theory of constructionism is premised on how learners relate to their constructed artifacts and how they negotiate meaning of those artifacts as they are shared with others. Cooperative Constructionism infuses Papert's constructionism with intentional reflection, resulting in a collection of IRAs learners can think about and share with others.

Intentional reflection, as an addition to constructionism, also adds more complex ways for learners to interact by stretching learner focus to reflection on those projects. This level of connection adds reflective sharing and negotiating of meaning of both the project and the IRA. That presents opportunities for exploring new ways of thinking and learning. Figure 6 is a schematic of the Cooperative Constructionism Model.

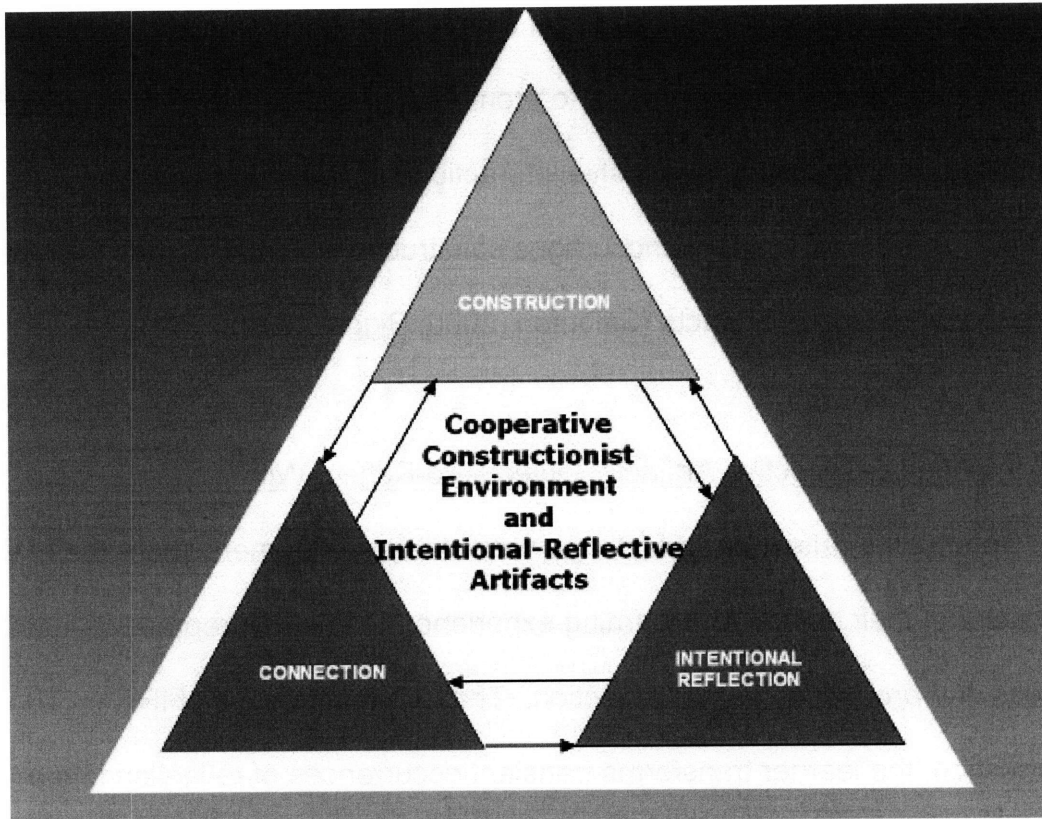


Figure 6. Cooperative Constructionism Model with the addition of the Intentional Reflection Pillar. The intentional reflection pillar adds new types of objects to construct, which promotes more complex learning activities.

3.2 Scaffolding Cooperative Constructionism

Effective scaffolds facilitate learner capacity to build on prior knowledge and internalize new information (Collins, Brown, & Newman, 1989). Wood et al. (1976) uses the term scaffolding to articulate Vygotsky's theories of cognition regarding learner assistance and guidance by more capable peers. The purpose of scaffolding is to allow learners to become successful in independent activities. The goal is to enable the learner to do more complex activities on his own, over time. I propose an approach to scaffolding Cooperative Constructionism that supports interactions between the tools, the learners, and their more capable

peers. The first scaffold is a computational toolkit for constructing and sharing intentional-reflective artifacts. The second scaffold is an interaction model, called the Reflective Mentor Model (RMM), to promote and sustain intentional reflection activities through focused, responsive interactions between learners and mentors. This social scaffold encourages construction, utilization, and promotion of intentional reflection artifacts (Salomon, 2000; Biggs, 1989).

3.2.1 Intentional-Reflective Artifacts: Objects-To-Reflect-With

Intentional-reflective artifacts are projects where learners share their reflections of their design and learning experiences. The IRA represents both the *process* and *product* of learner reflection. Through the process of IRA construction, the learner transforms transient occurrences of reflection into a tangible artifact. The resultant IRA is a persistent product that can be revised, shared, and discussed with others. The IRA is rendered an object-to-reflect-with. Seymour Papert (1980) defines objects-to-think-with as objects that embody meaningful and important concepts, and enable learners to connect previous learning experiences to new insights. Objects-to-reflect-with help learners make more complex associations with their learning. As the object-to-reflect-with enters the public arena, it also forms the basis for more complex interactions about the project and the IRA.

At its core, an IRA is a concrete instantiation of what, how, and why learner knows and considers meaningful about their learning. During IRA construction, the learner must identify and revisit key learning experiences

(Bamberger and Schön, 1983) and organize those into some meaningful, coherent structure. Figure 7 is an example of a Pearl; an IRA made using a computational scaffold called Pearls of Wisdom. A more detailed explanation of Pearls and the Pearls of Wisdom toolkit is presented in Chapter 4.

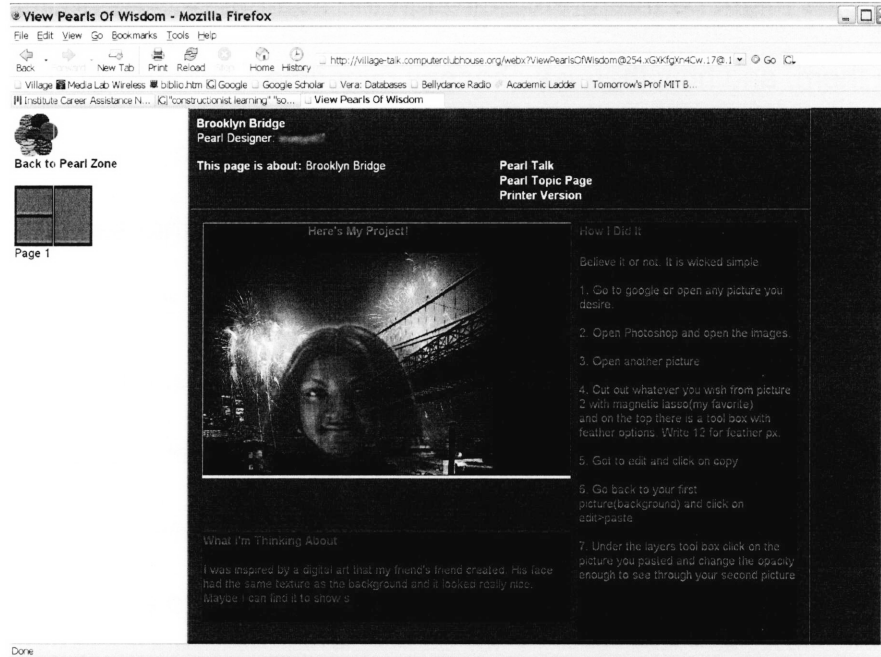


Figure 7. Pearl about an image-layering graphics project. The Pearl includes the learner's project ideas and motivations, and comments on her learning experiences. It also includes instructions for making the project.

As an activity, IRA construction contributes to the richness of the learner's reflection process. Just as project revision leads to richer project development and understanding, IRA revision leads to richer reflection activity, over time. Initial IRA construction involves more complex reflective activity than what learners usually engaged in during constructionist learning activities. Analogously, IRA revision can lead to refinement of learner reflections and ideas that did not arise during the initial construction cycle. Articulating their reflective

activity challenges the learner to look beyond personal perspectives and lessons to consider how an audience may interpret and use her IRA.

IRAs serve as social proxies (Erickson & Kellogg, 2001) by exhibiting learner expertise, reflective activity, and community membership status. For example, status might be interpreted through the number of IRAs designed, how others use them, and how that use changes over time. Because of its social nature, the IRA is able to function as a boundary object. Star and Griesemer (1989) describe boundary objects as artifacts and systems that serve to interface disparate domains. Within a learning community, disparate domains may exist along social as well as conceptual boundaries. For example, age differences represent a social boundary. As a boundary object, IRAs serve to connect learners across boundaries. In one instance from the case studies presented in Chapter 6, a 17-year-old male learned from and looked up to an 11-year-old girl, with the IRA brokering the connection between them. This connection resulted in new learning opportunities for both members.

As a collection, IRAs highlight the design ideas and project trends propagating throughout the community. Viewed over time, the IRA collection charts the rise and demise of ideas, popular design activities, and projects that resonate within the community (Chapman, 2001; 2004). At any given time, the collection presents a snapshot of what design and project ideas the community currently is thinking about.

3.2.2 The Reflective Mentor Model

The Reflective Mentor Model (RMM) is a vital component of the Cooperative Constructionism framework. RMM requires mentors to engage in their own learning and reflection as part of their ongoing mentor practice with the goal of effectively supporting learner intentional reflection. The RMM is organized in two operational phases, as mentioned in Section 1.2.1.2. The Reflection-in-Action phase occurs while the mentor is working with a learner. The mentor divides his time between attending to the learner and reflecting on what is working in the current session. Reflection-in-Action is thinking while mentoring by analyzing in the moment and thinking one step ahead of what was happening with the mentee. The Reflection-on-Action phase occurs when mentors are together and learners are not present. Reflection-on-Action consists of informal discussions about what worked and what didn't. This provides mentors with a mechanism for thinking about past mentoring experiences as a way to influence future mentoring outcomes. Figure 8 shows the two phases, with associated activities, of the RMM.

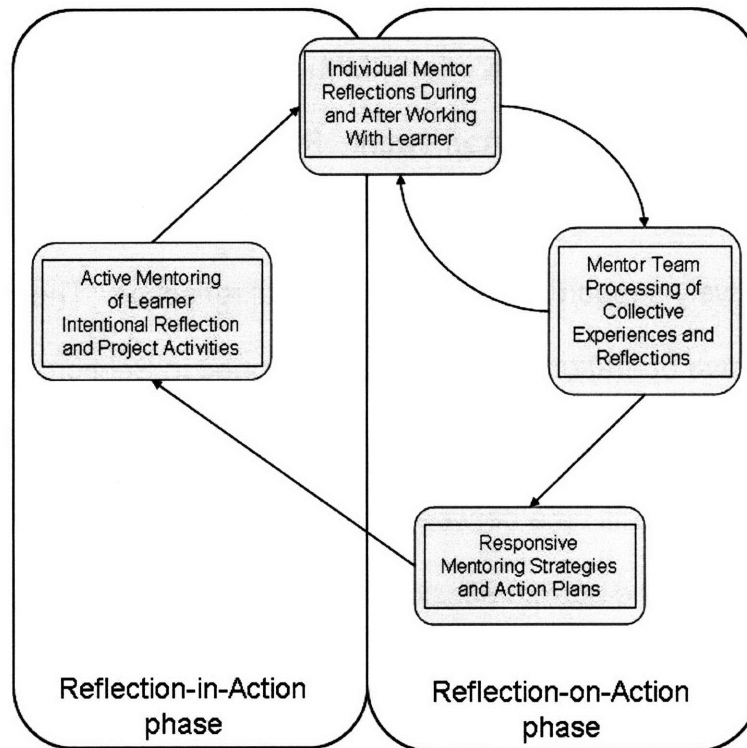


Figure 8. Reflective Mentor Model

Reflective practice is a process of problem solving and reconstruction of meaning while engaged in an activity. There is a great deal of literature on the effectiveness of reflecting on work practices and team building in the medical, education, and business areas. Much of the RMM is grounded in that literature. Educational theorist John Dewey (1904; 1910) advocated for more reflective approaches to teacher education and urged educators to learn to be thoughtful of their teaching. Dewey argued that in conjunction with adapting a reflective practice, teachers should concentrate their efforts on reshaping the learning environment their students work in.

The problem of method in forming habits of reflective thought is the problem of establishing conditions that will arouse and guide curiosity; of setting up the connections in things experienced that will on later occasions promote the flow of suggestions, create problems and purposes that will favor consecutiveness in the succession of ideas.

Dewey, 1933, p.56

More recently, educational researchers and technologists (Schön, 1991; Barab, 2000) have identified teacher reflective practice as critical to successfully engaging learners. Studies have showed that educators who engage in reflection during and after teaching events improve their ability to make sense of those experiences and are able to devise plans for improvements (Reiman, 1993). The theory-based RMM guiding principles highlight the activities that RMM mentors, both individually and as a team, should be engaged in. Table 1 summarizes the RMM guiding principles.

Table 1. RMM Guiding Principles.

Reflective Mentor Model Guiding Principles
1. Participate in mentor team roundtables.
2. Establish responsive action plans and responsive mentoring strategies.
3. Identify obstacles to member construction and use of intentional-reflective artifacts.
4. Establish a common mission around intentional reflection purpose and practices.

3.3 Cooperative Constructionism Indicators

Cooperative Constructionism indicators are a barometer for gauging the quality of a Constructionist Cooperative. They are a tool for monitoring its condition and tracking how it transforms over time. The Cooperative Constructionism indicators are organized in two categories: individual-level and community-level. Individual-level indicators focus on the nature of the individual learner's intentional reflection experience. Community-level indicators focus on group-level dynamics and how intentional reflection adds to the social fabric of the community.

The Cooperative Constructionism indicators are grounded in established theory on constructionism, learning in complex environments (Brown, 1992; Baxter-Magolda, 1992; Turkle and Papert, 1991; Perkins, 1986), emergence of communities of practice (Wenger, 1998; Barab, 2001), situated learning (Pea, 1996; Lave, 1988), and assessment of constructionist learning activities (Barab, 2001; Pinkett, 2001; Shaw, 1995).

3.3.1 Individual-Level Indicators

Five individual-level indicators, listed in Table 2, outline characteristics of an individual learner engaged in intentional-reflective practices.

Table 2. Summary of Individual-Level Indicators.

Individual-Level Indicators of Cooperative Constructionism
1. Learner takes ownership of IRA construction.
2. Learner adapts software use to suit her design objectives.
3. Learner experiments with alternative styles of project and IRA design.
4. Learner articulates her reflective and learning experiences.
5. Learner evolves new roles in the learning community.

1. Learner takes ownership of IRA construction: this includes initiating and designing the IRA. Additionally, sharing reflections and expertise gives the learner ownership of her thinking process.
2. Learner adapts software use to suit her design objectives: this indicates the learner has a functional level of fluency with and motivation for tinkering with the software.
3. Learner experiments with alternative styles of IRA and project.
4. Learner articulates her reflective and learning experiences: Baxter-Magolda (1992) uses the term mode to characterize the tone and depth of a learner's articulation of their thinking. The mode progresses from vocal to verbal to intentional articulation, characterized by a move from simple responses to inclusion of their voice, over time. For example, the mode may progress from responding only when asked to initiating more complex discussions and self-directing of their learning.

5. Learner evolves new community roles: the learner takes on new leadership and capable-peer roles related to her intentional-reflective practices.

3.3.2 Community-Level Indicators

Community-level indicators characterize the productive dynamics of a learning community, including how ideas are spread, how practices are negotiated and appropriated, and how learners assign meaning to their activities within the context of a larger community. Five community-level indicators, listed in Table 3, outline characteristics of a community engaged in intentional-reflective practice.

Table 3. Summary of Community-Level Indicators.

Community-Level Indicators of Cooperative Constructionism
1. Learners engage in regular discussion, sharing, and advocating of intentional reflection activities.
2. Learners evolve vocabulary around intentional reflection.
3. Learners negotiate alternative design styles and perspectives.
4. Learners increase the complexity of their learning relationships.
5. Learners' intentional reflection activities are highly visibility throughout the learning environment.

1. Learners engage in regular discussion, sharing, and advocating of intentional reflection activities: group participation includes discussions

of IRAs, sharing of project and IRA construction experiences, and advocating IRA construction.

2. Learners evolve vocabulary around intentional reflection: the learners develop new vocabulary to express aspects of intentional reflection practice. New vocabulary may be seen in IRA content or observed during learner interactions.
3. Learners negotiate alternative design styles and perspectives for their project and IRAs.
4. Learners increase the complexity of their learning relationships: the learner participates in more complex IRA-inspired interactions with other learners.
5. Learners' intentional reflection activities are highly visible throughout the learning environment: the learner's IRAs and associated intentional reflection activities are highly visible to the rest of the community.

Summary

This chapter defined the Cooperative Constructionism framework for promoting intentional reflection on learning experiences. The three pillars of Cooperative Constructionism - construction, connection, and intentional reflection - together add complexity to the learning affordances of constructionism. The hope is that the Cooperative Constructionism indicators contribute to our understanding of the Constructionist Cooperative that emerges through implementation of this framework with its computational and social scaffolds.

Chapter 4 further details the motivation and implementation of the computational scaffolds designed to support a Constructionist Cooperative community.

And since you know you cannot see yourself,
so well as by reflection, I, your glass,
will modestly discover to yourself,
that of yourself which you yet know not of.
William Shakespeare

4 Pearls of Wisdom: A Reflective Toolkit for Cooperative Constructionism

The purpose of the Pearls of Wisdom (PoW) software is to scaffold the authoring and sharing of intention-reflective artifacts (IRAs), called Pearls. IRAs are artifacts that learners design to share their reflections on their learning experiences. Reflection has been described as a mechanism for transforming experience into learning. A special form of reflection, called intentional reflection, situates that transformation within an authentic design practice. Authentic design engages the learner in relevant activities situated with their learning environment. This provides realistic scenarios for practice and feedback. The PoW technology, as a scaffold for reflection through authentic design practices, is critical to my inquiry into how computation can support intentional reflection.

Support of intentional reflection by incorporating a design component is a potential application of computational scaffolds.

Intentional reflection is a lifelong learning skill and of particular interest to those pursuing careers in science, education, and technology. It is through reflection and other higher-order thinking that design innovation occurs. As a young learner engages in higher-level thinking they can better explain why things happen the way they do and how they know what they know. Their articulations progress from simple representations of their ideas to more complex representations. The acquisition of representations is presumably a form of higher learning. Reflection is one of the critical thinking processes through which more complex representations can be developed.

The assumption is that integration of constructionism and computational tools presents a powerful combination for transforming reflection into learning. Integration of constructionism and computational tools results in technologies that are process-centered. The technology must support decision-making, and artifact manipulation and experimentation. An inherent characteristic of the most useful process-centered technology is that it supports continual process improvement in the course of accomplishing project goals.

Section 4.1 presents an overview of computational scaffolds for reflection. This includes discussion of different types of scaffolds, including computational scaffolds for supporting intentional reflection. Section 4.2 presents the PoW software design and rationale. Section 4.3 provides an overview of how PoW

would be used. Section 4.4 details various aspects of PoW software implementation.

4.1 Computational Scaffolds for Reflection: Establishing the Content Domain

Scaffolds are tools, guides, and strategies, designed to help a learner mindfully engage in tasks beyond of his current level of expertise. Wood, Bruner and Ross (1976) first introduced the term “scaffolding” in the context of adult-child interactions with the adult tutoring the child to accomplish an advanced task. The goal of scaffolding is for learner to be able to function independently once support is removed. The gradual removal of a scaffold is called fading. Ideally, scaffolds are faded as the learner skills within the particular learning domain increases (Pea, 2004). Table 4 summarizes several types of learning scaffolds.

Table 4. Examples of Learning Scaffolds.

Scaffold	Description
Content-specific (Sandoval, 2003) (Bell & Linn, 2000)	Provides learners with hints about content knowledge to use or incorporate into their lessons. This form of scaffold usually is highly structured.
Generic explanation-based (Kuhn & Udell, 2003)	Assists the learner in understanding a general framework regardless of the specific content area. For example, to scaffold algorithm development, generic scaffolds for each functional component (i.e., looping, indexing, etc.) of an algorithm would be provided.
Prompting (Reiser, et al., 2001) (Bell, et al, 1995; Linn, 1995)	Assists the learner in different modes of thinking by posing cognitive process questions (i.e. “How did you come up with this idea?”). Research has shown open-ended, generic prompts to be more productive than directed prompts (Davis, 2003).

4.1.1 Computational Scaffolds for Learning

Computation brings a host of affordances to learning scaffolds. Recently, there has been an increase in computational tools to scaffold learners as the work on more complex learning tasks. The three most widely used scaffolds aim to 1) display learner thinking, 2) focus learner attention on a sub-set of the problem, and 3) include mechanisms for communal discourse. Displaying learner thinking has been done using various mechanisms, including concept maps, electronic reflection journals, and document annotation software. The main goal is to have the learner's thinking remain visible as they use the software workspace.

Focusing the learner's attention involves managing the user interface so the learner is working on one sub-set of the problem at any time. The goal is to scaffold the learner moving toward a solution by working with smaller, easier to manage sub-problems. Mechanisms for community discourse can range from threaded-discussion, simple email, or electronic bulletin boards, etc. The goal is to provide the learner with a way to interact with other learners or more capable peers.

In these environments, scaffolding generally has consisted of some pre-determined range of user prompts or hints under software control but not at a level assessable to the learner. Scaffolds for constructionist learning must be open-ended and re-configurable by the learner within some pre-determined levels. In Section 4.1.2, I discuss the use of computational scaffolds designed to scaffold reflection. In 4.1.3, I then introduce a model for fading scaffolds, called intentional fading.

4.1.2 Computational Scaffolds for Supporting Intentional Reflection

It is important to identify those strategies crucial for scaffolding intentional reflection. They are all grounded in the constructionism learning framework. The first is promotion of learner ownership of their reflective process. Learner ownership of the reflective process can motivate, even when the process, in this case reflection, is hard. The second is provision within the software interface for open design spaces. An open design space invites the learner to freely structure their reflection in ways that make sense to them. The third is provision within the software for learner control of scaffold fading. Giving the learner control over scaffold fading is a new idea in computational scaffolds that is firmly grounded in the spirit of the constructionism paradigm.

In summary, the desired computational scaffolding strategies for intentional reflection include well-established methods grounded in the literature and intentional fading, an extension of current scaffolding theory. Table 5 summarizes requirements of computational scaffolds for intentional reflection.

Table 5. Computational Scaffolds for Intentional Reflection.

General Scaffold Strategies for Intentional Reflection	
Display learner process	Source: Educational Technologies Literature (Collins et al., 1989; Scardamalia, et al., 1984)
Focus learner attention onto specific aspects of reflection	
Include mechanisms for reflective community discourse	
Computational Scaffold Strategies for Intentional Reflection	
*Display learner process by prompting learners to include how they did their designs and why they made particular design decisions.	Contributions of this dissertation
*Focus learner attention by providing short prompts to scaffold reflection but also giving user access to modifying, adding, or removing prompts.	
Enable reflective community discourse by connecting learners to additional profile information about one another via Intranet connection.	
*Promote learner ownership by providing options for learner to change the structure of their Pearl to suit their design esthetics and communication needs.	
*Provide open design spaces by providing a blank canvas as part of the graphical user interface. This permits learner to be expressive using whatever variety of media makes sense to them.	
Leverage learner visibility by making Pearls persistent. They are published from the first save and accessible to other learners.	

* Feature afforded by embedding reflection into constructionist-learning activities.

4.1.3 Intentional Fading of Computational Scaffolds

Intentional fading permits the user to control the rate and nature of scaffold fading. The learner can control fading by changing, adding, or removing reflective prompts within the user interface. This requires the learner to make changes to the source code that generates his Pearl.

There are two advantages to intentional fading. First, fading is difficult to generalize to ill-structured, open-ended constructionist activities (David, 2003). Therefore, the user is the best judge of when to change the fading options. Second, constructionism presupposes learners taking ownership of their learning. While this has been demonstrated as an effective learning strategy in numerous studies of constructionist activities, it has never been applied to the computational scaffolds used to support those activities.

4.2 The Design of PoW

The PoW toolkit contains a Pearl authoring tool, a Pearl index for locating Pearls, Pearl discussion forum, and user tutorials and other documentation. The PoW software model is constructionist and therefore Pearl construction is intended to be a design activity. This discussion of the PoW design rationale maps design affordances and intentional reflection scaffold requirements to specific PoW software features.

There are areas of the Pearl interface designed to prompt learners about their project and Pearl design choices. Organized into three operational components, they are: meta-tags, navigation icons, and narrative prompting (Duckworth, 2001; Hutchins, 1995; Lave & Wenger, 1991). The top section

contains fill-in fields for meta-tagging the Pearl. Meta-tag information facilitates indexing of the Pearl within the Pearl collection. The leftmost margin contains five navigation icons, each representing one of the five Pearl pages. The remaining screen area contains three Pearl Panels, which is the canvas for the Pearl designer's work. Each of the three main sections will be examined shortly. Figure 9 is a screenshot of the initial Pearl layout.

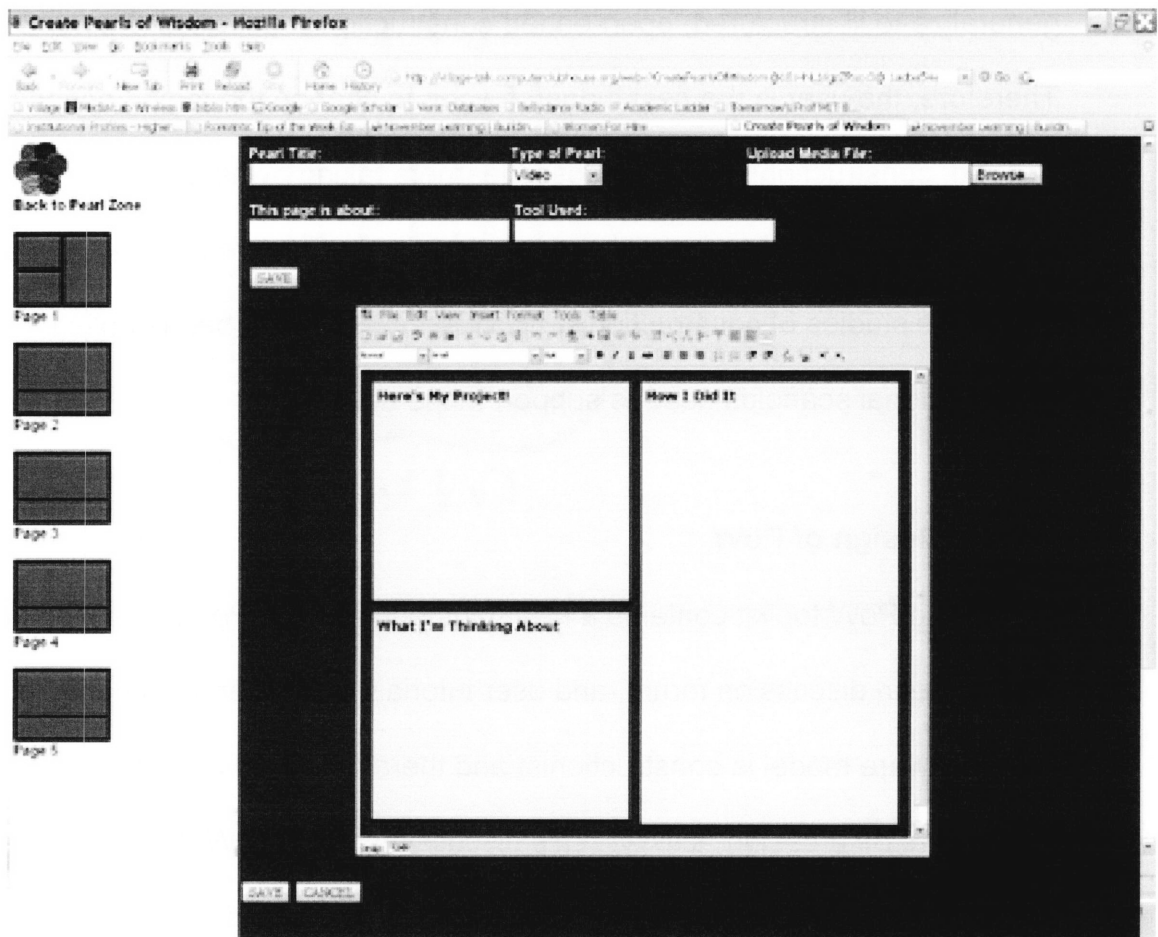


Figure 9. Pearl Layout.

4.2.1 Pearl Panels

At the top of each Pearl Panel is a prompt statement meant to aid the learner's understanding of how to organize their reflections. In Section 4.1.1,

prompting was cited as useful for initiating a cycle of reflective thought on past experiences. In particular, open-ended, process prompts were found to be most effective. Pearl prompts are intended to help organize the learner's reflective thinking by focusing his attention on various aspects of the project. These prompts are in the form of first-person statements. The prompts are: "Here's My Project," "How I Did It," and "What I Was Thinking About." Consideration of these statements moves the learner through a cycle of reflecting on their project.

"Here's My Project" prompts the designer to either describe or include a sample of her project. "What I'm Thinking About" prompts the designer to focus on non-operational aspects of their project. For example, he or she may include motivations for working on the project, insights from debugging episodes, or significant "ah-ha" learning moments. "How I Did It" prompts the designer to tell the story of how he put his project together. The four remaining Pearl pages contain two Pearl Panels each, each containing "How I Did It," and "What I'm Thinking About" prompts. From the user's perspective they are able to access the source code to change panel characteristics such as number of panels, layout, prompts, etc. However, from the developer's perspective, user access to source code is limited to that code which generates the panels. This gives the learner additional design freedom without compromising the operation of the essential software.

4.2.2 Meta-Tagging

While constructionist software may be open-ended from the perspective of the learner, this does not imply lack of structure. It is important from a system

developer viewpoint that the organization of the collection of Pearls be based on some standard indexing information. This requires the user to input information, including the Pearl title, genre, design tool, and page sub-title. To enforce this standard, the software has been designed so a new Pearl cannot be saved until the Pearl title and genre information is input. This ensures a minimal amount of information is available to the users and adequate for indexing by the software. The genre value is selected from a drop menu, and automatically defaults to “video” if left unchanged. Video projects are the least common which makes it a good “default” genre value. This allows for easy identification of Pearls whose genre value was ignored by the designer. From that point on, all Pearl content becomes a design decision. For example, the designer might go into great detail about how apply a cloud effect to an image by inputting specific parameter values into a Photoshop image filter. Conversely, the designer may only summarize the various project stages. For example, “create clouds in Photoshop and color.” Similarly, design decisions are made about content organization, Pearl layout, customization, and relevant media. Figure 10 shows meta-tag fields.

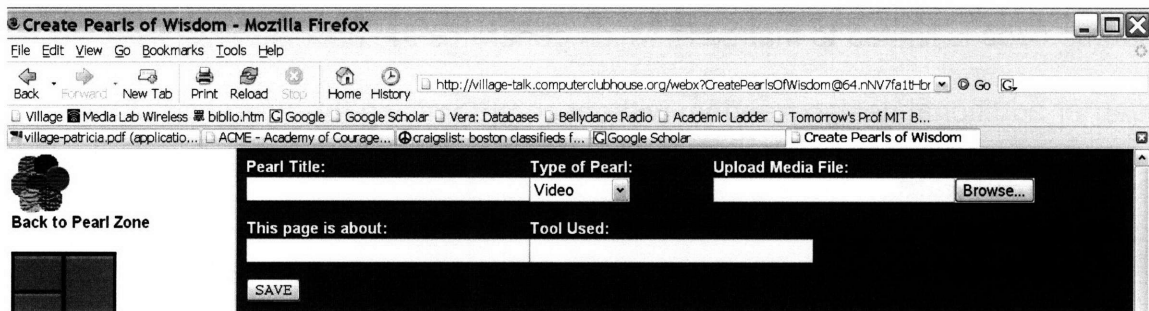


Figure 10. Screen Capture of Content.

4.2.3 Navigation Icons

When a new Pearl is created, the learner is presented with five navigation icons along the left margin of the screen. The rationale for displaying an icon for each is to suggest a staged inclusion of the Pearl content, effectively asking them to consider different ways of organizing what they plan to say. All but the first Pearl page can be deleted by the user.

4.2.4 Structural Flexibility, Interconnectivity, and Limitations of Pearl Design and Programming

The html the user accesses is partitioned from the PoW source code. That protects the PoW system from accidental corruption by user tinkering. An important aspect of the Pearl interface is that while it has a default panel layout, the learner may change that by revising the underlying html code. Pearl panels have an underlying html structure that can be directly manipulated to produce complex design options. This code is accessed by clicking on the “code” tab at the bottom of the Pearl. This permits user editing of the Pearl Panels as a means of promoting algorithmic thinking and panel layout customization.

Another computational construct available to learners is the Pearl link. Links allow referencing of other Pearls from within the Pearl being constructed. As all links do, Pearl links represent a relationship between the thinking of different Pearl creators.

4.3 Using Pearls

The Pearls of Wisdom home page is the portal to the Pearl collection, discussion forums, help documents, and researcher contact information. **Figure 11** is a screen capture of the PoW home page.



Figure 11. Pearls of Wisdom Home Page on ICCN Village Intranet.

4.3.1 The Pearl Zone

The Pearl Zone is accessible from the PoW Home Page and contains the entire collection of saved Pearls. Pearls are indexed by name, username, date,

design tool, or genre. Each Pearl has an icon that links to the creator's user profile, where additional information, such as their other projects and interests, may be available. The Pearl Zone also provides access to the Pearl authoring tool. **Figure 12** shows screen capture of the Pearl Zone.

The screenshot shows the 'Pearls of Wisdom' website interface. At the top, there is a header with the title 'Pearls of Wisdom' and two links: 'Create new Pearl of Wisdom' and 'Pearl Topic Page'. Below the header is a table listing various Pearls. Each row in the table includes a small thumbnail image of the Pearl, followed by its title, author, date added, type, and design tools used.

Designer	Pearl Title	Author	Date Added	Pearl Type	Design Tools
	Cherish Your Friends1	mercedes	Apr 4, 2005	Image	Photoshop
	Coloring a Scanned Image	slamonfund	Apr 4, 2005	Image	microsoft paint
	Cover Girl	jpatterson	Nov 14, 2005	Image	Photoshop
	Creating Pyramids	marlon	Jan 19, 2005	Image	Bryce 5
	Designing Great Pearls	mrc	Nov 13, 2005	Multimedia	Pearls of Wisdom
	Diseno en Painter 7	ctballist	Mar 7, 2005	Image	Painter 7
	Dreamweaver Templates	drumhead	Nov 11, 2005	Web	Dreamweaver
	Flower Girl	babyuanaca	Oct 24, 2005	Image	Photoshop
	Food Fight Comic Strip	llowekittens	Nov 15, 2005	Image	Paint
	Frames in Dreamweaver	nsanderson	Mar 7, 2005	Web	Dreamweaver
	Graphs and charts	lkoolkin	Jan 20, 2005	Writing	Microsoft Excel
	Hand Drawn Portraits	mrc	Feb 25, 2005	Image	Photoshop

Figure 12. Screen capture of Pearls Zone.

The Pearl Zone is indexed by the meta-tag information entered in each Pearl header. As mentioned earlier, this data includes the Pearl title, Pearl type (genre), and design tool. The PoW software generates additional information, including a link to the learner's profile page, their username, and the date the Pearl was created. Table 6 summarizes all Pearl Zone indexing data.

Table 6. Pearl Zone Indexing Schema.

Index Header	Information Source
Pearl Title	Entered by Pearl designer.
Designer	Retrieved from login state information.
Author	Generated by PoW software.
Date Added	Generated by PoW software.
Pearl Type	Selected from menu by Pearl designer. Choices included video, audio, image, web, writing, multimedia, and animation.
Design Tools	Supplied by Pearl designer.

4.4 PoW Toolkit Implementation

The PoW toolkit consists of the Pearl authoring software, the Pearl Zone, user tutorials, and discussion forums. PoW is accessible to all users logged onto the Intranet. Many PoW architectural details were predetermined by the host intranet. PoW was implemented using the WebCrossing threaded-discussion library routines. The user interface was further customized using XML-RPC (Extensible Markup Language Remote Procedure Calls) to design an interface that functioned in accordance with the PoW software goals. Threaded-discussion tools are static message forums that conform to a standard tree structure. The goal in this instance was to hide the inherent structure of the WebCrossing threaded-discussion tool by mapping PoW toolkit features over it.

This results in the threaded-discussion serving as a back-end for the PoW software.

In Section 4.4.1, I present the intranet that hosts the PoW toolkit. Section 4.4.2 lists the hardware and software that comprise the general infrastructure of the Intranet. Section 4.4.3 details how WebCrossing and XML-RPC combine to meet the design requirements for scaffolding intentional reflection. Finally, Section 4.4.4 details the mapping of PoW onto the underlying WebCrossing software infrastructure.

4.4.1 Host Intranet Architecture

Figure 13 illustrates the various parts of the intranet architecture. System-level intranet applications are summarized in Table 7.

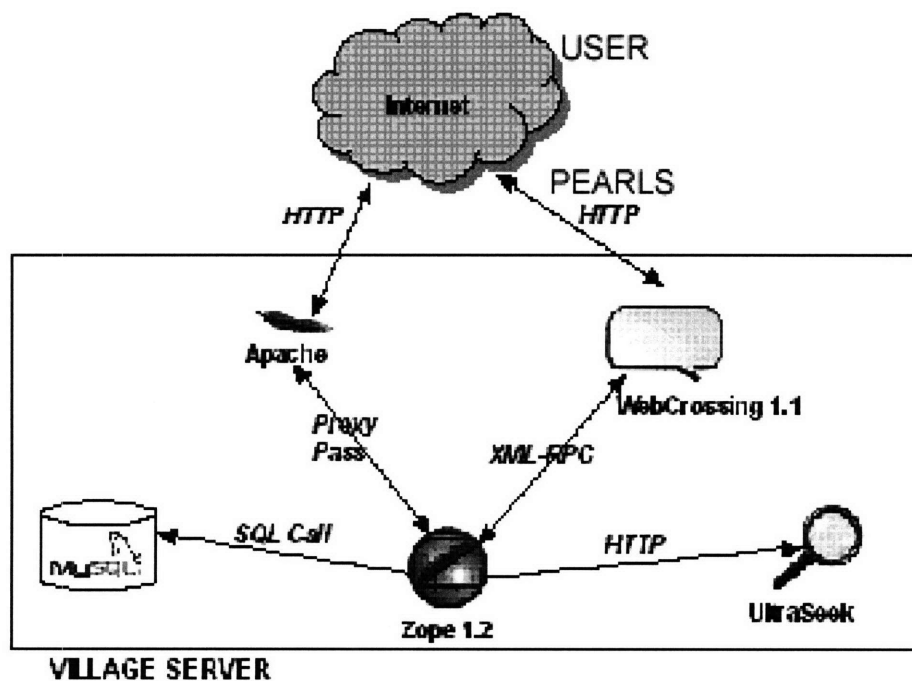


Figure 13. Intranet Architecture.

Table 7. Intranet System-Level Applications.

Development Tool	Purpose
WebCrossing	Discussion forum functionality is provided by WebCrossing intranet conferencing software. It is web-based and uses a contextualized message structure so that all the contributions in the thread are presented together. The user does not have to open and close messages.
Zope	Zope, an open source application server, uses an XML protocol to retrieve subscription and message information from WebCrossing. WebCrossing uses the same protocol to retrieve Village user information from the database via Zope.
Apache Web Server	The Apache web server is configured to serve files requests to Zope. All of the ICCN Village data, including user information, projects, and clubhouses, is stored in a MySQL database.
UltraSeek	UltraSeek provides search engine functionality, using an authentication token, in order to spider the site.
ProxyPass	Secures the Apache server against password violations.
XML-RPC	(XML-Remote Procedure Call) XML-RPC is a remote procedure protocol that works over the Internet. The specifications and set of implementations allow software to run on disparate operating systems by making procedure calls using HTTP as the transport and XML for the encoding. server-side and the return value is again formatted by XML. The procedure parameters may be any number of data types, including numbers, dates, strings, lists, arrays, or other more complex data structures. XML-RPC provides a compatible foundation across disparate computer systems.

4.4.2 General Infrastructure Routines: Zope, SQL, Apache, Ultra-Seek, and ProxyPass

The Intranet that hosts the PoW toolkit is composed of several interconnected applications (see Table 7). The system runs on an Apache web server in *mod_proxy* configuration (which implements a caching proxy inside Apache) where it passes user requests to Zope, the applications server. Zope then retrieves information related to subscriptions and messages posted from WebCrossing (<http://www.webcrossing.com>). WebCrossing retrieves user information, such as user name, from Zope. Communications between Zope and WebCrossing is managed by XML-RPC. The Intranet's data files (user information, etc.) are stored in a MySQL database. Search engine functionality is provided by UltraSeek, which logs into Zope using an authentication protocol to access the database and perform searches. The Intranet is currently running on a Dell PowerEdge 2650, with a single 3.06GHz Intel Xeon processor, a 512k cache and 2Gb SDRAM.

4.4.3 WebCrossing and XML-RPC Operation in PoW

WebCrossing is a well-known conferencing server platform (WebCrossing, 2006). It uses XML-RPC to share resources from its server and to access shared resources from other servers. Additionally, WebCrossing can operate as a server or client and handle search requests.

XML-RPC works by calling procedures to draw a Pearl interface as a replacement for the WebCrossing interface. It creates connections between

procedures running in different applications or on different machines, so called procedures may be local or remote (Buraga, 2002). XML-RPC also dynamically loads the latest Pearl database information into the interface as Pearl requests are made.

An example of how WebCrossing handles Pearl client requests follows. First, WebCrossing processes the HTTP request to extract the unique id of the Pearl object to be rendered. WebCrossing then determines which Pearls of Wisdom template to use based on the type of object that was referenced: a Pearl (initial page); a Pearl following page; or the Pearl Zone folder. In order to render the Pearl object Webcrossing requires additional user data from the MySQL database. This data is accessed via XML-RPC through Zope. The user id of the object's author is loaded in the XML format and sent to the XML-RPC server, in this case Zope. At this point a standard SQL query is instantiated to retrieve user information such as full name, and clubhouse. The query format will vary depending on the type of database server being used. Then a connection is made, the procedure called, and the results of the call obtained. This data is then packed in XML format and returned via HTTP to the XML-RPC client, WebCrossing. It generates the Pearl page and returns the generated HTML to the browser via HTTP. Figure 14 is a screen capture of the default layout for the WebCrossing threaded discussion.

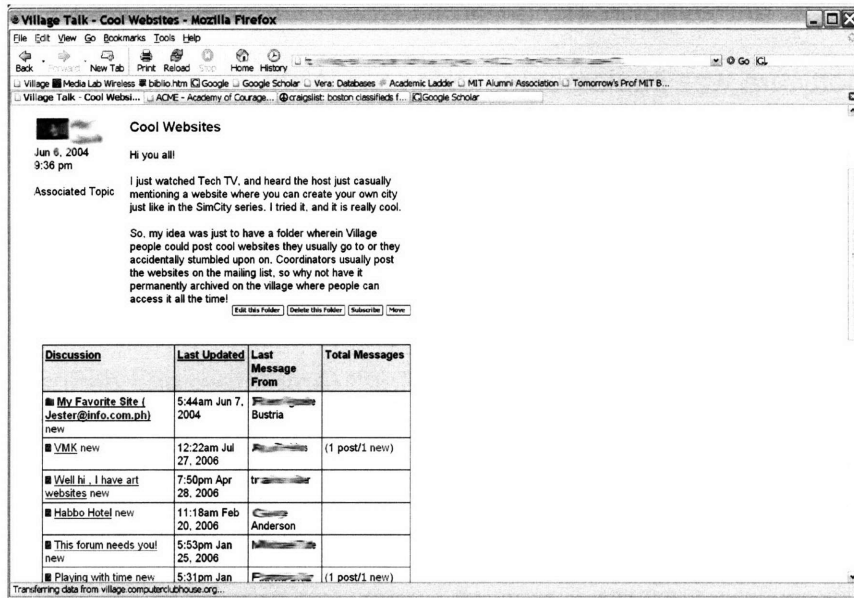


Figure 14. Threaded-discussion forum with default layout.

There are functions for adding graphics to the interface; however, layout options are limited. Figure 15 is a screenshot of a discussion page configured using the WebCrossing customization tools.

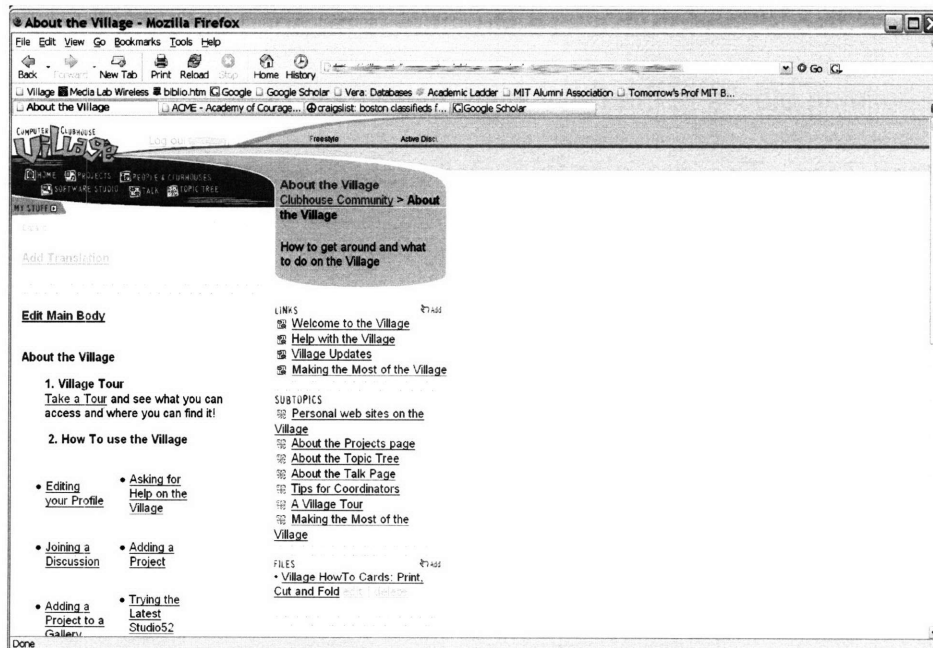


Figure 15. Threaded Discussion with Layout Template.

4.4.4 XML-RPC and WebCrossing Equals Computational Scaffold

The PoW software was implemented using the WebCrossing Template Language (WCTL). XML-RPC calls are used to retrieve user data that is kept in the MySQL database, but WebCrossing templates handle all formatting of the data for the user. WebCrossing is effectively the back-end for the PoW software.

The PoW software overrides the default templates, and defines new template macros to handle additional new object attributes needed by Pearls such as type of Pearl. The result is that PoW users experience the discussion software as a design interface similar to a Paint program.

From a systems perspective, WebCrossing consists of a discussion forum (essentially a folder), discussion header, and initiating message and response messages. Those features would be in sync if appropriate mappings could be made for those WebCrossing affordances that meet PoW design goals. Generally, the discussion forum's tree structure is mapped onto the three functional building blocks of the PoW system, namely the Pearl, the Pearl page, and the Pearl Zone. The idea was to exploit WebCrossing software features were already in sync with PoW design goals. For example, one PoW design goal was to ensure that once a Pearl was saved, it could not be deleted. So the Pearl, as a functional unit, had to be mapped either to the Forum Header or Start Message levels. These two levels can only be deleted by a system administrator, so Pearl users don't have the system permissions to delete their Pearls. The final decision to map the Pearl to the First Message tree level was motivated by two other design goals. First, not only could Pearls not be deleted by the user, but they also could not be saved until Pearl meta-tag information

was filled in. Second, as mentioned earlier in this section, a PoW design goal is for Pearls to be persistent in the database. Under the current WebCrossing to PoW mapping, Pearls cannot be deleted. The discussion starter message is mapped to page one of the Pearl. Starter messages also cannot be deleted by the user. This effectively prevents the PoW user from deleting the first page of the Pearl. Four message responses were mapped to pages two to four of the Pearl. Message responses can be deleted, which gives the PoW user the option of removing unused pages from the Pearl. The WebCrossing to PoW function mappings are summarized in Table 8.

Table 8. WebCrossing Functions Mapped to PoW Software Requirements.

System Perspective (WebCrossing Functions)	maps to	User Perspective (PoW Functions)
Discussion Forum		Pearl Zone
Discussion Headers _n		Pearls _n
Discussion _m Starter Message		Page 1 of Pearl _m
Message Responses		Pages 2 to 4 of Pearl _m

4.4.4.1 Pearls of Wisdom: A Source Code Example

This section contains a snippet of source code for the PoW interface. This snippet generates the meta-tagging field information described in Section 4.2.2. For example, when a Pearl is created, the learner enters the title information and selects a Pearl genre value from a drop menu.

Pearl Header Section Source Code

```

                                <font color="white"><strong>Pearl
Title:</strong></font><br><input type="text" name="title" size="30">
                                </td>

                                <td width="33%">
                                <font color="white"><strong>Type of

Pearl:</strong></font><br>

                                <select name="pearl_type">
                                <option value="Video">Video</option>
                                <option value="Audio">Audio</option>
                                <option value="Image">Image</option>
                                <option value="Web">Web</option>
                                <option value="Writing">Writing</option>
                                <option value="Multimedia">Multimedia</option>
                                <option value="Animation">Animation</option>
                                </select>
                                </td>
                                <td width="33%">

<html>
<head>
    <!-- Page produced by %% programName %% (r) %% platform %% - %% version %% (%%
programPromo %%) for %% siteLicensee %% -->
    <title>%% virtualSiteTitle %% - %% "lang".jscall( "extn", "addDiscussion" ) // Add
Discussion %%</title>

                                <script language="javascript">
                                <!--
                                function submitPoW(this_form) {
                                top.frames['nav'].location = 'http://village-
talk.computerclubhouse.org/webx?pow_nav_edit@@%%location%%';
                                this_form.submit();
                                }
                                function cancelbutton() {
                                top.location = 'http://village-
talk.computerclubhouse.org/webx?14@@@.1adba54e';
                                }
                                function submitAddDiscussion_pow() {
                                document.addDiscussionForm.header.value =
document.addDiscussionForm.ephox.value;
                                top.frames['nav'].location = 'http://village-
talk.computerclubhouse.org/webx?pow_nav_edit@@%%location%%';
                                document.addDiscussionForm.submit();
                                } //submitEditDiscussion
                                -->
                                </script>
                                <script src="webfolder/redistributables/editlivejava/editlivejava.js"></script>
                                <script src="vt_ephox.js"></script>

</head>
```

This code generated the Pearl title, Type of Pearl drop menu, and other input fields. It also instituted a SAVE function. See Figure 16 for the screen view.

Figure 16. Pearl Header Section Generated by Source Code.

Additionally, the html code which generates the Pearl Panels was simplified so users who choose to customize the html would find it easier to decipher the code. By using any online html tutorial, most users could figure out aspects of the code. In particular, user may recognize the panel prompts text, as well as other familiar phrases like font size, etc. There are no help documents supplied in the PoW tutorials. This is because most users would surf the Internet before using a tutorial, whether software- or paper-based.

As mentioned earlier, the user would only be able to access the Pearl Panel html and has no access to the XML-RPC code that generates the Pearl itself.

Pearl Panel HTML Code

```
<table bgcolor="#330066" width="100%" cellpadding="1" cellspacing="10" border="0">
<tr>
<td valign="top" width="300">
<table bgcolor="ccfff" width="100%" cellpadding="1" cellspacing="1" border="0">
<tr>
<td width="100%"><font size="4"><b>Here's My Project!</b></font></td>
</tr>
<tr>
<td width="100%"><br />
<br /> .... <br />
</td>
</tr>
```

```

</table>
</td>
<td valign="top" width="300" rowspan="2" colspan="1">
<table bgcolor="ccffff" width="100%" cellpadding="1" cellspacing="1" border="0">
<tr>
<td width="100%"><font size="4"><b>How I Did It</b></font></td>
</tr>
<tr>
<td width="100%"><br />
<br /> .... <br />
</td>
</tr>
</table>
</td>
</tr>
<tr>
<td valign="top" width="300">
<table bgcolor="ccffff" width="100%" cellpadding="1" cellspacing="1" border="0">
<tr>
<td valign="top" width="100%"><font size="4"><b>What I'm Thinking About</b></font></td>
</tr>
<tr>
<td valign="top" width="100%"><br />
<br /> .... <br />
</td></tr></table></td></tr></table>

```

Summary

The power of PoW to support intentional reflection is its grounded design, novel approach to scaffold fading, and re-shaping of WebCrossing into a design-based program. XML-RPC facilitated the programming flexibility needed to perform the mapping from threaded-discussion functionality to specific PoW design-based requirements. Next, Chapter 5 describes the study design and methodology for examining the impact of the PoW software on intentional reflection practices.

5 Research Design and Methodology

A goal of this research was to explore the emergence of the Constructionist Cooperative that developed during the PoW study. The research context was an after-school technology center for 10-year-olds to 18-year-olds. The study examined how the empirical data fit the Cooperative Constructionism Indicators described in Section 3.3. The Pearls of Wisdom intentional reflection software and the Reflective Mentor Model provided the experimental conditions for data gathering during the one-year study. The PoW research methodology was designed to answer the research questions presented in Chapter 1. The first research question, *how does construction of reflective artifacts enhance the ways people reflect on their learning processes*, focuses on how learners make meaning of their intentional reflections and use of the Pearls of Wisdom

technology. The second research question, *what scaffolds are most important for engaging a community in reflective practice*, focuses on how Cooperative Constructionism practices emerge within the construction learning environment. Answering these questions required gathering different types of in-depth information. The methodological framework employed was the design-experiment methodology as proposed by Brown (1992) and Collins (1992). The design experiment is a theory-based, mixed-methods research paradigm for conducting empirical studies in complex, real-world settings. The first section of this chapter describes the design experiment methodology and details the PoW design experiment. The next section presents the study participants and research context. The final section details the PoW empirical study.

5.1 Design Experiments

A design experiment is an empirical study where learning technologies and resources are developed, implemented, evaluated, and revised in the service of improving learning outcomes (Brown, 1992; Collins, 1992). Design experiments highlight how new computational technologies and teaching innovations influence learning. According to Brown, the design experiment is a mechanism “to engineer innovative educational environments and simultaneously conduct experimental studies of those innovations” (Brown, 1992). Of primary importance is that innovations take place in real-world settings so the outcomes are of value to both theory and practice. Collins argues further that innovations be theory-based with the goal of exposing learning pathways not previously captured by current theories (Collins, 1992; Collins, 1999).

Learning environments represent complex systems consisting of many interdependent components. Those components include the learners, teachers, learning pedagogy, teacher training, cultural norms, and computational and other learning resources. In design experiments, unlike science experiments, control of a single component, independent of the whole system, is impossible (Brown, 1992; Collins, 1992; Design-Based Research Collective, 2003). Instead, changes to the various components are viewed as system inputs. A typical design-experiment creates a context for the learning interventions and objects under examination. First, a theory-grounded model is proposed and implemented. The model's effectiveness is analyzed and results form the basis for model refinement. See Figure 17 for an illustration of the Design Experiment Cycle. This process provides insight into the reasons and methods of the model's success or failure (Brown, 1992; Barab & Kirshner, 2001; Design-Based Research Collective, 2003).

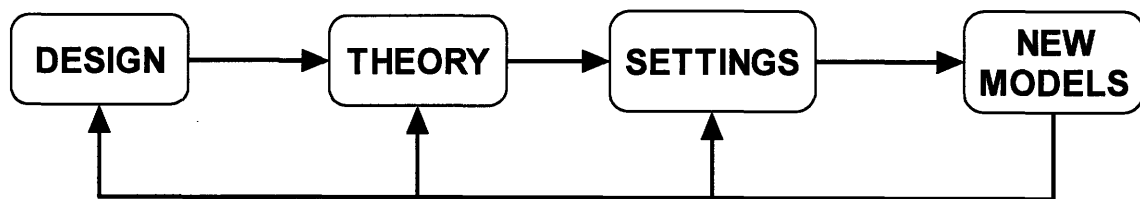


Figure 17. General Design Experiment Cycle.

For the PoW design experiment, the design context was the examination of intentional reflection on learning activities of youth at an after-school technology center. The learning objects and interventions were the PoW toolkit and the reflective-mentor model (RMM). Both the PoW toolkit and the RMM were grounded in constructionist learning theory. Theory-based indicators were also

developed and used to identify and evaluate the results of the PoW design experiment. The goal was to provide and further refine a new framework for supporting emerging intentional reflection practices within a constructionist learning environment. Figure 18 illustrates the functional aspects of a generic design experiment. In Section 5.1.1, the functional aspects of the PoW design experiment are discussed.

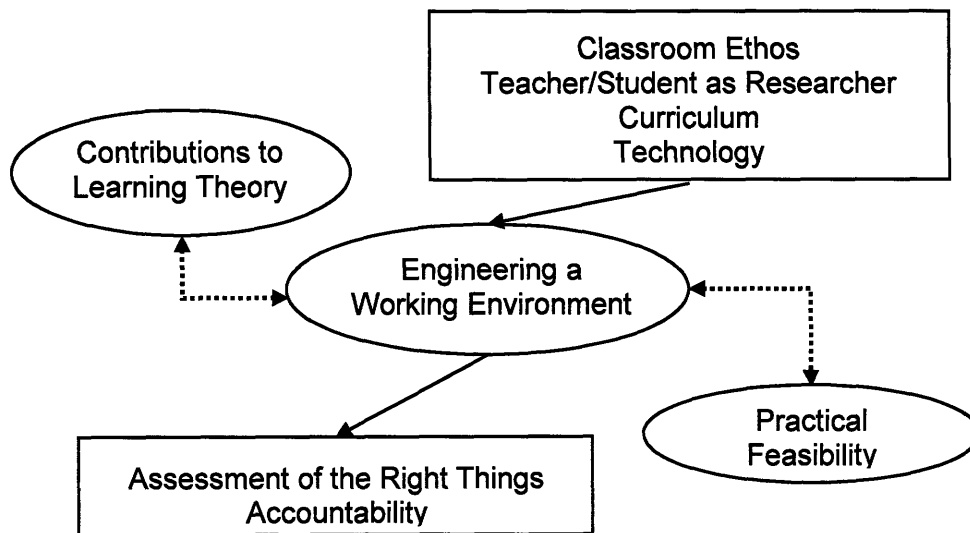


Figure 18. Functional Aspects of a Design Experiment (Brown (1992)).

5.1.1 PoW Design Experiment

The PoW design experiment examined the effects of technologies, scaffolds, and reflective practices on a constructionist learning environment. It required various types of reporting, including case study, treatment group analysis, and cross-case synthesis. Figure 19 illustrates the functional aspects of the PoW design experiment.

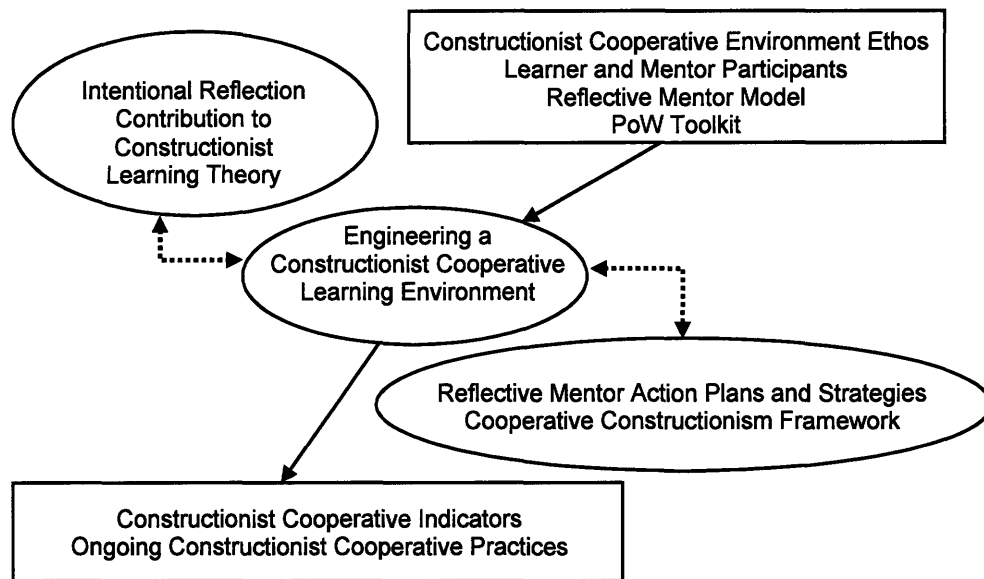


Figure 19. Functional Aspects of PoW Design Experiment.

PoW design experiment inputs included the environment ethos, participants, pedagogy, and resources. Establishing a Constructionist Cooperative environment ethos meant encouraging an environment that promoted intentional reflection as a desirable practice. Participation was voluntary; therefore it was important for participants to view themselves as contributors to the learning innovations. RMM represented a new pedagogy for mentors to explore and reconcile with the day-to-day demands of working with learners. The PoW toolkit was the technology under examination for its impact on reflective learning and appropriation by learners. PoW design experiment outputs included indicators of intentional-reflective practices and sustained Constructionist Cooperative practice. These were identified using the theory-based Cooperative Constructionism indicators and periodically checking for continued PoW use. PoW design experiment cycles involved implementing RMM action plans and

strategies and refining the Cooperative Constructionism framework with insights gained from examination of the empirical data.

5.2 Research Context

The PoW study took place at the Flagship Computer Clubhouse (FCC), located at the Boston Museum of Science, in Boston, MA. Earlier pilot studies were conducted at the Flagship, South Boston, and Roxbury Computer Clubhouses (Chapman, 2004). The Computer Clubhouse (Clubhouse) was jointly founded in 1993 by the MIT Media Lab and Computer Museum, which is now part of the Museum of Science (Resnick & Rusk, 1996). It has since expanded into a network of over 100 Clubhouses, worldwide. The Clubhouse is a free, drop-in program where youth participate in constructionist, project-based learning activities with the support of adult mentors. The Clubhouse model was designed to promote interactions that enhance learning. These interactions occur in several key spaces, including learning, social, physical, and virtual space, all detailed below.

5.2.1 FCC Learning Space

Clubhouse guiding principles embody the spirit of the constructionist learning model. The principles are outlined in Table 9 below.

Table 9. Computer Clubhouse Guiding Principles.

- | |
|---|
| <ol style="list-style-type: none">1. Focus on constructionist-learning through expressive design experiences2. Encourage learners to build on their personal interests to motivate new learning opportunities3. Cultivate an emergent community of learners and supportive mentors who provide productive learning examples4. Build an environment of respect and trust, where learners can feel safe to experiment, innovate, and take risks. |
|---|

The Clubhouse learning philosophy is based on the constructionist approach to learning and focuses on the importance of interpersonal relationships and community in the learning process. Members engage in constructionist-learning activities, utilizing expressive technologies and collaboration tools. For example, resources include professional graphic and multimedia development tools, digital cameras, arts and crafts supplies, robot construction kits, and music studio equipment. Through their use of these design materials, FCC members gain access to new ways of thinking about and using the materials for their individual self-expression.

5.2.2 FCC Social Space

Learning at the FCC occurs within a social context; therefore, member activities are both socially and culturally meaningful. FCC members visit the Clubhouse to work on projects inspired by their personal experiences. While there, they form friendships and collaborations based on similar interests as

others. On any given day, the FCC is alive with member chatter about projects, music, family, and other items of interest at the time. The FCC is a playful environment where learning happens through focused project design. Some members become experts whom others consult for project help and ideas. The FCC also enjoys a thriving collaborative culture, especially around movie-making and digital music projects. These interactions serve to promote lifelong learning skills like positive self-image, self-confidence, and good work and leadership ethics. For many members, the FCC is a microcosm where they can explore and practice these skills (Pinkett, 2001; Chapman & Burd, 2002; Chapman, 2004) while engaging in creative and intellectual work with others.

5.2.3 FCC Physical Space

FCC physical space supports many FCC social connections. The physical space is organized so project resources and activities are visible to everyone. There are eighteen high-end computer workstations, including workstations with software and equipment for music and movie projects. Computers are arranged in clusters, making it easier for members to view others working. Wheeled chairs invite movement throughout the room. This use of physical space differs from many classroom models where layout discourages movement and easy access to others. Other physical spaces help facilitate connections between FCC members and aid the spread of ideas. Clubhouse walls provide a gallery-like forum for members to display their work and serve as a persistent form of idea dissemination. However, while image-based projects are easy to display, the

walls cannot accommodate display of other media types (i.e., audio, video, programming, and physical constructions). The room also contains a large, oval table, called the Green Table, where members plan projects, work on homework, build things, and chat. Figure 20 depicts the layout of the FCC physical space.

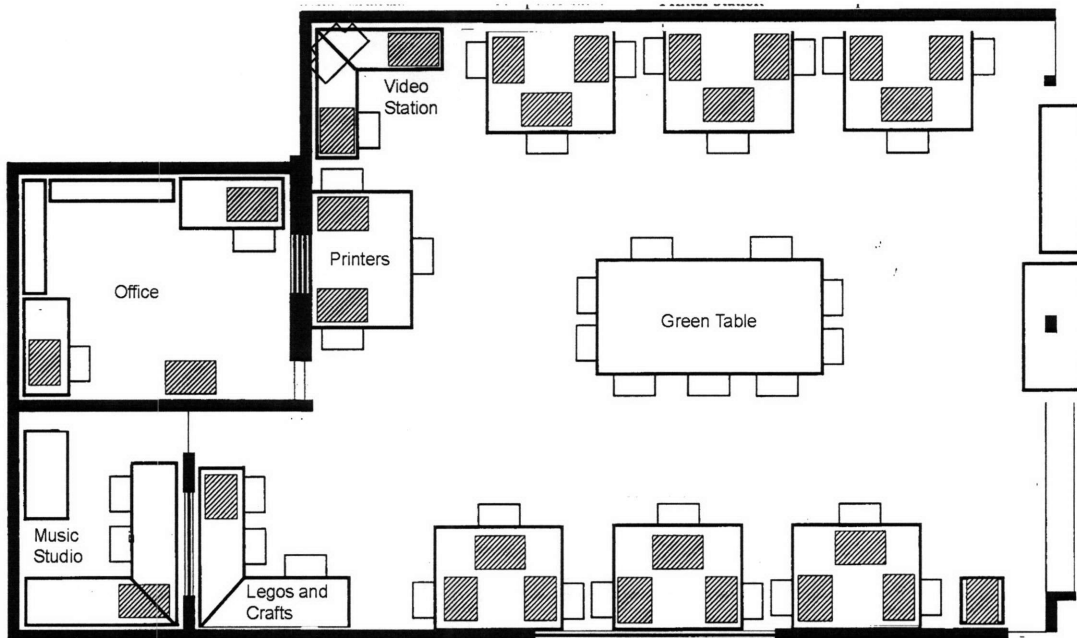


Figure 20. FCC Floor plan.

5.2.4 FCC Virtual Space

The FCC is part of a larger network of 100+ Clubhouses, worldwide. The Intel Computer Clubhouse Village intranet (Village) is the network connecting over 100+ Clubhouses (Diaz, 2002). **Figure 21** shows the ICCN Village home page. On the Village, Computer Clubhouse members can showcase projects, participate in discussion forums, and try out new project ideas.



Figure 21. Computer Clubhouse Village Home Page.

The PoW software is accessible through the Ideas and Inspiration section of the Village to any Clubhouse member with a Village account. During the course of the study, PoW was formally introduced to the FCC membership, although members or mentors from other Clubhouses were not restricted access.

5.2.5 Study Participants

Study participants consisted of members, mentors, coordinators, alumni, and administrative staff of the FCC. Member ages ranged from 10 to 18 years old. All other participants were over 18 years old. Member age distribution was 55 10-12 year olds (18%), 107 13-15 year olds (35%), 140 16-18 year olds (46%) and 3 non-respondents (1%). See Figure 22.

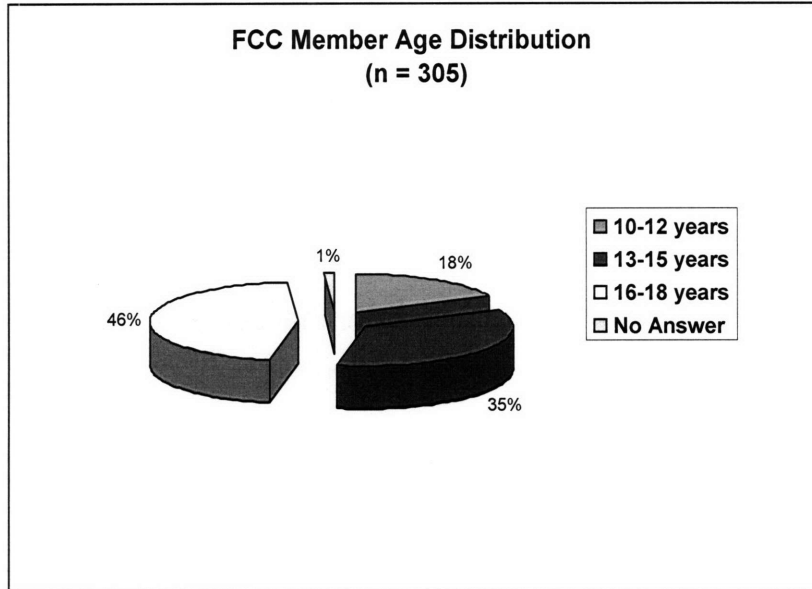


Figure 22. FCC Member Age Distribution.

5.2.5.1 Member Demographics

There were a total of 305 FCC members at the start of the PoW study. Of the 305 members, 36% were female and 60% were male with 4% non-respondent. See Figure 23.

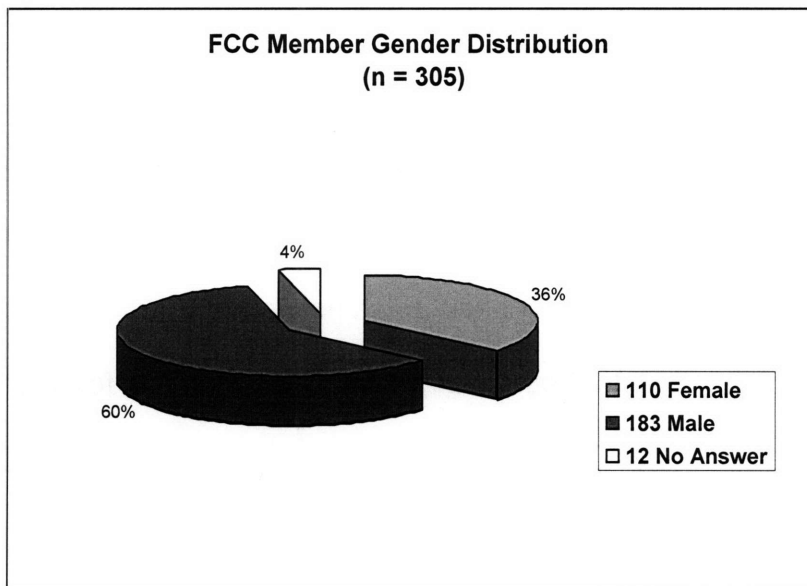


Figure 23. FCC Gender Distribution.

Over the course of the study, the daily average FCC attendance was 16 members. FCC members presented great diversity in culture, identity, and language, seen in Figure 24. While this offered rich opportunities for project creativity and discovery, it also presented barriers to connection among learners. For example, language was a common barrier that sometimes isolated groups of members.

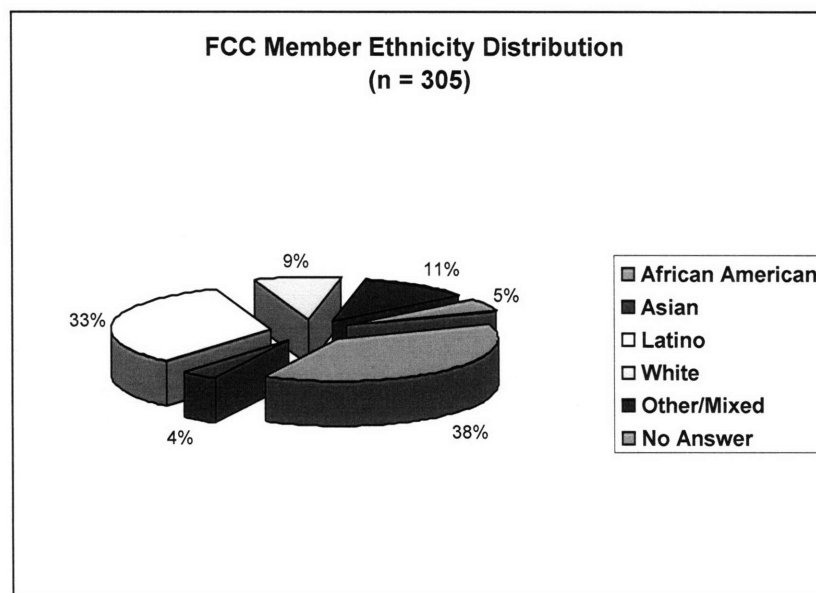


Figure 24. FCC Member Ethnicity Distribution.

The average tenure of the 305 members is 2-3 years. See Figure 25. Members who have longer tenure at the FCC have accumulated a greater number of design tool skills and have established a rich network of Clubhouse friends. New members often look to these veterans and their projects for project ideas and guidance.

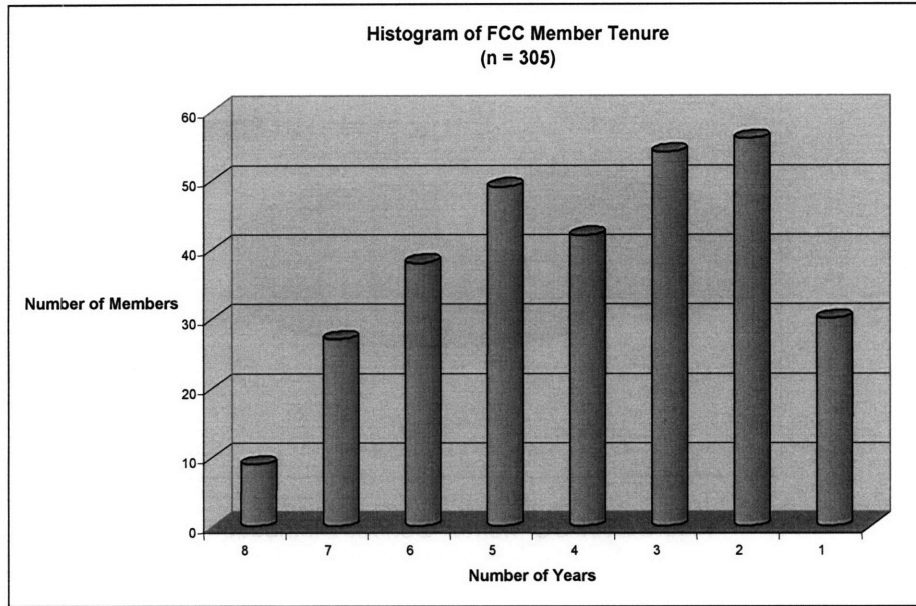


Figure 25. FCC Member Tenure in Years.

As might be expected, as the length of tenure increases, members graduate out of the program and/or stop attending the FCC to take jobs or engage in other after-school activities.

5.2.5.2 Mentor Demographics

FCC mentors are volunteers who support youth in their use of technology as a medium for personal expression (Resnick, et al., 1999) and personal development. There were a total of 30 FCC mentors at the start of the study, 19 (63%) male and 11 (37%) female mentors. See Figure 26.

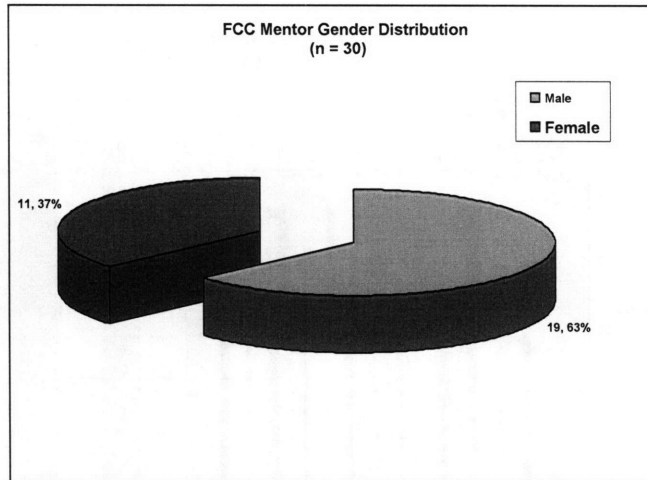


Figure 26. FCC Mentor Gender Distribution.

Mentors are 18 years or older and hail from diverse backgrounds, both culturally and professionally. They run the gamut from college students to senior citizens to artists to business professionals and process differing levels of mentoring experience. Mentors also bring a variety of mentoring styles and range from experienced to inexperienced in working with young people, especially from underserved communities. Figure 27 shows the mentor tenure distribution at the start of the PoW study.

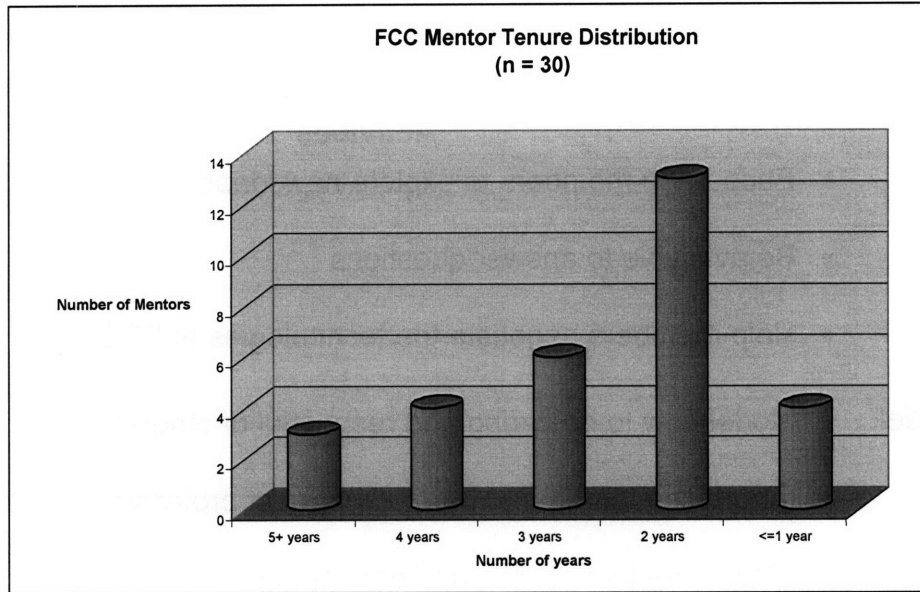


Figure 27. FCC Mentor Tenure Distribution.

Relationships between members and mentors develop informally and are broadly defined. These relationships provide emotional support and friendship to members, as well as project support (Pollack, 1995). The Mentor Handbook and Mentor Toolkit developed by the Intel Computer Clubhouse Network staff details mentor duties and responsibilities. All mentors receive these guides at the start of their FCC tenure. FCC Coordinators and veteran mentors provide additional assistance and information. Table 10 summarizes FCC mentor activities.

Table 10. FCC Mentor Activities.

Role	Activities
Guide	<ul style="list-style-type: none"> • Encourage members to explore new ideas • Be available to answer questions • Help members negotiate the technologies at FCC
Role Model	<ul style="list-style-type: none"> • Model how to be caring and respectful of others • Introduce members to mentor's area of professional expertise • Model problem solving and debugging
Participant	<ul style="list-style-type: none"> • Work on own projects and interests • Share projects and project ideas with community
Facilitator	<ul style="list-style-type: none"> • Encourage members to take risks • Encourage member exploration of project ideas

5.2.5.3 FCC Support Staff

During this study, FCC staff consists of 2 Clubhouse Coordinators, 2 Assistant Coordinators, 30 mentors, 4 interns, and the Intel Computer Clubhouse Network (ICCN) staff. See Figure 28.

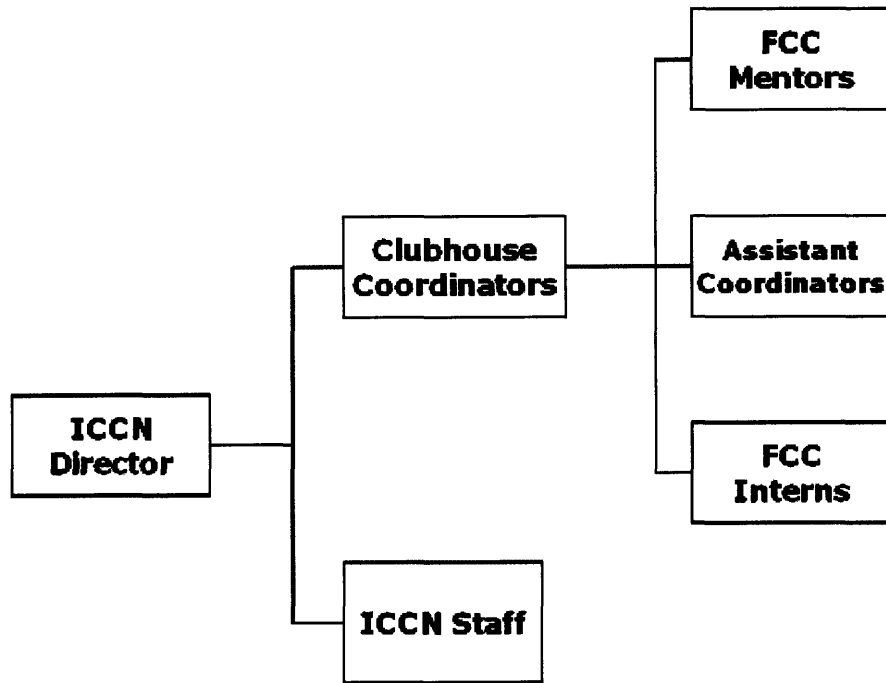


Figure 28. FCC Organizational Chart

Two Clubhouse Coordinators are responsible for overseeing day-to-day FCC operations, managing mentors, recruiting new members, and supporting member learning. In the PoW study, the Coordinators introduced the study and researcher role to the FCC community and assured community members that participation was voluntary and they could withdraw from the study at any time. Assistant Coordinators share oversight of FCC operations on Saturdays. FCC interns are experienced FCC members hired to assist the coordinators.

FCC alumni are a presence in the Clubhouse and visit primarily on Fridays and Saturdays. The FCC stance is “*once a member, always a member,*” and alumni are welcome to use FCC resources. Many alumni take advantage of their FCC connections, giving members an opportunity to connect their FCC activities to the real world of work.

ICCN staff consists of the ICCN Director and support staff responsible for managing and developing the entire network of 100+ Clubhouses. Some responsibilities include ICCN evaluation and assessment, staff professional development, fundraising, and new Clubhouse startup.

5.3 Empirical Study: Pearls of Wisdom at the FCC

A study goal was to identify and examine factors important to emergence of a practice of intentional reflection on learning, at both the member and mentor levels. This meant collecting different types of data and using different study methods (i.e., case study, treatment groups, cross-case synthesis) to evaluate the extent to which the Cooperative Constructionism indicators were observed.

5.3.1 Case Study

A case study is an empirical inquiry into processes within an authentic context with a goal of learning about and understanding those processes relevant to the research questions. Yin (2002) defines the case study as especially important when the boundaries between the processes and its context are not readily apparent. Erickson nicely summarizes the performance of a case study as an:

“intensive investigation of a single object of social inquiry such as a classroom [that] allows the total immersion of oneself into the dynamics of a single social entity and enables the uncovering of events or processes that one might miss with more superficial methods.”

Erickson (1986, p.238)

Multiple cases studies were performed for the PoW study using three units of analysis per Rogoff (1995) who argues for three critical aspects of learning

environment analysis. These units include examining the individual's experience, interpersonal interactions, and community processes. The PoW study included several participant cases with the individual as the unit of study. The FCC Mentor case study examined the interpersonal relations that supported mentor team development and its impact on the Constructionist Cooperative that developed. The FCC case study focused on community processes that promoted intentional reflection practices at the community-level.

5.3.2 PoW Study Treatment Groups

The rationale for treatment groups is to provide replication for case study validation (Yin, 1994). Numerous studies (Resnick & Resnick, 1992; Schumacher & McMillan, 1993; Yin, 1994) have shown that multiple treatments approximate a sampling approach similar to running multiple experiments. For the PoW study, there were three treatment groups, G1, G2, and G3, organized by the days of FCC operation. Group treatments were determined based on characteristics of the group itself. These included percentage of a group's mentors interested in PoW study participation and the group's existing constructionist learning culture, which was determined by levels of project development.

PoW software training comprised two mentor hands-on workshops that took place before the software was made available to members. A goal was to ensure mentors had opportunities to tinker with the software, experiences of building intentional-reflective artifacts (IRAs), and discussions regarding the purpose and goal of reflection on learning. IRA support and training included

online documentation and ongoing researcher support. RMM implementation included facilitation and ongoing support for growing a mentor community of practice around supporting intentional reflection. The three group treatments are outlined in Table 11.

Table 11. PoW Group Treatments³.

Group	Days	Characteristics	Treatment
G1	Mondays	High mentor participation High project development	PoW Software Training IRA Support and Training RMM Implementation
G2	Wednesday and Thursday	Low mentor participation Low project development	PoW Software Training
G3	Friday and Saturday	Low mentor participation High project development	PoW Software Training IRA Support and Training

Treatment groups do not imply group control, especially within most design experiments, where it is impossible to hold controls in that manner. The PoW study is typical of such studies. For example, FCC members are free to come and go any time the FCC is open and, therefore, it is impossible to assign a member to any particular group. Instead, the PoW treatment groups are viewed as natural clusters.

5.4 Data Collection

This empirical study is an examination of a complex environment in a real-world setting. This requires a combination of quantitative and qualitative data

³ Tuesday attendees were omitted from the treatment groups due to researcher scheduling constraints.

collection methods. The goal is to extend the range of information derived from the empirical data (Miles & Huberman, 1984; Yin, 1989; Patton, 2002).

Qualitative techniques add depth to any quantitative data collected. Quantitative techniques refine the degrees to which qualitative perceptions are shared (Yin, 1994).

Collected data included noting observed events, artifacts, interviews, and computer-generated data, which meant different data collection approaches, were necessary. PoW observational data includes capturing participant interactions with the intentional-reflective toolkit, and conversations and collaborative activities with others. PoW artifacts include learner projects, Pearls, and emails. PoW computer-generated data includes the network-generated logs of Pearl usage, learner logins, etc. Learner and mentor interactions were deeply relational requiring in-depth case study. PoW data collection techniques are detailed below.

5.4.1 Quantitative Data

PoW quantitative data included scored Pearls and Clubhouse projects, surveys, and PoW system logs. Pearls were scored using a rubric grounded in constructionist project and portfolio evaluation research (Scardamalia, 1991; Barab, 2001). FCC projects were scored using a rubric developed specifically for evaluation of Clubhouse projects by the Center for Children and Technology (Pryor, et al., 2002). Surveys, designed to evaluate the learning experiences of FCC study participants, were grounded in the Motivated Strategies for Learning

Questionnaire (Pintrich et al., 1992). PoW system log data was obtained via the Village system administrative software. Those data included Pearl view counts, revision cycles, etc. PoW study quantitative data sources are listed in Table 12 below.

Table 12. Summary of Quantitative Data Sources.

Data Type
Scored Pearls and Clubhouse Projects
Surveys
PoW system logs

5.4.2 Qualitative Data

PoW qualitative data included observational field notes and interviews. Detailed notes were made during observation sessions where tape recording was refused. Pre- and post-study semi-structured interviews were audio-taped and transcribed. Detailed researcher field notes, both descriptive and reflective, were taken and captured participant interactions, processes, and outcomes. Notes contained subject information, event descriptions, subject dialogue reconstruction, and setting descriptions. When permitted by the participant, audio transcripts of the sessions were also made. Field notes were compiled and organized along emergent themes. Additionally, the researcher made reflective notes at the end of the observation period that included reflections on and interpretations of observed events. For example, reflective notes included comments on content classification and directions for future observations. Field note validation was accomplished via participant checking (Stake, 1995; Guba &

Lincoln, 1989). Participants examined and gave feedback on researcher notes. Their feedback ensured the accuracy of field note data and identified areas for further clarification.

Semi-structured interviews were conducted and audio-taped. Interviews were conducted as individual conversations with structure and purpose (Cannell and Kahn, 1957; Patton, 1990). A list of pre-determined, open-ended questions were used to provide flexibility for refocusing the discussion, as needed, on relevant topics that surfaced.

Other qualitative data included participant emails shared with the researcher and discussion board content. These were coded in a similar manner as field notes and interviews. Qualitative data sources are listed in Table 13 below.

Table 13. Summary of Qualitative Data Sources.

Data Type
Field Notes
Interviews
Emails and Discussion Board Content

5.4.3 PoW Study Variables

PoW study variables were grounded in Collins' (1999) work that examined the underlying theoretical and methodological issues for design experiments. Collins identifies dependent and independent variables critical to evaluation of learning environments where design experiments are being implemented.

5.4.3.1 *Dependent Variables*

PoW dependent variables were grouped into three major categories per Collins (1999): climate, learning, and system. Collins identifies these categories as necessary for address specific education and learning research objectives. PoW climate variables focused on characterizing the effects of the PoW innovation *in situ*, for example, how participants engaged the software and each other. PoW study learning variables focused on FCC participant reasoning around their reflective activities and other learning strategies. Systemic variables are generally facilitator-oriented. Within the PoW study, systemic variables measured impact of the RMM on learning and practice at the FCC. The goal was to tease out what aspects of RMM contributed to spreading and sustaining a

Constructionist Cooperative. PoW systemic variables were evaluated through structured interviews and surveys, etc. The grounded, dependent variables assigned to the PoW study are summarized in Table 14 below.

Table 14. PoW Study Dependent Variables (per Collins (1999)).

Category	Dependent Variable
Learning	<ul style="list-style-type: none"> • Reflective strategies • Learning strategies
Climate	<ul style="list-style-type: none"> • Cooperation • Engagement • Risk taking • Learner control
Systemic	<ul style="list-style-type: none"> • Sustainability • Spread of reflective practice • Technology adoption

5.4.3.2 *Independent Variables*

According to Collins (1999), independent variables within design experiments are contextual and invariant over the course of a study. It is important to determine what characteristics of the environment will affect the success of the study. Study setting, participant characteristics, resources, and study-specific training are important aspects of educational studies (Rogoff, 1995; Collins, 1999). For the PoW study, the primary setting was the FCC, which included all the FCC spaces discussed in Section 5.2. Participants included members and mentors. Resources included the PoW toolkit and FCC suite of software. Professional development included PoW software training. The grounded, independent PoW variables are summarized in Table 15 below.

Table 15. PoW Study Independent Variables (per Collins (1999)).

Independent Variable	Description
Setting	Various FCC spaces
Participants	FCC members and mentors
Resources and Implementation Support	PoW toolkit and RMM
Professional Development	PoW Training

5.5 Data Analysis and Reporting

The data analysis framework is derived from Yin (1994) who advocates analysis taking place in intervals over the course of the study. PoW data analysis took place at three month intervals over the course of the study and included case study and treatment group analysis. A final cross-case synthesis was performed at the end of the study.

Case study data analysis includes pattern matching and explanation building techniques. Pattern matching involves identifying and comparing patterns in the empirical data patterns to grounded theory. These one-to-one mappings strengthen the validity of the observed patterns (Yin, 1994). Explanation building involves constructing sequences of events within the case in order to explain specific phenomena (Brown, 1992; Yin, 1994; Barab, 2001). This allows the researcher to derive explanations of how and why transformations take place.

Treatment group data analysis includes descriptive statistics comparing the differences in demographic inputs, participant activities, and other outcomes and artifacts. Cross-group comparison is useful when a study comprises several treatment groups (Merriam, 1998; Yin, 1994). The synthesis promotes understanding of processes and outcomes across multiple groups and facilitates understanding how group outcomes are influenced by study conditions. The PoW cross-group comparison examined similarities and differences across the three treatment groups with the goal of further informing our understanding of Constructionist Cooperative emergence.

“We never educate directly, but indirectly by means of
the environment. Whether we permit chance
environments to do the work or whether we design
environments for the purpose makes a great difference.”

John Dewey (1916), *Democracy and Education*

6 Empirical Studies

A goal of this research was to understand how learners make sense of their intentional reflection and how intentional-reflective practices emerged, at both the individual and community levels. In this chapter, I report the kinds of intentional reflection events that took place over the course of the study and relate those events back to the Cooperative Constructionism theoretical framework and PoW design.

This chapter contains three case studies that highlight two broad areas of interest, 1) how do FCC members make use of the PoW technology and make

sense of their Pearls, and 2) how do members incorporate intentional reflection into their regular FCC practices. Through these case studies, we gain insight into how intentional reflection became part of a constructionist-learning culture.

The Flagship Computer Clubhouse (FCC) community is the unit of analysis in the first case study. I present representative episodes as examples of observed reflective activities. Next, I present a detailed case study of a young, female FCC member and describe her transformations in learning through her intentional reflection activities. Her case typifies many areas of transformation seen within the FCC membership over the course of the study. The final case study is the FCC mentors. This study tracks the seeding and emergence of a successful reflective-mentor team based on the Reflective Mentor Model (RMM) presented in Chapter 3.

6.1 Case Study: Flagship Computer Clubhouse

In this section, I present examples of those transformations organized around the Constructionist Cooperative indicators outlined in Chapter 3. I report on how the FCC environment and practices evolved into a functioning Constructionist Cooperative over the course of the one-year study. Results show intentional-reflective behaviors did not emerge without an organized reflective mentoring practice in place. Cooperative Constructionism indicators served as a barometer for gauging the quality of a Constructionist Cooperative.

6.1.1 Individual-Level Indicators

This section reviews the individual-level Constructionist Cooperative indicators discussed in Chapter 3 and summarized in Table 16 below.

Table 16. Individual-Level Constructionist Cooperative Indicators.

Individual-Level Indicators of Cooperative Constructionism
1. Learner takes ownership of IRA construction.
2. Learner adapts software use to suit her design objectives.
3. Learner experiments with alternative styles of project and IRA design.
4. Learner articulates her reflective and learning experiences.
5. Learner evolves new roles in the learning community.

Individual-level indicators focused on the nature of the individual's intentional reflection experience. Through the observance of these behaviors, we can say whether an FCC member is engaged in intentional reflection.

6.1.1.1 Individual Indicator 1 - Learner takes ownership of IRA construction

A member takes ownership of his learning when he makes decisions about what and how to do his work. Work tasks include setting and evaluating design goals, constructing and revising projects. For example, within the FCC, members often make decisions about how to make a project expressive of their ideas and what materials suit those design objectives. Those same kinds of decisions were made by members as they worked on their Pearls.

Designing

Member commented that their initial expectations of the PoW software were they would be completing an online form of some kind. They expected to

be asked questions and fill in the answers, which was not a very compelling activity. However, faced with the blank Pearl canvas, most members expressed surprise.

"You can go through your Pearl and do whatever you like. It doesn't say you have to do this part first and then the next part. You can do whatever."

This member associated the Pearl canvas with other software canvases he had used in the past. He knew that in software like the Photoshop and Painter graphics programs, a blank canvas implied a certain kind of *design* freedom. His comment "you can do whatever" implied he felt that same freedom of expression was part of Pearl design, as well.

Writing

In this next observation, another member found his Pearl writing to be "different" in nature than others instances of writing. Writing is rarely seen in Clubhouse projects and often viewed as a nuisance or an embarrassment. Many members are self-conscious of their writing abilities. Pearl content generally contains some amount of text. By making a Pearl, a member is taking a risk by putting his writing on public display. However, members expressed that when constructing their Pearls, writing felt more *expressive* as opposed to proscribed activity. It is this expressive component that warranted taking the risks of public exposure.

"I only write when I'm in school and for homework. But I don't mind because my Pearl isn't homework."

Robbin: How is your Pearl different from homework?

"I don't have to do it so I can write what I want and not a lot if I don't want. I like to talk about my project anyway so I don't mind."

As discussed in Section 4.2.1, PoW does not use the "interviewing" approach seen in many systems that seek to get learner inputs to recount their learning experiences. Instead, PoW uses a blank canvas with short prompts. Many members who were at first disinterested in making a Pearl began to show more interest when they saw the software appeared like the other design software they were used to using at FCC.

That was real different than I expected. I mean, I don't have to answer a bunch of questions, that's so boring. I like that I can put what I want.

Designing as a form of self-expression and learning is familiar to FCC members. They design their Clubhouse projects. By designing their Pearls, the unfamiliar problem domain of reflection is tied to the familiar activity of project design.

Although members found a certain freedom in the "blank canvas" interface, they also felt challenged by it, as well. This motivated their giving their Pearl content careful consideration and revisiting their Pearls to refine them even further. A primary motivation seemed to be the sense of pride in their work and the knowledge that not only their work but their thinking is on display.

"You have to know what you're talking about because if you put it out there and you don't know what you're talking about you look stupid. I don't want to get dissed (disrespected)."

Explorations

Most members explored the range of formatting options supported by the PoW software. This type of exploration is characteristic of how Clubhouse design software is handled. Members like to "push the envelope" to see what interesting things they can do with software. It's all about finding new program functions they can exploit to make "cooler" projects. Members quickly discovered they could format their Pearls by using the PoW menu options. As they became more experienced with the interface, some members also discovered they could directly edit the html code that generated their Pearls. The html code is accessible by clicking the CODE tab at the bottom of the screen. The page view is updated once the member returns to the regular display. Any html changes are immediately reflected in the regular Pearl display. Members used html access to change the number of panels, background colors, and panel prompts, for example. This information spread quickly throughout the Clubhouse, via word of mouth. As new html discoveries were made, they soon began to show up in other Pearls.

6.1.1.2 *Individual Indicator 2 - Learner adapts software use to suit her design objectives*

Over the course of the study, Pearl designers were observed to co-opt the software for their own personal needs. Pearls are used for 1) making lists of their favorite Pearls, 2) storing ideas for future projects, 3) broadcasting messages to the larger community, and 4) sharing personal information with FCC members.

Pearl Linking

Several members made Pearls that contained Pearl Links to either their own Pearls or another member's Pearls. They reported their intentions were to use a single Pearl to hold a list of their favorite Pearls. The motivation was so other members could find all their Pearls in one place. As discussed in Section 4.2.4, Pearl Links allow referencing of other Pearls from within the Pearl being constructed. When questioned about her Pearl, a 15-year old, female member replied:

"It's hard to find my Pearls. If I can't find it, how is anyone else going to find it?"

She was clearly concerned that her Pearls would be overlooked and had decided on a remedy for that situation.

The Pearl link feature was intended for use in aggregating Pearls on various topics to create a more complex, composite Pearl. For example, Pearls on specific software features, link using layers in Photoshop, could be links within a Pearl about a complex Photoshop project.

Saving Up Ideas

Pearls were used to save up ideas to use in future projects. In essence, members used their Pearls as idea “bank” for “saving up” good ideas. Pearls are persistent therefore saved ideas may be developed more fully over time. This is a powerful way for members to refine their ideas, a deep learning activity.

Ideas are of great interest to FCC members. In particular, they want to know how to come up with new ideas: how the process of developing ideas happens. One member had been contacted by a number of other members regarding her ideas stored in her Pearl. Within the collection of FCC Pearls, the ones that focus on generating new ideas have the highest view rates of all the other Pearl themes. Idea sharing is clearly important to the FCC membership. It is an activity that took place sporadically with face-to-face encounters. Now, with Pearls such as these, ideas can be more easily spread throughout the membership.

Broadcasting

Some members used their Pearl to broadcast messages to other Pearl users. These messages relayed information about upcoming events or asked the membership for help with a specific design challenge. One such observance, the designer offered advice and invited others to contact her directly to talk about working in the FCC music studio. Details of this broadcasting example can be found in Section 6.2.5.

Getting Personal

Personal Pearls are not about Clubhouse activities. Instead, these Pearls are used to connect to the community in a more personal way. One member used a Pearl to share lessons she learned from her mother and grandmother about planning dinner menus and following recipes. I asked her about her motivations for making a Pearl on that topic.

Robbin: Why did you make a Pearl about recipes?

Gayle: "I want my friends to know how. It's not too hard. My nana showed me how. The secret is to get everything you need first so you don't mess up the food."

Robbin: What about people you don't know? What happens if they see your Pearl?

Gayle: "Well, they are members, so that's okay. They might not know how to cook so they can use my recipe."

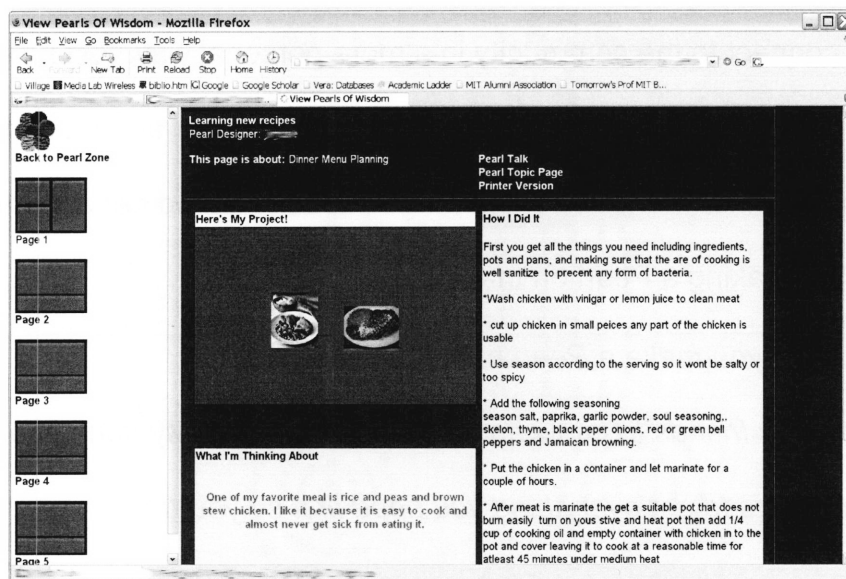


Figure 29. Learning New Recipes Pearl.
The designer lists "my experiences" as her design tool.

Her Pearl, seen in Figure 29, included a great deal of detail about how to organize the many smaller tasks that go into preparing a meal. Not only is she sharing a prized family recipe, she is also demonstrating how to break down a larger, complex task into its smaller, solvable pieces. This de-construction of the menu preparation task is an important lesson for other members. Also interesting, is the fact that she lists "her experiences" as the design tool for the Recipes Pearl.

Thinking of Audience

Members were keenly aware that other members would be examining their Pearls. Often members were observed re-structuring their explanations, over several iterations, to accommodate their perceived audience. They were

asked why they revised their Pearl and how is what they say in their Pearl different from what they say in person. One 14-year-old, male member had the following explanation:

"I explain it simpler than when I'm talking to somebody about it.

Robbin: Why do you do that?

"I don't know if people will know what I'm talking about. I can't look at them and see where I need to say more, so I say it real simple instead."

Thinking of their audience, members reconsidered how they were describing their project experiences. Here the member had a keen sense of his audience. He was concerned members wouldn't understand him. He knew that not "being there in person" made how he presented his message important and therefore he gave it more attention. His goal was to have his Pearl make sense. His solution was to break down the explanation into smaller pieces. When asked a similar question, another member said that talking to someone in his Pearl was different than talking to them in person. Again, being able to take his time building up his explanations, he experienced greater depth of thinking about his project.

"This wasn't like when somebody asks me how to do something."

Robbin: How was it different?

"I'm trying to work on my stuff so I want to hurry up. I just show them enough to get things going. I don't want to get stuck with them. I'm trying to represent so my work got to be tight."

Robbin: How was making the Pearl different then?

"Well, I can't go as fast. I mean my typing sucks too. And I can't leave it looking raggedy so then I got to fix the color and make the letters bigger. Stuff like that.... That takes time. Anyway, I'm working on my thing so I can take my time."

Robbin: Why take the time?

"I want make sure it's tight. I mean I don't put out my project until it's ready, you know. My Pearl is going to be out even if I don't finish so I got to give it a little extra flavor right then."

The fact that his Pearl would immediately enter the public domain motivated this member to slow down his regular process of explanation to ensure he would be well represented. Peer pressure was a common motivation members expressed as their reason for taking more time to develop their Pearls and revisiting the Pearl to make refinements.

6.1.1.3 Individual Indicator 3 - Learner experiments with alternative styles of project and IRA design

Within the FCC, Clubhouse projects are varied and people often use differing techniques to achieve similar project outcomes. This diversity is highly valued within FCC culture.

Idea Experiments

Over the course of the study, FCC members experimented with different ways of designing and thinking about their Pearls. In this observation, a member discussed a Pearl he had printed and used for his project.

"You can get different ideas and sometimes you just get something you know but you don't see it right away. Then once you do it you think oh, I already know that. There's a bunch of ways to say the same idea."

This member is acknowledging there are many ways to articulate what he knows. Sharing of diverse perspectives also meant a member included others' ways of doing into her own.

"It was good watching Shirley do hers. I learned how she put it together, you know and she didn't know what to put down too. She told me she didn't know how much to put in. I don't know what to put in. You know what she did? ... She said she looked at her project and then she just wrote about the stuff she messed up before it came out right. She put in all the layer stuff mostly. That's what I did in mine too. I put in the clone brush stuff because I messed that up but then I got it. The rest was easy but that was the hard part."

Hands-On Experiments

PoW software supports the uploading of project files so others members can download and use them. This kind of file sharing vary rarely happens and is not part of FCC culture. Members have always shared their projects through face-to-face interactions or via the FCC Walls; the source files themselves are stored in each member's online folder and remain private. It is a social taboo for one member to look in another's folder. Now the PoW software has presented a new way for members to showcase their work. In this case, they are letting other members play with (a copy of) their project files. This gives other members the opportunity to use, edit, tinker with, and learn with the projects. With access to the details of a project, they could de-construct it to discover how it worked. This is similar to taking apart a toy truck to see how the axle and gears make the wheels run.

The most popular file uploads were code-based and graphics projects. Code-based uploads were mostly Scratch programming language files and RPG Gamemaker script files. Scratch is media-rich programming environment for kids, which uses a Logo-type language. Gamemaker RPG is software for creating games. It uses scripting language to add additional functionality to games.

Sharing program code is in the spirit of what Papert hoped to see children doing with his Logo programming language. Sharing of program code was a new development and important addition to FCC practice. Previously, very little

programming occurred at the FCC, primarily because there were no good ways to support learning to program. Members who programmed were busy working on their own projects and did not have time to spend teaching other members. By uploading their program files, novices have the opportunity to see and play with working code. Members have always posted projects to the Clubhouse Walls and others have used those projects to get new project ideas. However, public access to another member's project folder was not permitted without their permission. However, uploading project files to a Pearl is the functional equivalent of a software developer posting open source code. This made it possible for a Pearl designer to safely share their project files. Once posted, other FCC members could download and examine the files to see details of how the project was actually constructed. Then those observed techniques could be appropriated for their own projects. That behavior was especially popular for Photoshop, RPG Game Maker (RPG), and Scratch projects.

One member was first introduced to the Photoshop layering feature by tinkering with Photoshop project files she downloaded from the *Abstract Pearl*. Layers are like stacked transparencies and each layer can contain different images. When stacked, the collective content of those layers appeared as a single image. She was able to play with restacking and adding layers to gain an intuition about how layers function to produce certain image effects. Now layering is a common feature of her Photoshop projects.

Poser is software for creating 3D animated characters. Poser uses object-oriented concepts in the assembly of these characters. For example, there are

classes of body parts and accessories that make up the composite figure. Object parts can be re-used on other figures and properties of those objects are inherited along with the object. This is an important computational concept that is taught in college-level programming courses. By working with Poser, members develop an intuition about object-oriented behaviors like inheritance of object properties. Being able to download and tinker with working Poser files allowed members to explore how Poser objects can be used to build new objects with more complex behaviors.

Sharing Pearl Designs

Other members commented that using another member's Pearl gave them ideas about their own Pearl designs. In those cases, another member's perspective on reflection and Pearl design became a backdrop for them to think about their own ways of reflecting and designing. For example, a popular way to design a new Pearl was to have the Clubhouse software (i.e. Photoshop graphics software) open in another window while working on the Pearl.

Another Pearl design trend that caught on was team Pearl designing. Members would get together and work on a Pearl together.

"I noticed that too! The girls like to work in pairs. They do that in their projects too, so it makes sense they might make a Pearl that way. Too bad there isn't some way both their names can show up in the index. "

Normally, at the Clubhouse, members may work collaboratively on a project. Most decisions are made together, or members will take turns. Alternative design directions are hashed out through discussion or turn taking. In these cases, the designer group has a flow. Those members who normally worked on projects together often designed Pearls together. They employed the same strategies as well, especially when designing projects together. They took turns adding content to the Pearl. They challenged each other when there were disagreements about some design feature. They each printed out a copy of the Pearl when it was finished so they could each have printout to take home. This is normally seen with members working on projects together and was seen again when they worked on Pearls together, as well.

There was some discussion about whether working in pairs was benefiting both members equally.

"I liked that way they worked together. In pairs, they are learning new things all the time... and thing that they probably didn't know about on their own or at least didn't think were important. That's good for the girls to learn about. I would think the Pearl would end up with more stuff in it."

The mentor had identified a key way two members were scaffolding each other's reflection on a single project. In another instance, a mentor made an observation later shared by most mentors in the study.

“There’s something about being on the same computer and doing it together that makes it so much easier when they get confused about how to talk about the project. Actually, what I’m finding really interesting is how differently Mercedes thought about her project and how her friend helps with thinking about it. They each had their own ideas about the best way to describe the project. All the back and forth to reach a consensus was fascinating to watch. I don’t remember ever hearing those kinds of exchanges in the Clubhouse before. They were really getting into the nitty-gritty details of the project and what they thought was important to put in the Pearl. If they weren’t making a Pearl together, but were instead just talking, the comments would be more superficial. Something about writing together made a difference.”

Both peer discussion and writing together have been shown to enhance learning (Rivard and Straw, 1999).

6.1.1.4 Individual Indicator 4 – Learner articulates her reflective and learning experiences

Having learners reflect through their Pearl designs was a means of having them more richly articulate what they think about what they know. This richness was observed in member Pearls and in their face-to-face conversations.

Learners were articulating their process and learning. For example, one learner articulated her Pearl design strategy of building Pearl content over time.

“I like that I can come back later. I can’t think of everything to say at once.”

In another observance, a member acknowledged that spending more time thinking about and planning her Pearl was a successful strategy.

"I have to think about my ideas first. Whenever I don't, I end up writing a lot of stuff that I have to take out later. I don't want to write more than I have to."

For this member planning and organizing her thoughts before working on the Pearl was a more efficient and productive strategy. In another observance, a member shared how she did "test runs" of her recollections of project work. Her goal was to make sure her Pearl content was accurate.

"It's not like I'm thinking to myself exactly. Its kinda more like I'm thinking but out loud to somebody else except nobody answers you. (giggle) Well, at least until you save it then they might say something if they look."

She was thinking of her audience as part of her strategy for making her Pearl.

In the case of a 14-year-old female member, tinkering began to take on an almost algorithmic quality. She described her heuristic for designing good Pearls.

"I just go through every single part and just put in the parts I know and then I print it. Then I go back in the software and look for the part I don't remember and then go back to my Pearl and put it in."

Her approach was to assemble a skeletal structure that was filled in and refined over successive iterations. Her refinements included adding new skills she had learned, highlighting key design points, or adjusting the layout of the Pearl content. I asked her to walk me through her decision process regarding her Pearl content.

"When I was doing my Pearl, it would be like 'How I Did It' and so I just wrote down how I did it. You have to explain it good. Then I have to add more when I read it. Every time I look at it I think of some part I forgot to say and so I put it in."

This is evidence of staged reflection as described by Boud, *et al.* (1985). Staged reflection involves returning to and re-evaluating the learning experience over some number of cycles. Those reflections may also include feelings associated with the learning experience.

"Robbin: How did making your pearl help you reflect?"

"I don't know if I reflect that much... I just write down what I do. Later I look and put in more and I add a picture. Then I put in how I was thinking about the sky at night and how pretty the stars are and how I love the sky at night."

Other members began to notice and appreciate their software skills. Many members at FCC take their design skills for granted. They see other members doing projects and don't always realize that their software discoveries are an accomplishment. Feedback from other members about some aspect of a Pearl

gave many members a greater appreciation of what they knew and its values to the community.

“When I think, what do I actually remember about it, well I think there’s not that much to put in here but when I go look at Photoshop then I see all the stuff I’m missing. I mean I know it but I just do it so I don’t remember that I know it.”

For this member, building her Pearl made her look at what she knew. She began to note how much she had learned by designing her Clubhouse projects and how much she had “forgotten” she had learned. This next observance was of a member who liked making RGP Gamemaker projects. She made various video games for other members to play. Here she talked about how including the “hard parts” in her Pearl would help others get through similar difficulties.

“I just think back over how I did the characters and then everything pretty much comes together. Then I remember what the problem was with the direction controls and that always gets messed up so I had to go back and talk about that too. I mean I’m pretty good and I still have to pay attention to the controls.”

In a conversation with a mentor, I observed her reflecting on the kinds of learning interactions she was noticing between members, the PoW software, and their Pearls.

"I thought that working on their projects was enough. Now I can see the difference, like when they talk about their project or how they did something. Even when they talk to each other, they say more about how they decided to do things, not just the steps... I never really thought about it before but their projects are about more than just putting pieces together."

The mentor had expressed how learning by design went much deeper than she had realized. She indicated that what kids were doing at the Clubhouse ran much deeper than just assembling the parts of a project. In this next example, a member responded to my question "if you go back and change your Pearl, why do you do it?"

"I like that I can go back. When I help somebody on the computer, if I forget something and remember later I can't go back because they might not be there or don't need help anymore or I'm too busy. If I think of a bit of something later I can add it to my Pearl anytime and then print it again."

For this member, the choice to rethink her Pearl gave her a chance to revisit her thinking. This revisiting represents a cycle of critical thinking, a deeper form of engagement with her project and her Pearl.

Members frequently mentioned the word *like* in their descriptions of their Pearl design experiences. Another word often mentioned was *hard*. Their comments allude to Pearl design being what Papert (1998) termed "hard fun."

He argued that kids engaged in hard fun, not in spite of the fact the activity was hard but because it was hard. Such engagement was a combination of intense focus on the task at hand and intense motivation to continue (Kafai, 1995). In most of the observances noted here, members expressed the different challenges they encountered in building and refining their Pearls as hard fun, which is a learning experience at the heart of constructionism.

"I just did it all in one go. If something's missing then I might add it later but only if somebody wants to use it.

6.1.1.5 Individual Indicator 5 – Learner evolves new roles in the learning community

Evolving new roles, at the individual level, was judged from the perspective of the learner. This is accomplished by determining if the learner feels he has taken on new roles that are valued within the community. For example, a member began to take on the role of mentoring others in how to use the PoW software. However, what is important is that the member views himself as taking on that new role. Here is an example of a young, female member stating her role in helping others learn about Pearls.

"I make Pearls, not that many people make it. They don't even KNOW, but I tell them, then they know..."

Robbin: "What do they know?"

"About my PEARLS." ... "I just tell them what to do and then they do it and then they know"

This member had seen herself in the role of Pearl advocate. She had undergone a change in how she perceived her place in the FCC to include this new and arguably valued position.

6.1.2 Community-Level Reporting

Community-level indicators focused on groups of learners as the unit of analysis. Table 17 summarizes the community-level Constructionist Cooperative indicators discussed in Chapter 3.

Table 17. Community-Level Constructionist Cooperative Indicators.

Community-Level Indicators of Cooperative Constructionism
1. Learners engage in regular discussion, sharing, and advocating of intentional reflection activities.
2. Learners evolve vocabulary around intentional reflection.
3. Learners negotiate alternative design styles and perspectives.
4. Learners increase the complexity of their learning relationships.
5. Learners' intentional reflection activities are highly visibility throughout the learning environment.

At FCC, what members talk to each other about are those practices that are at the heart of FCC culture. Typically, members talk about software they use, shortcuts they've discovered, and plans for later projects. They also occasionally work on projects together.

6.1.2.1 *Community Indicator 1 - Learners engage in regular discussion, sharing, and advocating of intentional reflection activities.*

Members were observed working together to develop a Pearl. In this case, two members had worked on a Clubhouse project together and decided to make a Pearl about the project. I asked one member, Mercedes, why she worked with her partner Carmen.

"I like making my Pearl with Carmen better.

Robbin: How is it better with Carmen?

"I guess... because every time I do something I sort of ask 'what do you think of this part' and she goes 'it's good' or she would go 'let me put that part in' or something. Sometimes it is hard to decide what to put in, so we just put in some pictures. It was fun doing it with her because we could talk about it..."

Carmen and Mercedes were having conversations that contained elements of deep learning, decision-making, problem-solving, and organization of their Pearl information. Their negotiations played an important role in scaffolding each other in ways similar to Vygotsky's (1978) "*zone of proximal development.*" An interesting dynamic here is that Carmen and Mercedes have similar levels of

software and project skills. Yet, they were still able to scaffold each other's critical thinking by working together.

In another session, a mentor remarked on how the two girls helped each other think through their Pearl activities.

"I've noticed that they help each other when they get confused about what to add next or what the next step should be. I don't even have to do anything anymore when they get in that mode. I'm just the glorified spelling checker."
(laugh)

The girls had developed a strategy for including negotiation and critical thinking into the building of their Pearl. While members have occasionally developed Clubhouse projects together, they rarely revisited that process or refined their thinking in such sustained and concrete ways.

6.1.2.2 Community Indicator 2 - Learners evolve vocabulary around intentional reflection.

This indicator considered the development of language that allowed for shared experiences of reflection. This next observation showed different decisions that were made about the scope and focus of the Pearl. In this case, the member decided to say more about her process than how she actually put her Clubhouse project together.

"First I put in my project. Then I like to talk about it. Sometimes I say how to make one like mine. It depends."

Robbin: What does it depend on?

"Mostly on what else I want to do. Sometimes it's boring to say how to make my project. It's too much typing. Anyway, I want to say more about my project anyway. Somebody else can talk about the other stuff."

Robbin: Why is talking about your project in your Pearl?

"I want to put my project on the walls. I like that. But it's better to Pearl it because then everybody can read what I like about it and they can email me and stuff..."

She also labeled her Pearl designing as "Pearling." Throughout the study, other members were observed also using this term, which indicated it had spread throughout the FCC. It indicated that members saw making a Pearl as different from making a project. Making a Pearl was something you did to the project.

"I can do it on my own. I mean, I don't have to do it only when someone tells me. You know, like school... I can Pearl stuff on my own time as much as I want. (laughs) I just can't leave it halfway for too long or else I'll hear about it."

The verb "Pearl" had become new vocabulary to describe translating Clubhouse projects into Pearls.

What further highlighted the role members had assigned to Pearl, was when exhibition of Clubhouse projects began to take a secondary importance to exhibition of the “Pearled” projects. That underscored how Pearls were viewed differently from Clubhouse projects; in particular they were being viewed as a particular mode of Clubhouse project presentation. There were numerous observances of member preferences for exhibiting their Pearls over their Clubhouse projects. The Pearl served as both project advertisement and reputation builder. Because a member’s Village user name displayed on the Pearl, other members could look online and find out more about them.

6.1.2.3 Community Indicator 3 – Learners negotiate alternative design styles and perspectives.

Bruner (1996) argued that meaning-making leads to knowledge construction. Because the mechanism of meaning-making involved negotiation, it was recognized as being socially driven. Pearl designers were often observed negotiating the meaning of their Pearls with the larger FCC community. This happened in either face-to-face discussions or through member feedback. These negotiations often led to a Pearl editing cycle that subsequently led to more negotiation of meaning.

Team Negotiation

Negotiation was also an important dynamic in collaborative Pearl design. In this next example, a member commented on her negotiation experiences with another member.

“Sometimes we would argue on what to write down and then we have to put down a little of both or I put down something and she adds something to it. I guess when I get my own idea then I think like ‘I want to do it this way and I don’t want to do it that way’. I mean we don’t do that all the time but when she wants to do it different than me then we say it two ways.”

This member and her partner had negotiated a way to include both their perspectives in the Pearl. This made for a richer Pearl, which now included two ways of accomplishing the same project tasks. It also made it clear to the partners and anyone using the Pearl that there was more than one way to approach the design challenge posed by that Clubhouse project.

6.1.2.4 Community Indicator 4 - Learners increase the complexity of their learning relationships.

Another observed addition to regular FCC practice was the posting of Pearls on the Clubhouse Walls. Over the course of the study, 34 Pearls were exhibited on the Clubhouse Walls. In 31 of those instances, the corresponding Clubhouse projects were not displayed. When asked about their choices to exhibit their Pearls without the Clubhouse project, there were a variety of responses.

“That’s why I drop my Pearl. Then my name gets out there. Before I just posted my project. How could people know I did it?”

The term 'drop' refers to a form of name dropping that happens when someone's name is associated with their work. This is traditionally accomplished through word-of-mouth. Other member comments were:

"I do it for advertising! I want them to hit my Pearl. "

"I like to tell them why I did it. This way they can ask me if they want to know more. Well, they need to be able to get me."

"Hey, that's just my artist statement!"

Pearl designers preferred the richer form of public exposure that Pearls provided. Posting Pearls were a way of getting your work noticed and your name known.

6.1.2.5 Community Indicator 5 - Learners' intentional reflection activities are highly visible throughout the learning environment.

New members are generally not known for their work until some of their projects have been seen by others. That process can take months for reputations to be built. This is common dynamic of moving into the mainstream of FCC life. Much like Wenger (1998) describes legitimate peripheral participation (see Section 2.2.2) the new member needs time to learn FCC culture and be recognized for their practice.

New members were introduced to PoW and Pearls along with other FCC software. They were encouraged to post projects and Pearls. As these Pearls

became public, new members began to become known, by name, a process that usually takes time at the FCC. In particular, some new members were becoming known even on days they did not attend the Clubhouse. The members were known by name, and because of their Pearl narratives, other members wanted to talk with them about their projects and their Pearls. These new member began to move more quickly to the center of the community than was normally seen at the Clubhouse before this study began.

Making Pearls also led to rapid growth of new members' personal social network within FCC. They began to make Pearl-based connections, in addition to those connection made from face-to-face encounters For example, some members began to establish relationships with members who attend the Clubhouse on a different day of the week.

An example of a novice who moved quickly from the periphery to a more central role was Carmen. Carmen was still new to the FCC, bi-lingual, and very shy. Her Clubhouse project was an image of a rose with her in the middle. Again, her Clubhouse project was not posted to the FCC Walls, however, her Pearl about the project was. Normally that type of member would remain at the periphery for weeks or months before attempting to exhibit projects or to gain a reputation for her project. Once Carmen posted her Pearl, other similar projects began to pop up over the weeks that followed. She was approached by members who needed more information than was available in her Pearl. In one email exchange, a member complimented Carmen on her project and offered an alternative method for accomplishing the same Photoshop effect by using the

masking feature instead of layers. This member also attached a project to the email. In Figure 19 below, the left image is the attached project where masking was used. The right image is Carmen's Pearl.

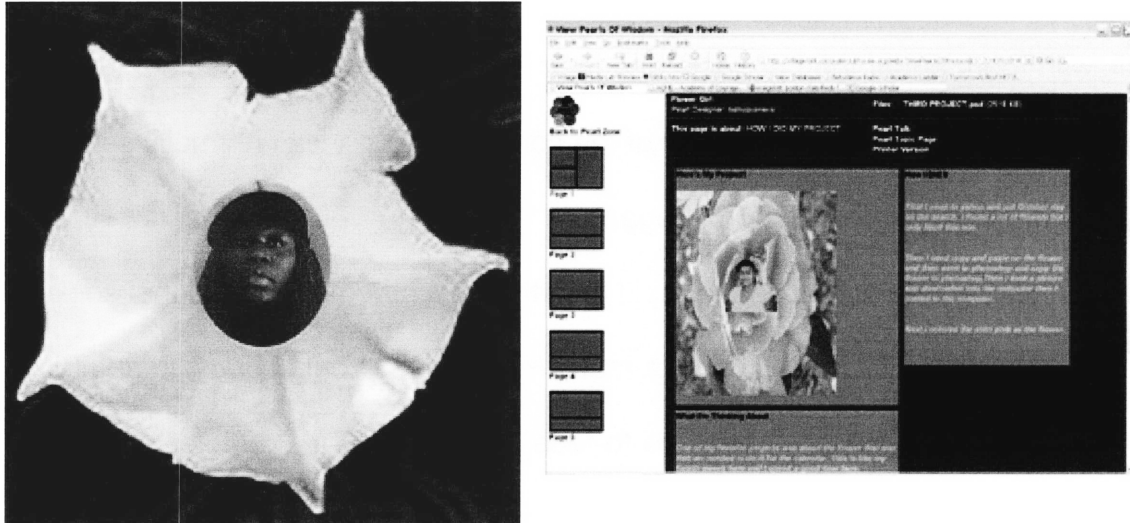


Figure 30. Members shared alternative Photoshop design techniques. The project on the left used a masking technique. The project on the right uses layers to achieve the same effect.

The following is an excerpt from the content of Carmen's Pearl.

How I Did It

First I went to yahoo and put "flowers" on the search. I found a lot of flowers but I only liked this one.

Then I used copy and paste on the flower and then went to Photoshop and copy the flower in Photoshop. Then I took a picture and downloaded into the computer then I pasted in the computer.

Next i colored the shirt pink as the flower.

What I'm Thinking About

One of my favorite projects was about the flower that was that we needed to do it for the calendar. This is like my fourth week here and I spend a good time here.

Another mechanism for spreading project and Pearl ideas is the Pearls Binder. The Pearl Binder was made by FCC members so they could have a quick reference to Pearls without logging onto the Village. The Pearls Binder could be found on the Green Table (Section 5.2.3) and had been decorated using craft supplies. Often, new members were shown the binder as part of their introduction to Pearls. Adding new Pearls to the binder was an event. The new Pearl was printed, 3-hole-punched and put in a vinyl leaf to protect it. When a member updates her Pearl, she added the new print to the Binder, as well. The Clubhouse Coordinators have used the Binder to introduce new mentors and visitors to the type of learning that is going on at the FCC.

Also, FCC project showcases take place on the second and last Friday of each month. Members can show their projects using a more formal presentation format. Pearl designers have give presentations about both their projects and their Pearls. This is another opportunity for members to practice articulating what they know and fielding comments from their peers.

Next, Section 6.2 presents a detailed case study of a young member's learning and social experiences mediated by her PoW experiences.

6.2 Case Study: Nicole

This case study details a young member's learning transformation as mediated by her Pearl experiences. During the course of this study, she experienced a number of shifts in learning behaviors and strategies along three key themes - *reflection, identity, and community participation*. Meet Nicole, an 11-year-old female FCC member who visited the Clubhouse an average of once per week over the course of the study. Full of nervous energy, Nicole seems to find it impossible to sit for more than a few minutes at a time. She constantly twirls her short, brown hair, pops bubble gum, and proudly sports her oversized New England Patriots jersey. Having so much undirected energy had caused Nicole discipline problems, at school, home, and at the FCC. During the first two months as a member, Nicole had difficulty adjusting to the rules of the FCC Code of Conduct (see APPENDIX 2). She often used bad language and had to be reminded by the Clubhouse Coordinator or other members about acceptable use of language in the Clubhouse. At times she would ignore or behave rudely towards the Clubhouse Coordinator when asked to stop accessing chat sites, another community taboo. Her behavior put off many members, who noted her frequent rule breaking. Members who were normally social and outgoing to

others began to separate themselves from Nicole. This only served to isolate her further from the group. Noting this, the Clubhouse Coordinator and mentors gave Nicole extra attention and made efforts to turn difficult situations into learning opportunities rather than reprimands. It was slow going, but over time Nicole began to settle into the Clubhouse routine.

At the beginning of her Clubhouse tenure, Nicole's level of social interaction was negligible. She avoided direct contact with other members and rarely spoke to anyone. She kept to herself, whether at the computer or wandering around the room. If she noticed a member working on an interesting project she would look, but quickly walked away if the member attempted to engage her in conversation. Mentors tried to help her assimilate into the group, but attempts met with little success. Nicole was especially protective of her projects and never showed them to other members. When anyone came around her workstation, she covered the screen. The only time she allowed anyone to see her work was when she needed help with a project.

Her Clubhouse visits followed a predictable pattern. Upon arriving, Nicole immediately claimed her workstation and opened a web browser to check email. She also frequently logged onto one of her favorite chat sites. If left unchecked, she would spend all of her FCC time in the chat sites. However, when the Coordinator or a mentor noticed this activity she was asked to log off. Next, Nicole wandered the room, looking over the projects hung on the Clubhouse walls. Once bored with that she would amble over to her workstation to search Google for pictures. Nicole's average FCC visit was two and one-half hours.

From the time of her arrival to when she settled in took about half an hour.

Nicole spent about half her time at the Clubhouse working on projects. The rest of her time was spent emailing or chatting online, surfing the web for media, and other inspiration. Over the course of the PoW study, Nicole's Pearl activities influenced her project design style and involvement in the Clubhouse community.

This report details Nicole's project and Pearls experiences. examine how she made sense of her Pearls and the impact of her Pearl activities on the FCC community. During the study, Nicole created five Pearls on a variety of topics and with varying levels of complexity, shown in Table 18.

Table 18. Nicole's Pearls.

Pearl Name	Design Tool	Genre
<i>Bubblez</i>	PhotoShop	Image
<i>HTML Programming</i>	Pearls	Web Design
<i>Bart</i>	PhotoShop	Image
<i>Getting Ideas for Music Beats</i>	My mind	Audio
<i>Simpson</i>	PhotoShop	Image

This report highlights key moments in Nicole's development as a learner and as a full member of the FCC community.

6.2.1 First Encounters

Monday, November 15, 2004

I ran three member workshops that introduced Pearls of Wisdom software to each of the PoW study treatment groups (see Section 5.3.2). Each workshop

consisted of three fifteen-minute sessions with a fifteen-minute break between each session. The final fifteen-minute session focused primarily on showing example Pearls and more advanced software features. Workshops were purposely structured so members could join or leave at anytime and included a brief demonstration of good Pearls and later hands-on tinkering with the software (Chapman, 2004). There were fourteen attendees over the course of the workshops, a total of twelve members and two mentors. Three FCC workstations reserved for the workshop and my personal laptop was also made available.

Nicole watched the first workshop from her workstation but did not join in. She spun her chair back and forth, divided her attention between the workshop activities and her computer. When I announced a second workshop session was starting, she joined and remained for the entire workshop. She did not ask questions, test-drive the software, or otherwise show any interest. About two weeks after the workshop, Nicole approached me and asked about the PoW software. She would not answer my questions about what motivated her interest.

6.2.1.1 *Pre-Pearl Learning*

6.2.1.2

During her time at FCC, Nicole had been introduced to several project design tools, including Photoshop, Poser, and AcidPro. Most software introductions were mentor attempts to draw her out and involve her in more constructive design activities. My early observations of Nicole revealed a lack of maturation in her project activities. From project to project, she used identical

construction practices and never revisited her Clubhouse projects. The repetition and surface-level project development meant she missed opportunities for restructuring and reemphasizing lessons learned from her work.

Nicole's projects were very simplistic. She performed the same action, by rote, from one project to the next. Most often, her graphic design projects consisted of downloaded images that she printed or downloaded line-drawn images which she colored in using Photoshop. There was the occasional line-drawing she traced and colored in, but those were rare. Her music projects were more complex and consisted of pre-packaged digital beats that she downloaded to AcidPro and mixed to create her compositions. She would layer and arrange any number of beats and instruments within a single project. At the beginning of this study, those music projects were her most complex constructions.

Nicole preferred to stay within her design "comfort zone," sticking with the same design activities in the same order over numerous projects and project cycles. She shied away from using new Photoshop software features or ideas in her projects. For example, her most complex Photoshop projects were primarily line tracings. To accomplish this, she used a Photoshop graphic design technique called layering. Layers are like stacked transparencies and each layer can contain different images. When stacked, the collective content of those layers appeared as a single image. Tracing in Photoshop was accomplished by using a blank layer placed over a layer containing downloaded image. That blank layer worked like "tracing paper" that permitted the image to be outlined.

After tracing, the layer containing the original image was deleted leaving the tracing. See Figure 31.

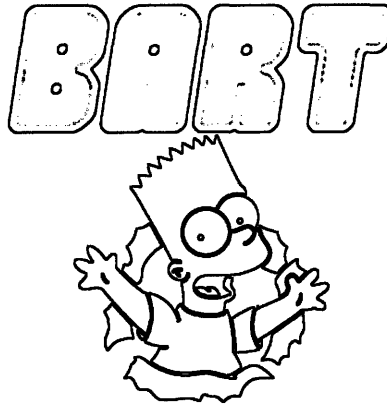


Figure 31. Nicole downloaded this image from the Internet and used the Photoshop Pencil tool to trace it.

This is a good starter activity for exploring layering for introducing the computational concepts of layering and ordered layers. There are more complex graphic design effects that can be explored, and image filtering. However, Nicole continued producing the same tracing and coloring activities over the course of nine projects. Her earlier projects were primarily image tracing. For other project, she just downloaded images, printed them, and declared the project completed. Her activities had merit; however, her project growth had stagnated. The one exception was where she used two layers to form a composite image of a girl lying on grass. This use of layers was a more complex project activity for than her earlier Photoshop projects.

When encouraged by myself or mentors to try other Photoshop effects, Nicole was adamant about sticking with her current project format “because I know it.” When asked how she decided what project to work on, Nicole insisted

she “just does them” When pushed her to say more about her process, she would become unresponsive. When I mentioned that sometimes people tried new things in their projects as they got new ideas, her response was a sassy, “Well, why would I do that?” Nicole didn’t participate in activities such as decision-making, problem-solving, exploring new idea, and adapting to new situations. Those are all indicators of deeper project involvement. Nicole expressed similar vagueness about the source of her project ideas. Her only offered comment was that she considered her ideas to be “stupid” so she got ideas from “somewhere else.” She did mention the Internet as a good place to look for ideas. Nicole believed she was a poor learner. Successful repetitions of simple projects reinforced this behavior. She found comfort and gained confidence from knowing what to expect. Her body language displayed confidence. In contrast, her body language showed that her confidence crumbled when the familiar walls of her routine were threatened. She would become flustered and agitated. If pressed further she became defensive and eventually uncommunicative.

Another consequence of her frustration was often project abandonment. When she encountered problems, her first reaction was to drop the entire project. Her frustration, discomfort, and fear precluded any other course of action. A survey of her Clubhouse network folder revealed seventeen projects that she identified as “mistakes” she had abandoned. She described them as “ugly” and “garbage.” Many appeared to be the same project, interrupted at various stages,

early on in the project. When I asked why she saved the abandoned projects; she claimed it was easier to leave them in the folder.

6.2.2 Early Pearl Experiences

Monday, December 5, 2004

Today, Nicole worked on her first Pearl, which she titled, *Bubblez*. That was her Clubhouse Village user name. She decided to self-name this Pearl even before she picked the topic. When asked to explain her choice, she responded she wanted people to know it was hers. I explained that her user name would already show up in the list of Pearls. I added that the Pearl name could help others understand what her Pearl was about. Nicole insisted her Pearl title would be her user name. I found her reaction significant for several reasons. Her Pearl, from its inception, would become a public artifact. Her Pearl would immediately become an object others could critique, use, and respond to. This was also the first time Nicole had expressed interest in making herself or her Village persona visible to others at FCC. She had been a loner most of her time at the FCC and most members didn't even know her name.

I decided to work closely with Nicole while she designed her Pearl. I knew from earlier observations that she could quickly abandon her work if frustrated. I hoped to be able to keep her motivated. I asked if I could see her project folder on the FCC server and she agreed. We looked through the folder together. I hoped to gain insight into how she determined the project to use for her Pearl. I was hesitant to prompt her choices, and instead quietly observed.

Nicole: "I have lots of projects... (sighing) I don't know which one to do."

RNC: "Which one do you think others might like to know about?"

Nicole: "I don't know!! I don't know what to do. Nobody cares about what I do no way."

RNC: "Well, I care. I want to know more about your projects. Are any of your projects up on the walls?"

Nicole: "Noooo."

RNC: "How about on the Village? <Nicole shakes her head no> If you could pick one project to put up on the walls right now, which would it be?"

Nicole: "Ummm, I got one that's in the park. <she scrolls back and forth over the project files. She settled on a Photoshop project.> I used PhotoShop. I like the hairdo and I like that way I did it."

RNC: "Cool. What do you like about the way you did it?"

Nicole: "I dunno. I like that her hair is so long and the flowers too. I put in the grass so she could lay down."

RNC: "Great. Do you want to use that one? I can help you get started if you like."

Working with the PoW software, the first action Nicole took was to delete pages two to five of the Pearl. I watched as the software error message informed her to enter and save the Pearl title and genre before attempting to delete. She sighed dramatically and kicked her feet under the table. That software error marked the first dangerous moment for her Pearl. In the past, frustration or distraction could have led to project abandonment. In an effort to direct her attention, I asked why she was so eager to delete the extra pages. I reminded her that once deleted, the pages could not be recovered. I had hoped to convince her to leave the pages intact. That would leave future edit options open if she wanted to extend

the Pearl, for example, if she decided to reorganize the Pearl content into logical sections by page, she could make use of the blank pages. However, once deleted she could not insert additional pages due to software limitations. My role as researcher required that I step back and simply observe her next decision. Nicole had probably reasoned, based on her current Clubhouse project pattern of abandoning project, that there would be no need to revisit or add to her Pearl. Rather than to try to convince her to keep the pages, I decided to take another tack.

Robbin: "How do you know one page will hold everything?"

Nicole: [shrugging] "I don't know. I guess I make it fit. I don't want to say nothing, no way."

Two interesting points were evidenced in her answer. One, Nicole approached her Pearl the same as her other Clubhouse projects. She had not given much forethought to what she wanted to do. She seemed unsure of how to proceed and seemed to feel she had nothing of value to say. The Pearl structure offered some prompts, in the form of panel headings (i.e., "How I Did It" and "Why I Did It"). I encouraged her to use those heading statements as a starting point and pretend she was telling a friend about her project. I then assisted her with importing and resizing her "Girl in Park" project image. Based on Nicole's previous reluctance to put "extra" effort into her projects, I was prepared for her to refuse to input the genre and design tool information. However, she spent a full minute musing over which Pearl genre⁴ to select (although I thought "image"

⁴ Pearl genre choices are: video, audio, image, web, writing, multimedia, and animation. These choices are not meant to be inclusive of every kind of project at the Clubhouse. I decided against

was the obvious choice). Apparently being asked to make a choice merited consideration of what her project was really about. She seemed torn between “image” and “multimedia” choices. Settling on “image” she then turned her attention to the design tool value. She typed in “Photoshop” and sat back with a sigh. Confronted with the empty Pearl canvas, her flow ground to a halt.

Nicole: “What do I put down?”

RNC: “Well, that’s up to you. You can tell how you did your project or where you got your ideas or whatever you like. How would you explain to me how to make a project like this one?”

Nicole: “I get it. Do I have to say everything? I don’t want to write that much. This is like homework!”

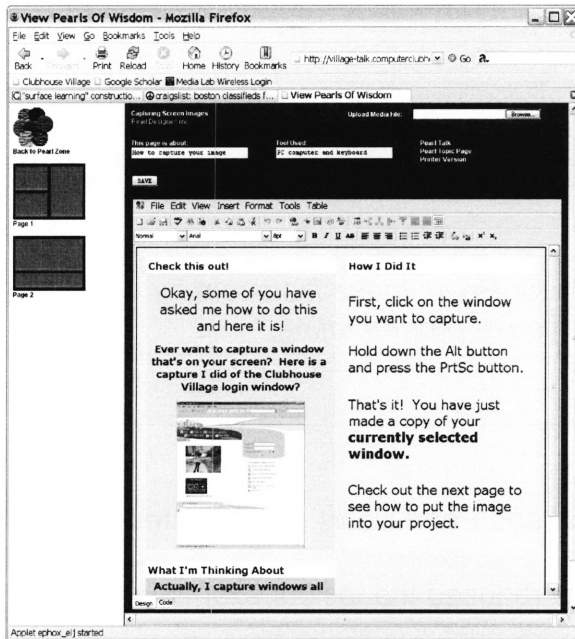
I assured Nicole she could decide what to talk about and how much to say. I suggested she start by saying something about what it was like making her project. That was pretty hands-on direction, especially since panel headings “suggest” how the Pearl may be organized. My goal was to avoid a situation where she became frustrated and abandoned her work. Nicole didn’t acknowledge my comments but instead told me to go away. I expected she was going to abandon the Pearl.

About ten minutes later, Nicole called me over. She had exited the authoring tool and was looking over the Pearl index. At that time, the majority of Pearls had been contributed by mentors and Media Lab researchers. I sat quietly as she continued browsing the index. She stopped at a Pearl title, *Pearl*

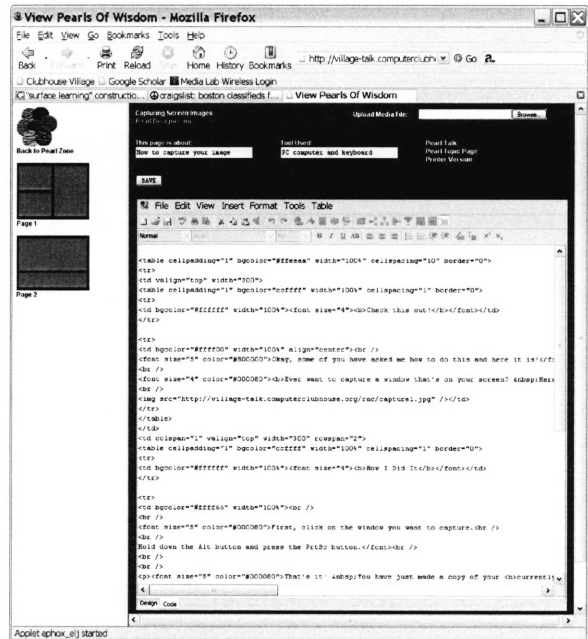
listing every possible choice. Instead, I included several of the most popular (image, web, audio) and other design tools the Coordinator, mentors, and I hoped to see more of (video, writing, animation). “Multimedia” is the catch-all choice. Pearls about programming, PC viruses, and Pearl design have all been classified as type “multimedia.” Video is the default value, as it’s the least occurring project type at FCC.

Background Colors. Nicole paged through and asked for my help to print it. She then informed me she wanted to color her Pearl purple and green, her favorite colors. I assisted her with those changes using the software menu options. With the panels newly colored, Nicole then insisted on also coloring the main Pearl background, because “it doesn’t look right.” She wanted it to be dark green instead of the default sky blue. There are no menu options for changing the background color. We had arrived at the second dangerous moment in the life of Nicole’s Pearl. I decided to chance showing Nicole the html code that generated her Pearl. That code was accessed by clicking on a “code” tab at the bottom of the screen⁵. From this view, changes can be entered directly into the html code and the Pearl is dynamically updated and redisplayed when the “design” tab is selected. See Figure 32 for an example of both the regular Pearl view and html view. Nicole would have to use direct html manipulation, with my assistance, to change the background color. I knew looking at raw html could completely alienate her from her Pearl project. That represented a move out of her comfort zone. However, I weighed that risk against the risk of Pearl abandonment.

⁵ The html that generates a Pearl can only be viewed while Pearl is being edited. Users can only edit Pearls they have created.



Pearl View of Capturing Screen Images Pearl.



HTML View of Capturing Screen Images Pearl.

Figure 32. Pearl and HTML Pearl Views.

I explained that she could change the background color by typing special words directly into the html code.

RNC: "You want to see something interesting? Check this out... This program tells the computer how to show your page."

Nicole: "What is that? I don't know that, I can't program stuff. Do I have to use it?"

RNC: "Not unless you want. Remember your dad's car?"

Nicole: "My step dad and he's always wasting time on that stupid car..."

I had referred to a conversation Nicole and I had several weeks ago, about how her step dad was always under the hood of his car trying to fix it up "special."

RNC: "Well, this is like the car. The Pearl is the outside but this code is the inside, like under the hood. What do you think that means?"

Nicole: "Like it makes it go?"

RNC: "Yes, that's right. You can do that to your Pearl; make it custom by changing or adding stuff to the code. Then, you're programming."

Nicole: "I don't know how...I can't do that."

I showed Nicole how to switch between html and Pearl views. I suggested she look for special words in the html page. That reduced the task of examining program code to a more familiar one, a word search puzzle. I knew the html would contain words like "table," "height," and "font." I hoped that would help her become more comfortable examining unformatted html. I made a list of words to search for. Once she became comfortable with it, I planned to walk her through the process of changing the code to specify another background color. Nicole just sat and stared at the html for a few moments. I quietly waited to see what she would do. Then she surprised me by agreeing to look for the "hidden words." Fifteen minutes later, Nicole called me over brimming with excitement. This was the most animated I had ever seen her. She wanted to show me what she termed her "discovery." I assumed she had located one of the "special" words in the html code. Instead she had stumbled upon the "How I Did It" panel text. She had then deleted several of the letters. Switching back to Pearl view, Nicole discovered the letters she had deleted were gone. Her wide grin and bright eyes showed her pride in her accomplishment.

Nicole: "I can change this here... <pointing to panel text> See! I go here and put it back."

Nicole switched to html view and replaced the remaining "How I Did It" text with her name. However, when she switched back to display the Pearl the panels were misaligned. Her reaction was both surprise and alarm. This was the most dangerous moment for Nicole and her Pearl. She had just experienced a severe project breakdown. She was pouting and kicking her legs under the table. But, she stayed. She seemed curious about the html because she kept leaning in and squinting at the screen. I suggested she look for the other panel headings to see how they looked and maybe she could figure out what happened. I sat quietly, but after several aborted attempts, she asked me to leave. She spent another twenty minutes flipping between the html and design views searching for panel heading clues. She occasionally pecked at the keyboard. Her tinkering paid off when one of her changes caused the panel to be restored.

RNC: "Can you tell me how you fixed your heading?"

Nicole: "I looked for the other heading... I looked for that font thingy in my heading. So then I changed it to be like the one of the other heading thing and it went away. Then I put in my name instead. See!"

Nicole switched to Pearl view. The panels were restored and heading text changed from "How I Did It" to "Nicole." I called over the Clubhouse Coordinator and another mentor and asked Nicole to explain. They praised Nicole and made a big deal over her accomplishment. Nicole beamed from all the attention.

Nicole: "I still want to change the color, too. I'm gonna look for my color part. ... DON'T TELL ME!"

Over the course of the next ½ hour, I observed Nicole while she worked. She managed to change the Pearl background color by altering the color number in the html.

Nicole: "I can just find this part and change the color number like this..."

She tinkered and tested several number values. I soon realized she already knew about color codes. When I mentioned this to her, she replied that she knew about color ranges from using PhotoShop. She had also memorized the color codes for her two favorite colors, purple and green. Nicole had applied knowledge gained from coloring line drawings using Photoshop software to aid her understanding of the html code. Several big ideas occurred here. One, Nicole's debugging was a deeper learning activity. She had to employ decision-making, an understanding of cause and effect relationships, and resolve inconsistencies her knowledge. Second, Nicole had entered a cycle of reflection-in-action (Schön, 1983) when she constructed and re-constructed the html code while exploring the coloring mechanism. Third, Nicole had incorporated old lessons into new ones. She used prior knowledge of color numbers to address the new challenge of coloring directly in html. Finally, Nicole came away from her experience with a new computational idea: coloring by coding. She connected the idea of "coloring through code" to what she already understood about color from using the Photoshop software. However, she had managed to "look under the car hood." Nicole had used the *Changing Background Color Pearl*, created by Chris G., to learn to customize her *Bubblez Pearl*. At first glance, her choice of Chris' Pearl may seem arbitrary; however, coloring was a

familiar design activity for Nicole. It provided the entry point for her Pearl design activities. That outcome was plausible. What was unexpected was how Nicole extended what she learned about changing panel colors to include color change methods not discussed in Chris' Pearl. Nicole used what she knew and tinkering to build upon ideas gleaned from Chris' Pearl.

I called over the Clubhouse Coordinator to show off Nicole's latest discovery. Nicole was both flattered and embarrassed by all the praise and attention, blushing and hiding her face in her hands. The Coordinator announced to the entire room that Nicole had something to show everyone. Here was the fourth dangerous moment for Nicole. In our excitement, the staff and I had put a spotlight on her, which thrust her into the direct scrutiny of her peers. Nicole handled the situation well. Eleven of the fourteen members present gathered around her workstation. Nicole used phrases like "I programmed..." and "I just tried doing..." to explain what she had done. Her characterization of her work as programming denoted a change in her view of her problem solving abilities. In the more obvious sense, she had programmed, albeit very simply, by looking through the code and figuring out what to edit. More importantly, she had test driven a new way of exploring options in her project construction, by tinkering with the design materials at hand. Nicole had developed a strategy of making small changes and switching views to observe their effect. She then offered to make a Pearl so others could change their background colors too.

Nicole: "I can show you how... I'm gonna make a Pearl too."

Nicole set about designing a Pearl about programming the Pearl background color. With my assistance, she copied-and-pasted parts of the applicable html code to the “How I did it” panel. Then, she added a personal narrative, reciting parts aloud as she typed. She became engrossed in a cycle of writing, deleting, and re-writing portions of the narrative until satisfied with the results. I had never observed her so focused and careful in her work. She had entered a cycle of reflection and action not common in her previous Clubhouse experiences. Nicole seemed to give a lot of thought to the wording of her message. Finally, once she was satisfied with her narrative, Nicole added additional text to cheer on the reader to “go and change those backgrounds!” She saved her work and exited from the program and the Village. She asked me to log on and view her Pearl. She wanted to see her Pearl listed in the Pearl Zone index. Several weeks later when I looked back over my notes of those events, I realized the events that day served as Nicole’s formal re-introduction to the community. Members began seeing Nicole differently. For example, they would say hello when they passed her at her workstation and she would respond.

6.2.3 Early Revision Experiences

Tuesday, December 6, 2004

Nicole asked me to sit with her while she edited her *Programming Pearl*. She had decided to highlight portions of her Pearl she thought were important for members to notice. She had made a design decision to use color to make those

portions of the Pearl stand out. Again; she chose coloring, a familiar activity, as an entry point into the new activity.

Nicole had made a conscious decision to revisit her Pearl. This marked the first observed instance of her editing any project. That act represented a deeper project engagement activity for her. Second, Nicole had a clear sense of what changes she wanted to make and why. Her design goal was somehow to highlight the important sections of the Pearl. She had decided to utilize a specific design element (color) for a specific purpose (highlighting important Pearl sections). She had reflected on her Pearl and devised a plan of action to resolve perceived inconsistencies with its intended function. Finally, Nicole had been motivated to revisit her Pearl and made those specific edits. She expressed concern about the usability of her Pearl and spent several minutes mulling over how to change the text colors. When she became frustrated, instead of giving up, she asked me for help.

Nicole: "I want just to color the part with the numbers"

RNC: "Sure. What difference will that make?"

Nicole: "I don't know. I just like some other color."

RNC: "Okay, what color do you want? "

I showed her how to use menu options to make the changes. However, Nicole wanted to change the color using html edits, which is more difficult to do. In spite of the fact that combing through html code was tedious compared to using menu options, she chose the "harder" option. This is another example Papert's (1983) notion of hard play that was discussed in the Flagship case study. I suggested

Nicole use the menu options first and then check to see how the html changed. She agreed and once she made the Pearl changes I talked with her about her choices.

Nicole: "I want to just color the numbers"

RNC: "Sure. What difference would that make though?"

Nicole: "I don't know. I just like some other color." ... "I don't like that one" ... "Can you see it good?"

RNC: "Am I supposed to?"

Nicole: "Yeah" ... "I want everybody to be able to see what I did."

RNC: "And what did you do?"

Nicole: "The PROGRAM. Come on." <she spins in the chair>

RNC: "You're programming now?"

Nicole: "Yeah. I can program that if I want. I can change color and maybe other stuff. I don't know."

Nicole had colored an area of text that contained the html code to change the Pearl background color. Her goal was to make it easier for others to find what she considered the "meat" of her Pearl. As she considered other changes, she focused specifically on text font, color, and size as important properties. Making her Pearl more readable seemed to be an important design goal. To accomplish that, she focused on those Pearl aspects that best expressed her values, priorities, and aesthetics. Coming to terms with her Pearl as a social artifact had raised concerns about presentation of her ideas. This marked a shift in her design perspective from her earlier *Bubblez* experience. Initially, Nicole was only concerned with personal design preferences with respect to her Pearl. When

asked about her color choices, she acknowledged that other colors might be easier to read but she wanted “her favorite colors.” Unfortunately, fuchsia and neon blue rendered the text difficult to read. Still, for other edits, her design perspective shifted from inward and her personal desires to outward and her audience’s perspective.

After more code tinkering, Nicole came up with a way to manipulate the Pearl panel using color to mask the panel. She ran up and pulled me over to her workstation to take a look. She seemed too excited to sit. I immediately noticed the “How I did it” panel missing. However, the remaining panels were still properly aligned.

Nicole: “I can make the text box disappear... You know how? I just look up the color for the background part. Then I put that number in the background for the text box. See!”

RNC: “Wow. How did you know what to change?”

Nicole: “I just keep doing it and look at the page and doing it. But if you look near the text, then go back over the line, then change the color number, like this.”

The panel was still there, but color masked. That is, she had made the panel the same color as the Pearl background, which effectively rendered it invisible.

Nicole had made the connection between matching the panel and background color to render the panel invisible. Her tinkering had led to an “ah ha” moment and a new idea about what coloring could be used for. She had made an important connection between knowledge she already possessed about coloring and a new possibility for utilizing that knowledge. Nicole wanted to show off how adept she was at controlling her newest invention. She reset the color so the panel would appear, viewed the results, and then adjusted the html to render it

invisible again. She flipped back to Pearl view and scrolled down to the end of the current text. Her rhythmic movements portrayed her self-confidence, control of the software interface as she rapidly pecked at the keyboard.

Nicole: You just go find the number in there (pointing to portion of html). You got to look for the words. You just keep looking... You take out the number near that word (pointing to portion of html code). Then put in your number.

Robbin: So you're telling me that once I find that word I can always find the number? How do I know I'm coloring the right thing?

Nicole: Well... You use the words to find it. Then you um you start at the top so you get it right. I'm gonna put that in my Pearl... <she types in the importance of starting at the top of the html code>... I'm done. Its beauuuuutiful!"

It was fitting that Nicole characterized her work as “beautiful.” She had experienced a *beautiful idea*. Her success with manipulating the html to mark out the panel marked a shift in her view of her learning acumen. She had drawn on prior knowledge and built up to more complex concepts. Such ideas comprise the intersection of Duckworth’s (2001) notion of *wonderful ideas* and Papert’s notion of *powerful ideas*. Duckworth argued that making connections from earlier experiences was the basis of intellectual development. Nicole used her early project coloring experiences to construct the more complex understanding of color masking. This was a sophisticated connection. Nicole had begun to think more critically and therefore had begun to *learn* to think critically. Papert’s notion of powerful ideas emphasized the exploration of new ways to put old knowledge to use. Nicole had taken an affinity for “coloring in” line images and expanded that idea to include “coloring out” the Pearl panel. She had used her new idea to solve a real world problem. Those powerful and wonderful ideas had culminated in a beautiful idea. That moment represented a profound shift in how she

connected her learning with her will. In that moment, her work didn't just happen to her, she happened to it (Kafai and Resnick, 1996). Figure 33 illustrates the concept of beautiful ideas, premised on the powerful and wonderful ideas of Papert and Duckworth.

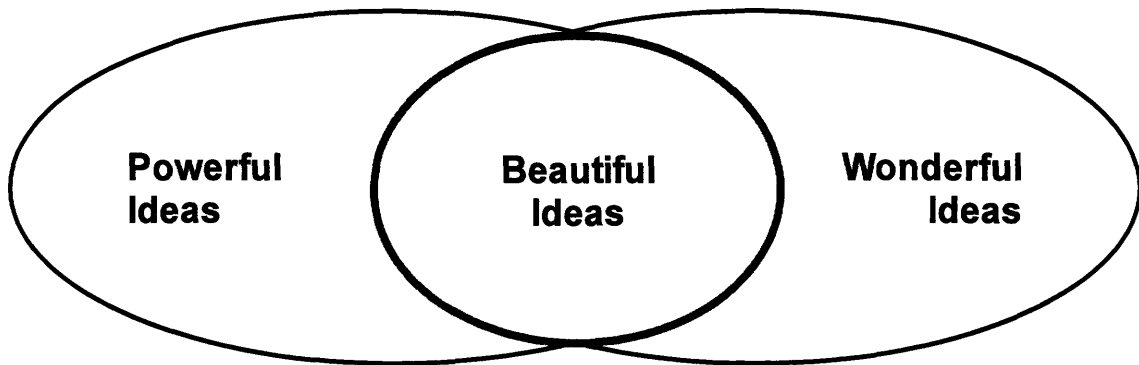


Figure 33. Beautiful Ideas.

Earlier in the study, when I asked Nicole to critique her projects she characterized them as “ugly.” With her new discoveries, her tinkering, and her beautiful ideas, Nicole appeared to be undergoing a change in perception of her work. The biggest change was in her delight in her new skills. Now her explorations had become a source of personal power. She wanted to be recognized for her Pearls, her discoveries, and her accomplishments.

6.2.4 Redefining Pearls

Saturday, January 8, 2005

Nicole and I had been having a discussion via email about how she came up with ideas for her “beats” (her label for the digital music she composed in the music studio). She had once invited me to the music studio and showed me how she sampled music to construct her compositions. That session marked a

change in our relationship. Up to that point in the study, she had not included me or other mentors in her sessions. Instead of peeking over at what I was writing, she seemed to ignore it. That new willingness to let me and potentially my criticism into her space was an indicator of her growing self-confidence. Also, she was always suspicious of my note taking while observing her. She would constantly ask to see what I had written. That day in the studio, she didn't ask to see my notes.

In the studio, Nicole seemed more relaxed. The studio is in a separate room at the FCC. I sat quietly and watched as she deleted several "failures." The lone survivor was saved to her Clubhouse folder. I asked her why the other songs were deleted but not this one. Her only comment was "they weren't right."

Later that evening after reviewing my field notes, I noted another instance when she had mentioned that her music had to be "right" or she wouldn't keep it. I decided to probe further. I used the opportunity to ask questions about her creative process. I emailed Nicole and asked how she knew when her music was "right." Her emailed reply included a link to a Pearl she had created in answer to my question. The Pearl was titled, "*How to get ideas for music beats.*"

Pearls

Thanks for asking Robbin, actullay Robbin I try to give them the best answer that I can convince them that I really don't know anything about it... And I would like to say again Thank You for asking me....

Robbin I will try my best to making more Pearls when I have free time about right now. I probally will after this..

Can you help if I am going to make one.

Bye

Nicole 🗨️ *sike* 🗨️

Figure 34. Nicole's Email About Her *Beats* Pearl.

Like her email, the “*Beats*” Pearl narrative was conversational, direct, and casual. See Figure 34. Nicole had used html edits and altered her Pearl layout format from the default 3-panels to 2-panels. However, this time, in addition to color-masking to “hide” the third panel she also reduced the size of the panel which allowed the other two to line up next to each other. She had also edited the html to change the Panel Prompts. In one panel, she addressed me by name and answered my question directly. In the other panel, she shared her design strategy for making beats. Then, she directly addressed the larger community. She offered music composition tips and encouraged members to try their own music projects. She solicited their feedback and ideas. Finally, she encouraged them to make a Pearl or email their responses to her.

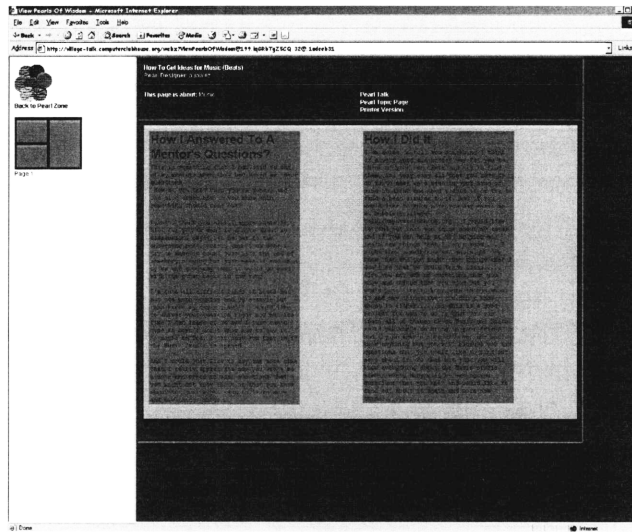


Figure 35. Beats (Pearl View)

That was a direct attempt to connect with the FCC community. See Figure 35. Nicole had included her Village email address so others could contact her directly. The following is the left panel content of *Beats*. Nicole had changed the panel headings, background and text colors.

How I Answered To A Mentor's Questions?

This is something that I had said to one of my mentors when they had asked me these questions
 How do you know when you're done?, and she also asked How do you know when something should come out?

Robbin, thank you alot I appreciate it alot for you to send me a note about my disscusion, okjay let me get to the answering part. Robbin when i am done i try to make it sound just like the end of somebody singing but just make it end in a rythm and good way that it would go good with the other beats in the song.

I'm into all diffrent kinds of beats but not too much country and 80's style but raps kinda my style , we'll i would like to answer your question right now but its like I can image of it but I just can't type it down I don't know how to say it. So maybe on Wed. I can show you that is if the Music Studio is opened.

And I would just like to say one more time that I really appreciate how you wrote me a note and asked me some questions that you might not know about or that you know about but just might want to learn more and new things about...

Nicole had used her Pearl as a communication tool. Although her response was to my question, she included my original question in the Pearl text. That indicated an awareness of her larger audience who would need to know what question she was answering. She demonstrated a growing comfort with the public sharing her thoughts and ideas. She talked about her desire to learn and seemed eager to learn new project skills from other members. The next excerpt was from the right panel.

How I Did It

I am going to tell you something I think is a very good and better way for you to think of your own beats and try to find them, its very easy all that you have to do is to make up a beat in your mind or sing it aloud and then record it or try to find a beat similar to it. And if you would like to know more you may email me at Bubblez@village-talk.computerclubhoue.org. I would like to find out what you think about my ideas and if you can help me by, helping me learn new things that I don't know ... I might know somethings and you might not know that and you might know things that I don't so that we could trade Ideas..... Also you may ask me questions that you know and things that you know but you would just like to know more things about it and new things that you don't know about it either.....So this is a good project for you to do so that you can learn all of things about Music and Beats so if you where to bring in your friend and try to make a song with her she won't know anything but you will because you ask questions that you would like to find out more about it. So that not just you will know everything about the Music studio almost every body will be asking you questions that you know and would like to find out about it again and more new things.....
Sing your heart out...

There are several points of interest in this panel's content. First, Nicole had engineered a new Pearl function. She had converted the Pearl to make a public broadcast. Second, she had incorporated earlier Pearl lessons, namely color-masking, panel heading customization, and background coloring into her Pearl design. Her continued use of these advanced Pearl editing techniques suggested she was engaged in a richer project development cycle that she had

experienced with her Clubhouse projects. Third, her explanation of music composition was systematic, even algorithmic, in nature. The flowchart shown in Figure 36 is derived from a process analysis of her Pearl narrative.

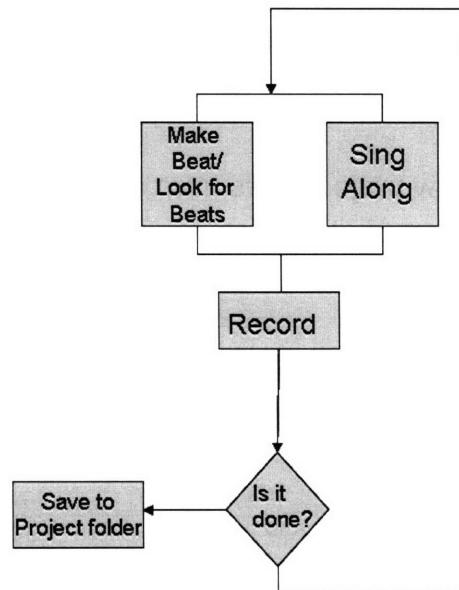


Figure 36. Work flowchart for Nicole's *Beats Pearl*.

Fourth, Nicole intentionally provoked a public review of her ideas by soliciting member feedback. Her goal seemed to be establishment of new connections with FCC members. Fifth, in both panels, she addressed the reader directly, and used her “outward-directed” voice. In her *Bubblez Pearl*, her narrative was inward, in relation to herself only. In this Pearl, her voice was directed outward, toward others. Finally, Nicole encouraged others to make music projects for the notoriety it would bring. That implied she considered such notoriety desirable.

Nicole’s actions with this Pearl indicated she was becoming a more confident learner. She moved from addressing herself to addressing an authority figure (this researcher and an adult) to addressing a group of her peers. Her narrative was thoughtful, articulate, and showed she was establishing a role for

herself as a Pearl advocate. Her *Beats* Pearl represented a shift in her perception of her role in the community. She offered advice, shared her ideas, and mentored others. That suggested that her Pearl provided a forum where she could take social risks.

Later, I questioned Nicole about her process and motivations in making her *Beats* Pearl. She explained how she wrote the email and *Beats* at the same time, flipping back and forth. When I asked why she used a Pearl to answer my question, she replied ingenuously, "You asked me so I answered." Nicole had co-opted her Pearl as a communications tool. She had established a comfortable Pearl design style, namely moving between Pearl and the familiar email program. In spite of her forward strides, Nicole continued to utilize font sizes and colors that were difficult to read. When asked about her choices, she shrugged and replied they were "her favorites." That response underscored how her transformation was a dynamic process but also had an ebb and flow process.

6.2.5 Making Pearl-Based Connections

Monday, February 28, 2005

Several members had used Nicole's Pearls over a four-week period. That was evidenced by her Pearl's print activity, and new Pearls that incorporated her Panel Prompt changes and panel masking technique. There was a growing perception among members that Nicole was someone who could provide project help, especially with making Pearls. She was growing into a new role, as pearl guru.

Carmen is a 13-year-old female and member since June 2004 when she and her family moved to Boston from Nicaragua. Carmen spoke and read some English, but was more comfortable speaking her native Spanish. Her social group at FCC consisted of other Spanish-speaking members, although not exclusively. Carmen had stated she wanted to “learn new English.” She also had an idea for a Photoshop project: a picture of herself with the Nicaraguan flag in the background. Her project was inspired by Nicole’s *Bubblez Pearl*, which was posted on the Clubhouse Walls. Carmen looked over the Pearl, but was disappointed to find there were no detailed instructions. While *Bubblez* covered how to assemble the project, it didn’t detail how to use the Photoshop software. When Carmen asked a mentor for help with Photoshop and showed her Nicole’s Pearl on the Clubhouse Walls, the mentor introduced the two girls. Referrals of Pearls and Pearl designers to other members had become a growing mentor practice.

Nicole and Carmen eyed each shyly while introductions were made. When Nicole noticed a printout of her *Bubblez Pearl* at Carmen’s workstation, she perked up. Nicole showed Carmen how to use the magnetic lasso and magic wand tools to highlight and remove unwanted parts of her images.

Nicole: “You can put more than one on top then take out the rest of the picture. I used two, but you can use a lot if you want.”

Another member, Juliana, came to watch the two girls work. Even after Carmen got the hang of it the Photoshop tools, Nicole stayed on to chat with the two girls. This was not an easy process because of the language barrier. Their

exchange was significant for several reasons. First, Nicole had deliberately prolonged contact and conversation with a member she had just met. Second, the language barrier was a significant communications obstacle. Carmen spoke very little English. Juliana spoke only Spanish. The two girls spoke to each other in Spanish, which Carmen then attempted to translate. As I observed Nicole, Carmen, and Juliana together I noted an increasing complexity to their interactions. First, the girls shared more than expertise; they also shared ideas and some personal anecdotes. Carmen completed and printed her project. With much fanfare, it was hung up on the Clubhouse Walls. That marked the first interaction the three ever had although they had attended the Clubhouse together for the last four months. I later questioned Nicole about her exchange with Carmen and Juliana.

RNC: "Why did you work with Carmen?"

Nicole: "cause I know the answer and she don't so I can tell her. Its better if somebody can tell you"

RNC: "So you're like Carmen? How is that? Can you tell me more about that?"

Nicole: "You know." [pause]

RNC: "I want to know. Can you explain it?"

Nicole: [giggles] "We're girls."

RNC: "What does being girls have to do with it?"

Nicole: [shrug] "I don't know. [...] We listen I guess. You want them to listen cause you want to help."

RNC: "Is that the only reason Carmen and Juliana would listen to you?"

Nicole: [pause] "I guess. [...] I told them stuff and they asked me more things. So I just answered and they do the steps the way I said."

RNC: "Did that help her? What did you say?"

Nicole: "I don't know... I just showed her how I do it. She don't know about the lasso."

There are several interesting points to that exchange. First, Nicole was able to serve in the role as peer mentor. That meant sharing her Photoshop software expertise and understanding of layering techniques. Second, her response to my question about her motives for helping was a familiar one. She had mentioned early in the study that she helped because she was asked. Again, she had helped, but only after being invited. I hoped that over time and with more opportunities for working with other members, she would move toward initiating new connections on her own. Third, from the member questioning her about her Pearl, Nicole had validation that FCC members were tying their projects to their use of her Pearl.

6.2.6 Idea Storage

Wednesday, March 2, 2005

I noticed Nicole had edited her *Bubblez* Pearl again, this time adding content to one of the panels on page two.

What I'm Thinking About

If I was going to add-on to this picture I would probably put some birds in the back and her looking in the air and it would show all the clouds and the clouds would look like all different things like animals, toys, cars, and etc. I would also put people in the back maybe reading a newspaper and walking there dogs. Then i would probably put kids playing in the park or playing on the grass. That is what I would do if I would add-on to this picture.

That edit cycle was significant for several reasons. First, she had established another use for her Pearl: to store her ideas. Her narrative style was reminiscent of a brainstorming session. Second, she did not seem concerned about public exposure of her ideas. She knew her Pearls were in the public eye. Third, that was her first Pearl longer than one page. Fourth, the Pearl was now organized by function; page one was about her project and page two about her future ideas for that project. I caught up with Nicole and inquired about her Bubblez Pearl edits.

RNC: "Hi Nicole, what's up? ... I see you added some things to your Bubblez Pearl."

Nicole: "You noticed!? I just did it." <she grins>

RNC: "Of course, I noticed. That was nice of you to say more. Why did you do it?"

Nicole: "I don't know... Guess, what, I'm going to do something to my picture, make it bigger like a park."

RNC: "Is that what you added to your Pearl?"

Nicole: "Uh huh. I have a bunch of ideas, but haven't started it yet though."

RNC: "Okay, why did you put your ideas in the Pearl?"

Nicole: "I just got it but I don't want to change my picture yet because I don't know which idea I'll use, so I put them all down so I don't forget."

RNC: "Your Pearl can hold your ideas? What if other people see them before you add them to your project?"

Nicole: "I don't care, they can use it but I had it first... When I fix my picture, I'll add it too."

Nicole had begun to realize she had done something most members had not.

She had become a "trailblazer" within the Pearl-making arena.

"I make Pearls, not that many people make it. They don't even KNOW, but I tell them, then they know..."

Robbin: "What do they know?"

"Nicole: "About my PEARLS." ... "I just tell them what to do and then they do it and then they know"

Nicole had re-evaluated her role in the community. She took responsibility for "spreading the word" about Pearls. Her viewpoint was teaching others to make their own Pearls and would help them know more.

6.2.7 Widening Pearl-Based Connections

Saturday, March 12, 2004

It was another busy Saturday at the Clubhouse. Things were pretty raucous, with lots of loud talking, laughing, and horseplay. Music videos blared in the background. On Saturdays, most members were older, fifteen to eighteen years old, and male. Nicole had come around noontime and settled down to work on a new Photoshop project. Dwight was a 17-year-old male Clubhouse member. He had been introduced to the Clubhouse a few weeks before by a

friend, who had been a member for over a year. During his few visits to date, Dwight had mostly watched music videos and downloaded music from the Internet. During our conversation, I discovered he had an interest in making music but wasn't sure how to get a project started. I showed him the Pearls of Wisdom site and Nicole's Beats Pearl. He printed a copy, and then at his request I introduced him to Nicole. To his surprise and shock he was introduced to an eleven-year-old girl. Dwight questioned Nicole about how she came up with her music project ideas. Then he asked for advice planning the project. Nicole acted shy and embarrassed by his attention. She was flattered to be getting attention from a seventeen-year-old guy and acted a little flirty. Nicole's was grinning from ear to ear.

Nicole: "Why did you have to look at mine" <smiling, she slides out of the chair and onto the floor>.

Dwight: "<laughs> Are you okay? I just want know about your project. I going to cut some tracks; I'm just planning it now though...Can I hear some of your beats?..."

Nicole: "Nooooo, I can't."

Dwight deferred to her as a mentor, in a friendly and respectful way. With the gender and age differences, such an exchange was not typical.

There was also an exchange between Nicole and Cisco and Ruby, FCC alum. Both young men continued to be involved with the FCC community. Over the last month they had noticed Nicole's Pearls. Nicole had gotten to know Cisco and Ruby. Their friendship and interest helped further solidify her position as a

mover and shaker in the community. At Nicole's request, the guys looked over her *Beats Pearl*. Their candid feedback centered on her presentation choices.

Cisco: "Man, I'm going blind here. These colors are too bright for me... Looks good Nicole, looks good though."

Ruby seemed to purposely soften his critique, but he was clear that it was difficult to read. Then he told me I should be honored that Nicole referred to me in her *Pearl*. Ruby was teasing me and complimenting Nicole. She giggled and bumped him with her shoulder, a sign of affection and camaraderie. She loved receiving his attention. She had taken Cisco's comments to heart. That and further reflection on her *Pearl* prompted some ideas. Nicole focused on playing with different font colors.

Nicole: "Wait. I can change that. See. Watch!"

Cisco: "that looks better."

Nicole: "Noooo, that's not it. <she makes more changes>

RNC: "What's wrong with it?"

Nicole: "I don't know. It's ugly. I want it to show better... yeah, I can see it better."

Nicole had taken responsibility for the condition, form and content of her *Pearl*.

The impetus to revisit her *Pearl* presented a period of reflection apparently sparked by Cisco's and Ruby's remarks. Nicole showed Ruby her changes. He complemented her work. Even though he approved, Nicole continued to consider making other changes. When I asked her why, she replied "So more people will know what it's for." She mulled over what changes to make next.

The FCC Coordinator had already begun shutting down idle workstations because the Clubhouse closed in ten minutes.

RNC: "Why are you making changes now? Why not wait until next time?"

Nicole: "Noooo, I want them to see my words better... I might add a picture of a mic, but if its good....Wait for me!"

Nicole opened several Google search screens and searched for images of drums, keyboards, and guitars. She switched to her Pearl and tripled the font size. She flipped between the Google screens looking for the right images to put in her Pearl. She seemed concerned that people wouldn't know that those instruments were supposed to represent the music studio. That seemed to be a problem that required a design decision. After several moments of quiet thought, Nicole made her choice.

Nicole: "I need some headphones too ... Everybody uses headphones though. I need some real ones..."

She searched for headphone and microphone images. After selecting two pictures, Nicole considered several locations and settled on the bottom.

Nicole: "I want them both to be the same size, so they match.... That looks better!"

RNC: "What's better about the Pearl now?"

Nicole: "I dunno. It's not so boring because the pictures help. I might put another in later."

RNC: "How do the headphones and microphone make your Pearl better?"

Nicole: "Cuz, now they know you supposed to LISTEN and that's the headphones. Then they need to MAKE THE MUSIC, so I use the mic, because I don't know what music they pick. They have to listen to their music and fix it until its good."

She had decided they were generic studio items. Nicole used stock images of common studio objects to represent a more general case of music making process. She had started with images of her favorite instruments but then decided to use images that best represented music studio activity. She wanted her Pearl to make the most sense to the most users. To accomplish this, she generalized what she knew about the music design process. Satisfied with her edits, she added a final entreaty to her readers. She urged them to "sing your heart out!" when they got their chance in the studio.

6.2.8 Seeds of Reflection

Monday, March 14th, 2005

The following Monday, Nicole and I discussed her music projects and the possibility of adding one to her *Beats Pearl*.

RNC: "Which one do you think would go best with your Pearl?"

Nicole: "I don't know...any, I guess" ... "But maybe my jazzy one. I called it jazzy."

RNC: " Why is that one better for your Pearl?"

She sat with that question for a few moments.

Nicole: "Cuz, I don't do it all at once, you know. I play a beat and listen and then after a while I add a beat then more until it's good."

Nicole had identified an aspect of her composition process that she articulated as being particular to her and of possible interest to others. Unlike in similar conversations early in the study, she did not base her choices merely on her

personal likes or tastes. Instead she seemed to have another standard, based on uniqueness, ownership, and possible interest.

RNC: "Sounds like you're styling. Do you have a trademark"? <I explained the meaning of the work trademark> "How will I know when I'm listening to Nicole's creation?"

Nicole: <giggling> "Cuz, I have my own mark..."

RNC: trademark?

Nicole: "Yeah, mine is special. I make music then I take out some and more then the first beat is left, then it ends..." ... "All my songs go like that, so its mine."

Our conversation marked how Nicole seemed to better articulate her design process as compared to the beginning of the study. There was richness to her narrative. She had examined how she stepped through the process and articulated her music making heuristic. She described she ended her compositions using her particular, personal style. Both verbally and in her *Beats Pearl* narrative, Nicole reflected on how she "builds up" a good composition. That represented a fundamental shift in how she was thinking about her work. She displayed an awareness of how her music came into being, most notably from *inside* of herself. None of our earlier conversations had revealed such depth of awareness. Through her Pearl constructions and Pearl-inspired interactions, she had managed to articulate her understanding of her process so others could understand it and use it.

6.2.9 Discussion Theme: Reflection

Reflection was an important theme that emerged from the data. Nicole had undergone a number of important transformations in her learning

experiences during the study. Nicole's changes in reflective practice occurred along two sub-themes: reflections on her design process and reflections on her learning strategies.

6.2.9.1 *Reflection on the Design Process*

At the start of this study, Nicole's projects were simplistic and repetitive. She performed the same actions from one project to the next. This "design by replication" approach resulted in her resistance to experimentation with new software features or ideas in her projects. She denied having a design style noting that she was not the source of her project ideas. Schön (1985, 1987) defined reflection-in-action as a process of reflection while immersed in activity. It defined the learner's relationship with the project at hand. When Nicole reflected on a section of her *Programming Pearl* she decided the font was too small. She iterated through the process of enlarging the font size and critiquing the result until she felt it was "right." Part of her perception of the problem was based on her worry that others wouldn't be able to "see" what she considered important text. Subsequently, she moved through a series of design decisions that resolved the problem. Her final evaluation cycle came when she was satisfied that with the new font size her text would perform as she envisioned within the context of her entire Pearl. This is seen in how Nicole took an active part in structuring the problem, progressed toward a solution, and evaluated her process. Her reflection was focused on the content of her design decisions according to her perception of what the problem was. Reflection-in-action became a design strategy Nicole cultivated over the course of her Pearl design

experiences. However, that was not a linear progression. Instead, she moved back and forth from none to varying degrees reflection on her design process. Examples of progress were those instances when she questioned the quality of her Pearl content. Those instances resulted in formative Pearl changes.

6.2.9.1.1 Critical Self-reflection

Dewey (1933) put forth the idea that deeper understanding and meaning could be achieved through critical reflection. Kolb (1984) went further to claim that critical reflection was part of a learning cycle. For Nicole, her Pearls were a concrete instantiation of her Clubhouse experiences and provided a platform for her to engage in reflection on those experiences. The Panel Prompts caused her to stop and think about her work in a specific context. For example, in her *Bubblez* Pearl, Nicole stopped to consider what genre her project fit into. The same occurred when had to name her Pearl. She selected her Pearl genre and design tool values from the program drop menus. She could have used default values and left out the design tool information. I was prepared to remind her to revisit them once she finished adding the Pearl content. To my surprise, she spent a short time musing over which genre to select (although I thought “image” was the obvious choice). Apparently being asked to make a choice merited thought about what her project was really about. In her *Programming* Pearl, Nicole customized section headings, which crystallized her thinking about the Pearl's organization and content.

How I Answered To A Mentor's Questions?

This is something that I had said to one of my mentors when they had asked me these questions

How do you know when you're done?, and she also asked How do you know when something should come out? Robbin, thank you a lot I appreciate it a lot for you to send me a note about my discussion, okay let me get to the answering part...

Webb (1982, 1989b) showed that when a learner was required to further explain and answer questions about her thinking, her learning experience was enhanced. He theorized that those interactions required the learner to reorganize her thinking, further clarify concepts, and reformulate her knowledge in a more generalized way. For example, after getting feedback and attention from Cisco, Steve, and Dwight, Nicole was highly motivated to make refinements to her *Beats* pearl. In this case her Pearl had facilitated meaningful connections with her community and motivated a cycle of critical self-reflection. In that example, Nicole's Pearls played the role of object-to-reflect-with.

6.2.9.1.2 Articulation of Design Strategies

Opportunities to articulate what had been learned provided the impetus for Nicole to self-critique and refine how she articulated her design process to others. This was evidenced by how she questioned herself about what to include in her Pearl and how best to craft her "take home message." For example, as she further refined her *How to Make Beats* Pearl, Nicole expended a great deal of thought and energy finding the images that would best represent what most music studio users would experience, namely using the mike and listening via

speakers. She moved away from more personal images of her favorite instruments and reflected on more general objects that are part of the music studio experience. Schön would characterize Nicole's "deliberation" of her music-making process as an indicator of her "knowing in action," an understanding of ways of framing and resolving problematic situations, which he described as a starting condition for reflection. For Nicole, "deliberation" meant thinking about what was important about what she knew. She thought of what her audience will glean from what she had to say and how she said it. She adapted her Pearls to reflect this complex relationship.

Nicole's increased focus on her Pearl design was the result of a cycle of creation, feedback, and revision that was characterized by richer development of her Pearls. Those Pearls that received attention from the larger community garnered the most focus. As a result of her Pearl-related interactions with others, Nicole became motivated to engage in more reflective design practices. Biggs (1997) provides some insight into what underlying mechanisms might be driving Nicole's increased level of critical self-reflection and self-awareness. He showed how an increased level of focus on projects can lead to increases in self-examination and self-critique.

6.2.9.2 *Reflecting on Learning Strategies*

Surface learning behaviors result in mere coping with a design task but not extracting any meaningful learning from the process (Chi & Brown, 2000). Surface learning indicators include reliance on familiar work patterns, no re-examination of work, resistance to new ideas, ready abandonment of projects,

and simplistic project development. Deep learning behaviors, on the other hand, find the learner taking action to extract meaning by relating ideas and establishing patterns based on old and new knowledge (Chi & Brown, 2000; Henri, 1992). Deep learning indicators include integration of new knowledge with old, understanding cause and effect relationships (Biggs, 1987), and resolving inconsistencies in knowledge. At the beginning of this study, Nicole exhibited many surface learning behaviors and none of the deep learning behaviors. Her confidence and project focus was tempered by what she believed about herself as a learner. That affective component could not be ignored because it factored into her early learning strategy. The work of both Biggs and Ramsden (1987) showed the profound effect intellectual self-esteem has on development of effective learning strategies. Prior to her first bout of html tinkering, Nicole was clearly unsure and fearful about the outcome of her efforts. This reaction was based on established beliefs about herself as a poor learner and problem solver, reinforced by her experiences at school and at home: she often commented on how “dumb” she was or how she “couldn’t do anything right.”

6.2.9.2.1 Emergence of Deep Learning Activities

At the beginning of the study, Nicole’s project design experiences at the Clubhouse were characterized by surface learning. She sought only to replicate, over numerous projects, those skills she was familiar with and took a “design by replication” approach to new projects. Over time, however, Nicole began to have more deep learning experiences. Her Pearl design experiences immersed her in

deeper learning activities both through the reflective components of Pearl design and increased opportunities to test alternative learning strategies. Nicole's deep learning experiences were sparked by her having to focus attention on the underlying mechanisms that had disrupted her Pearl design process (Jarvis, 1992, Schön, 1983).

Piaget (1976) considered the integration of new material into existing beliefs and knowledge a process of assimilation. Accommodation served as backup should assimilation fail. It required alteration of the concept model. Nicole had assimilated some lessons learned while working on her clubhouse projects into her pearl lessons. In one example, she was able to bring in her knowledge of color codes to aid her tinkering with a Pearl's html. She tried several color changes and as I watched, I realized she already knew about color codes. Nicole eventually delved deeper into html tinkering to solve the problem of her undesirable header text change. Her earlier efforts resulted in the sections becoming misaligned. Prior to this bout of tinkering, Nicole already expected failure. Her reaction was based on beliefs about herself as a poor learner and problem solver.

Nicole: "What is that? I don't know that, I can't program stuff. Do I have to use it?"

Her response was best understood in the context her earlier project design style of repeating project actions by rote and putting up resistance to trying new things. By encouraging her to play with the html, I had pushed Nicole out of her project design "comfort zone." While she agreed to look over the html, she insisted she be left alone to work, possibly to avoid the embarrassment of looking "dumb" in

front of an audience. Later in the study, after she experienced some success through her tinkering, Nicole better tolerated an audience.

Have gained fluency and some comfort with the PoW technology, Nicole moved on to invent other Pearl uses. Feeling comfortable enough to play with the technology had led to using Pearls to store her project ideas for future use.

Nicole: "I don't know... Guess, what, I'm going to do something to my picture, make it bigger like a park."

RNC: "Is that what you added to your Pearl?"

Nicole: "Uh huh. I have a bunch of ideas, but haven't started it yet though."

RNC: "Okay, why did you put your ideas in the Pearl?"

Nicole: "I just got it but I don't want to change my picture yet because I don't know which idea I'll use, so I put them all down so I don't forget."

RNC: "Your Pearl can hold your ideas? What if other people see them before you add them to your project?"

Nicole: "I don't care, they can use it but I had it first... When I fix my picture, I'll add it too."

She also used her *Beats* Pearl as communication medium, to broadcast a request to whoever was looking. The following is an excerpt.

And if you would like to know more you may email me at Bubblez@village-talk.computerclubhoue.org. I would like to find out what you think about my ideas and if you can help me by, helping me learn new things that I don't know ... I might know somethings and you might not know that and you might know things that I don't so that we could trade Ideas.....

She re-shaped her Pearl's structure to suit her own design choices. She changed rendered sections invisible and made other customizations. Those changes required fluency with the PoW technology.

Nicole's PoW experiences closely modeled Henri's (1992) *five dimensions* of critical reasoning skills. First she engaged in *elementary clarification* when she realized a problem existed and understood the nature of the problem, even without understanding the underlying mechanism that caused it. She moved on to *in-depth clarification* of the problem when she began to look for the reasons behind it. In short, Nicole had narrowed down the problem domain to a more manageable size. Next, she made *judgments* and *inferences* about possible solutions to the problem. That led to *strategy employment* and *observation* (tinkering and debugging), where she gained deeper insight into the problem. Nicole's deep learning experiences were sparked by having focused her attention on the underlying mechanisms that had disrupted her design flow. Her learning strategy was a holistic one, where she re-organized, re-structured, and integrated her prior knowledge with what she had discovered through her tinkering.

6.2.10 Discussion Theme: Identity

Erikson (1963), a pioneer in the study of identity development, described identity as an individual's ability to experience continuity and sameness in her view of self and match that view with congruent actions. For Nicole, the transformation of identity, both internal and external, is one outcome of her Pearl practices. How she self-identified, her internal identity, developed out of her questioning the meaning of her work and what had been said about her as a learner. Making her design thinking explicit reflected back the type of thinker she was. How others saw her, her external identity, changed as a consequence of the concrete instantiations of her ideas, concerns, and desire to connect with

others (Wenger, 1998, Bers, 2001). Identity was created, recreated, and sustained through the individual's reflective actions, especially during changing social circumstances.

I organized my discussion of Nicole's identity transformation along two sub-themes, *identity and learning efficacy* and *identity and community*. What follows is an analysis and discussion, including how her Pearl experiences contributed to her identity transformation from insecure loner to respected community member.

6.2.10.1 *Pre-Pearl Identity*

When I met Nicole, I observed she often commented negatively about her learning ability. She didn't seem to view herself as a capable learner. That negative self-image only served to reinforce her reluctance to try new projects. Nicole was also very secretive about her projects and isolated herself from the rest of the Clubhouse. She rarely shared her projects and insisted on privacy while doing her work. When she first started working with Pearls, Nicole would repeatedly ask me to "go away" so she could work.

6.2.10.2 *Identity and Capable Learning*

Nicole's Pearl activities had an impact on her view of her learning capacity. During her various Pearl experiences forced her reevaluation of her learning competencies. Nicole had moved toward becoming a better problem solver and more creative thinker. And she had the Pearls to prove it to herself and to others.

Nicole: "[...] I want everybody to be able to see what I did."

RNC: "And what did you do?"

Nicole: "The PROGRAM. Come on." <she spins in the chair>

RNC: "You're programming now?"

Nicole: "Yeah. I can program that if I want. I can change color and maybe other stuff. I don't know."

Referring to her debugging html as "programming" required a change in her view of her problem solving abilities. Nicole had taken ownership of her actions. She saw her debugging as intentional, not serendipitous. Programming had not happened to her, *she* had happened to it. That required her to reconcile her learning strategy of tinkering with her prior one of abandonment. Nicole tinkered over numerous Pearls, further reinforcing the notion of this strategy as a positive one. Over time, she also tinkered more in her Clubhouse projects. This learning strategy led to a new way of viewing herself.

When her tinkering had led to her color masking discovery, Nicole characterized her work as "beautiful." That was an about face from her earlier labeling of her projects as "ugly" or "garbage." Her changing perception of her work, and consequently, herself, suggested that the success of her newer learning strategy had also become a source of personal power. She even began to take credit for her pre-Pearl creations and acknowledged that they came from *inside* of her.

6.2.10.3 *Identity and the Internal Voice*

Over the course of the study, Nicole developed a public voice. That process started with her first two Pearl narratives and continued through her public exchanges with members. Telling their stories can be an important mechanism for learners to think about who they are (Bers, 2001). For Nicole, her Pearls were her stories. Bruner (1990) considered narrative to be an important conduit for the individual to see the self, especially in the context of a culture. Nicole was learning her value to others through sharing her Pearls.

6.2.10.4 *Identity and Awareness of Audience*

Nicole moved from making Pearls for herself to making Pearls for her audience. From that first involuntary public exhibition of her html discoveries, she had become acutely aware of her audience. For her, responsibility accompanied that realization. She became more thoughtful about the experience of Pearl users. She shifted her design perspective from inward to outward. That motivated her to reexamine her Pearls for clarity of message and quality of presentation. That was another indicator of deep learning. The care she took with her audience required Nicole to think about what she knew in new ways. A consequence was she began to think about herself in new ways, as well. Coming to terms with her Pearl as a social artifact had focused her attention on what her Pearl said about her.

6.2.10.5 Identity and Community

Identity is not static. It is a continuous negotiation between the individual and her situated context (Dewey 1963, Bruner, 1996). Both Dewey and Bruner argued that within the situated context, identity was validated by peers. Bruner also pointed out that we must have some general notion of ourselves based on our actions. That was evidenced in observations of Nicole. Having her work validated by others seemed a factor in her evolving identity as a valued FCC member. Nicole's Pearl activities, both creating and sharing, required her to reconsider herself and her place in the Clubhouse. At the beginning of this study, Nicole clearly felt she was invisible to others in the Clubhouse. According to her, no one cared about her or about what she did.

Nicole: "I have lots of projects... I don't know which one to do."

RNC: Which one do you think others might like to know about?"

Nicole: "I don't know!! I don't know what to do. Nobody cares about what I do no way."

Her self-imposed isolation had only reinforced her invisibility. Nicole made no effort to escape her world of social isolation. On the contrary, she often engaged in behaviors that discouraged and new social connections. When she engaged in bad behavior, those incidents served to separate her from other members. Another form of social isolation resulted from her unwillingness to share her work with others.

Nicole underwent an important shift in her perception of her role in the community. This shift was driven in part from within her and in part by what the

community reflected back to her. She had become a member who offered advice, suggested creative ideas for projects, and mentored others. She encouraged members to make more projects so they could make more Pearls. She had tied how others used her Pearls to their resultant projects. These connections reinforced her new role both for herself and for her community. An example was her hands-on mentoring of Carmen. That experience challenged her preconceptions of her role in the community. Nicole was moving from peripheral to fuller participation (Wenger, 1998). Nicole took responsibility for "spreading the word" about Pearls. She also viewed that practice as a benevolent task, as if making their own Pearls would help others in some way.

Nicole: "I make Pearls, not that many people make it. They don't even KNOW, but I tell them, then they know..."

Robbin: "What do they know?"

Nicole: "About my PEARLS." ... "I just tell them what to do and then they do it and then they know"

Nicole had modeled a new role for herself and others at the Clubhouse. That role was to help others not just build projects but help them *think* about the building.

6.2.11 Discussion Theme: Community Participation

Lave and Wenger (1991) described participation as the way of learning and the road to community membership. They argued that shared participation in a community of practice provided a foundation for learning. At the Clubhouse, community participation typically draws the learner deeper into the community

and reinforces commitment to quality project construction and sharing (Chapman and Burd, 2002). Participation served as an important facilitator in Nicole's continued negotiation with the FCC community over the meaning of her Pearls. That process of participation and the resultant relationships were a key catalyst in her changing view of herself. Her Pearls had become a kind of social proxy.

In this section, I examine how Nicole's Pearl experiences were tied to her evolving status of community participant. I examine relationships that formed, both between people, and between people and Pearls. As baseline for this discussion I reviewed her level of participation in the FCC community at the start of the study.

6.2.11.1 *Growing New Roots*

At the beginning of the study, Nicole did not participate in the FCC community. She stayed on her own and avoided interactions with others. She did not share her projects. That behavior led to limited opportunities for participation. Her Pearl activities were a catalyst for new participation practices. Pearl practices had her reaching out to the community, establishing new social connections, and gaining community acceptance as a source of new project ideas. Her behavior exemplified several Constructionist Cooperative indicators. She actively pursued the exchange of ideas with the larger community. She solicited their critique of her design ideas. She encouraged others to contribute their own Pearls. She seemed to take responsibility for "spreading the word"

about Pearls. As Nicole gained momentum through participatory Pearl activities, she moved from the periphery to toward fuller participation within the community. By the end of the study her repertoire of participatory activities also included sharing her work through the various FCC venues and being the “go-to girl” for Pearls.

Nicole’s story of transformation has provided a richer look at the effects of the Pearls of Wisdom technology and associated scaffolds on her learning and reflection experiences. At the start of the PoW study, her membership was characterized by isolated, marginal participation, both in the FCC and in her projects. Over the course of the study, her interactions with other members coupled with the challenge of her Pearl experiences helped to facilitate her process of transformative learning (Cranston, 1992).

Over the course of the study, Nicole experienced changes in her project activities. She still used Photoshop and worked with her favorite subject, Bart Simpson (see Figure 37). However, she also employed a variety of additional graphic design techniques. Examples include cropping, using the magnetic lasso tool to extract part of an image, and using various Photoshop filters.

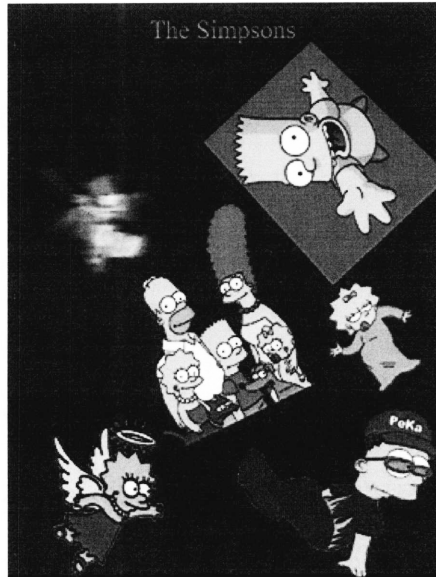


Figure 37. In this Photoshop project, Nicole made use of several advanced software features, including layering, filters, rotating, magnetic lasso, and the text tool.

In her next project, Nicole included images of herself. This is a regular practice for FCC members but new for Nicole.



Figure 38. Nicole's first project with her image.

She later put that project up on the FCC Walls.

Scratch programming language was her next challenge. When series of workshops took place at the Clubhouse, Nicole joined in and learned to use the software. It's difficult to imagine she would have learned Scratch without her success with her html programming. Before her Pearl experiences, she didn't believe she could learn anything new, especially programming.

Nicole also updated her Village profile page with more personal information and an updated picture. This was a major departure from where she was at the beginning of the study. Then, she didn't want contact with anyone and kept to herself. By the end of the study, her Pearls were on the Walls and in the Pearls Binder. She also had a presence in the ICCN Village, both with her Pearls and with her Clubhouse projects and comments on her profile page.

Nicole's movement from peripheral to full participation in the Clubhouse community has become apparent on a number of levels. Nicole understands and accepts the Clubhouse practices of sharing projects and ideas. She has established meaningful relationship with other community members, in both mentor and apprentice roles. She has learned to "talk the talk" through her reflections on her projects and sharing of her ideas with others, and "walk the walk" by contributing to her community and taking responsibility for those contributions.

“The way we teach reflects the conception we have of
what knowledge is and does.”

Ann Berthoff (1981), *The Making of Meaning*

6.3 Case Study: Growing the Reflective Mentor

The Reflective Mentor Model (RMM) was designed to support mentors' reflection on their mentoring practice so they could better support learner intentional-reflection activities. RMM uses the Reflection-In-Action and Reflection-On-Action model based on Schön's (1983, 1987) reflective practitioner framework as the core of reflective mentor practice. The Reflection-in-Action phase occurs while a mentor is working with a learner. In that case, the mentor divides his time between attending to the member and reflecting on what is and isn't working at the moment. The mentor thinks "on his feet" in order to stay one step ahead of the member's needs. The Reflection-on-Action phase occurs when mentors are together without members present. Mentors participate in informal discussions about strategies that achieved their teaching objectives and those that did not. Thinking through those questions as a team provides mentors with a mechanism for using past lessons to inform future mentoring outcomes. Figure 39 summarizes the process flow of the RMM model.

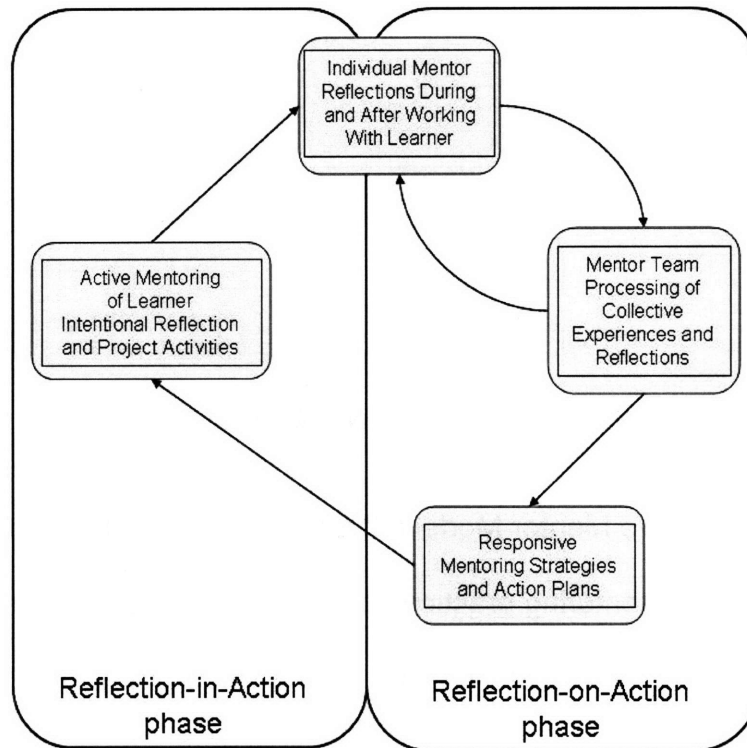


Figure 39. The Reflective Mentor Model.

Reflective mentors learn by constructing and reconstructing their approach to mentoring. Rather than creating a definitive best practice, a set of evolving best practices responsive to the needs of learners and the learning environment are being invented and re-invented. Mentoring becomes a cycle of working with youth, garnering new experiences, reflecting on those experiences, both individually and as a team, and converging on corrective strategies.

The RMM guiding principles (see Table 19) outline the day-to-day activities mentors, both individually and as a team, engage in to sustain an effective mentor team.

Table 19. RMM Guiding Principles.

Reflective Mentor Model Guiding Principles
1. Participate in mentor team roundtables.
2. Establish responsive action plans and responsive mentoring strategies.
3. Identify obstacles to member construction and use of intentional-reflective artifacts.
4. Establish a common mission around intentional reflection purpose and practices.

In the education (Jonassen, *et al.*, 2003; Johns, 2000; Star, 2000), management (Sheard, 2002; Reynolds, 1999), and medical (Cunningham, 2000) literature, professional teams have been shown to be effective in facilitating the professional development of its members. The Flagship Computer Clubhouse (FCC) mentor case study, presented in this section, is an examination of how the RMM could support intentional reflection activities at the FCC. In particular, the case study focuses on the successful treatment group G1, labeled Team-G1, and their development into a coherent, effective reflective-mentor team. Please refer to Section 5.3.2 for details of the different treatment groups.

The mentor case study reports the stages of mentor team development that emerged from the empirical data on Team-G1's development. The three stages were: construction, emergence, and convergence. Section 6.3.2 reports on the construction stage, where mentors practiced team building and devised strategies for introducing the PoW software and intention-reflection activities to

FCC members. Section 6.3.3 reports on the emergence stage, where the mentor team coalesced into a functioning unit as described by the Reflective Mentor Model. Section 6.3.4 reports on the convergence stage, where the fully developed mentor team is in place.

6.3.1 Team-G1 at the FCC

From the empirical data, the development of Team-G1 can be viewed as a process of training the group, followed by a continuous cycle of their negotiation of new mentoring strategies and action plans. One goal was for negotiating to become a meaningful practice, over time.

The construction stage consists of all the start-up activities the team completed before the FCC members were introduced to the software and the concept of intentional reflection. The emergence stage marks the formative growth of the team as it negotiated the best ways to work together. The convergence stage marks the arrival of the team to a productive steady-state. Individuals knew their roles and how to work as a team. The team had a common vision for their mentoring practice. Cycling between emergence and convergence stages kept the team responsive to learner needs. Figure 40 illustrates the process flow of the three stages.

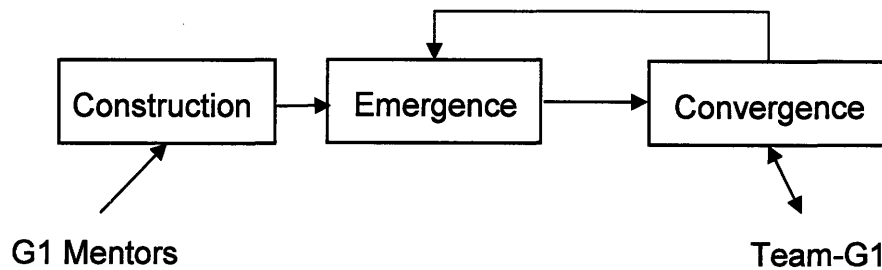


Figure 40. RMM Case Study Emergent Stages and Their Relationship to the Growth of Team-G1.

6.3.2 Stage One: Construction of Team-G1

There were a handful of tasks that were required to acquaint mentors with the PoW software, the RMM model, and other intentional-reflection activities, such as Pearl authoring.

6.3.2.1 *Setup*

At the beginning of the study, only a handful of members and mentors had accounts on the Computer Clubhouse Intranet (Village) and a smaller number had ever used the Village. Because the Village hosted the PoW software, Village training sessions for mentors were run first and then workshops for PoW software tinkering. Accounts had to be set up for all mentors and members. This took place over the first two weeks of the study.

A goal was to have everyone familiar with the Village and knowledgeable about where to find PoW. Though this seemed to be a straightforward process, it

proved very difficult to execute. Using the Village was not part of mainstream FCC or mentor practice. Mentors started using the Village more regularly and encouraged members to log on and explore the site. The sign up and engagement with the Village added more work to an already busy mentor workload. In general, Team-G1 took the extra work in stride.

“Just the whole process of giving them Village accounts was a great thing. Even if I screw up the rest of it (PoW study) I at least know that they will be connected to the Village. (laughing) I didn’t even have a Village account before this.”

All told, six mentor roundtables, where the team could meet, reflect, and plan, took place during the first 6-months of the study⁶. Mentors met either around the Green Table at end of mentor workday or at the sofa area during Clubhouse hours. Roundtables provided a regular forum for mentors to engage in Reflection-On-Action activities. The time was used to address youth-related challenges, share practices, and devise new action plans.

6.3.2.2 *Mentor Agreements*

The next step was having mentors establish a mentoring style that would scaffold the member “hard play” of intentional-reflection. It was important that Team-G1 generate what they thought were necessary strategies for supporting member Pearl construction. There were several suggestions offered:

⁶ There were six planned roundtable meetings scheduled to take place over a six month period. Following that period, Team-G1 continued to meet on their own on a regular basis. Team members indicated the meeting process was helping with the Pearl activities and non-study-related areas of their mentoring practice. At the conclusion of this one-year study, Team-G1 was still meeting, when needed.

"You just have to sit back and bite your tongue. That's what I do. Look, these kids are used to making things. They're comfortable with deciding how they want things to look. I say just sit back and watch. Once they've done enough of that, that's when they really need someone to help them get to that next level. The look of it is the easier part for them, but the words, well that's a new idea. They are not used to talking about their work like that. They're learning how to articulate what they build so you know they're going to get more out of making the Pearl and the project instead of just making the project."

"We should encourage them to come with their own questions. Like with their projects. I like to ask them what they want to do. I mean, they know what they want, they just don't know how to put it all together so that it makes sense. I worked with Mercedes today and she was really worried that no one would understand what she was saying in her Pearl. Actually, I've seen this same thing come up before. Anyway, I encouraged her to practice by telling me about the project and not to worry about what to write yet."

Team-G1 had negotiated a hands-on reflective-mentor model. They decided one-on-one engagement with each member could help members get started making Pearls.

6.3.2.3 Mentoring Intentional Reflection

After their training on the Village and PoW software, mentor discussions began to focus on working with members. Mentors realized they weren't sure of the best ways to introduce members to the idea of reflecting on their projects and to translating their reflections into Pearls. This sparked a number of brief roundtable meetings. The main concern seemed to be what to do with the members once they get them to sit down to work on a Pearl. The roundtable sessions produced several options all mentors agreed to try:

"I know the toughest area will be getting the girls to understand what the Pearl was for. It might just work best to show them a couple of Pearls first and then just let them talk about their own projects. But really, what could I really talk to them about unless I got some idea of how they were thinking about their projects and what they might find interesting to make into a Pearl. Once they find the interesting part, then they'll started to get really excited about putting their Pearl together.

This mentor was acknowledging that the team would have to get to know the members better. More specifically, they would need to know what the members cared about and know the member's projects. The team agreed that member projects could be a great entry point for introducing Pearls.

“It was peculiar how I’m finding it more useful to think about my process. I can’t imagine it will be helpful to talk to them about how to make a Pearl or at least how I make Pearls. Instead, it seems to make more sense to me to talk about how I make reflection. Like how I put together my reflection, like a recollection. “

For this mentor, modeling the Pearl design process for members made the most sense. She regarded the process of Pearl design to be the real challenge, more than the decision of what the Pearl topic would be or what content to include.

Many conversations followed, between mentors, regarding how to best support Pearl construction. Throughout the entire study, this became a central question with differing answers depending on the members’ ages, interests, native language, and other attributes.

This construction stage highlighted those tasks Team-G1 engaged in to prepare for promotion of intentional-reflection activities. These tasks are summarized in Table 20 below.

Table 20. Constructs for Launching Team-G1.

Task	Action
Gain fluency with Village Software	<ul style="list-style-type: none"> • Set up mentor and member Village accounts • Help members use Project Gallery, Member Profile, and PoW areas of the Village
Reflective-Mentor Training	<ul style="list-style-type: none"> • Mentors agree to attend at least one PoW workshop
Reflective-Mentor Support	<ul style="list-style-type: none"> • Mentors agree to attend Roundtable meetings • Meetings with Coordinator or Researcher, as needed
Scheduling the software launch	<ul style="list-style-type: none"> • Team agreement on when to introduce members to PoW software
Establishment of Team-G1 Goals	<ul style="list-style-type: none"> • Mentor Roundtable meetings for planning and bonding • Outcomes: Strategies and action plans for introducing Pearls and PoW software
Mentor Verbal Contract	<ul style="list-style-type: none"> • Tacit agreement for initial participation in team building by majority of group mentors

The final preparation was to establish those action plans to put in place for their next mentoring session with FCC members. Several tangible actions were recommended and agreed upon. They are summarized in Table 21 below.

Table 21. Team-G1 Action Plans and Strategies.

Team-G1 Action Plans and Strategies for PoW-based Encounters with Members	
Action Plan	Strategy
Have members log onto Village	Sit down with them and explore the project gallery and then show them the PoW site.
Set up Village accounts for all members	Assign one mentor to set up necessary accounts.
Make sure the PoW software is always present in the room	Have Clubhouse Coordinator laptop on the Green Table and a Pearl loaded.
Have members make Pearl about one of their projects	Pick two members to get to know better. Become familiar with their work. Sit down and help them get started on a Pearl.

Once the start-up tasks were completed and action plans established, Team-G1 was ready to proceed with introducing Pearls to the members that following Monday. The next section tracks Team-G1's process of introducing PoW to members and their decisions, as a team, for deepening member involvement in intentional-reflection activities.

6.3.3 Stage Two: Emergence of Team-G1

During the emergence stage members were introduced to the PoW software and Pearls. Mentors referred to the agreed upon action plan from a printout taped inside a supply cabinet door. They also occasionally got together

in pairs to share ideas. Here we began to observe how Team-G1 coalesced from a new, sometimes uncoordinated group to form some distinctive group characteristics.

6.3.3.1 *Refining the Common Vision*

Team-G1 called an emergency roundtable meeting. They wanted to share what they had learned so far working with members. Several of the mentors felt it was time to make sure they were all working for a common purpose. Mentors were concerned about how much time members should be spending making Pearls instead of working on their projects. So far, mentors had discovered that making a Pearl was not a fast process. Like any other design process, it had to happen over time and through stages of refinement. A mentor spoke of her concern about members spending so much time using PoW.

“That’s all great and fine but how are you going to do it? I mean, what’s the point of having the software if it’s too much work to put the darn thing together? I don’t want to feel like a teacher. I mean, I like the fact that the kids here can do what they want. If they don’t want to do this, then I don’t want to make them do it.”

The meeting also revealed there were frustrations about how to best engage members in reflective activities without adversely affecting the spirit of the constructionist learning environment. The deepest concern was how to encourage member reflection while not imposing the new activity on them.

After some discussion it was agreed that making Pearls could be as important as making Clubhouse projects and to stick with the original action plans.

It's a good learning tool. I definitely encourage kids to make Pearls. If you know something, share it. Knowledge is a powerful thing, it should be... PoW allows for like, interactivity with other kids. It's pretty good for that, not only can kids show each other they can show their parents what they know.

Another member felt that Pearl construction would enhance what members got out of their Clubhouse projects.

I think it is very important that Pearls make the kids look at what they've forgotten. Most of them really don't have a sense of all that they've done.

Another mentor talked specifically about how she viewed making Pearls were impacting a member she had worked with.

"Like when I was helping Mercedes with her Pearl. In that situation I knew she was learning something. She was mulling over what to do next and how to say it and where to put it and all kinds of decisions were being made there. She kept picking up her project and turning it and looking at it. I can't imagine she connected with the project on that level before. "

This process of sharing, negotiation, and compromise Team-G1 went through was important for the team to make sense of their uncertainties and conflicts of regarding their practice. Schön (1987) argues that the uncertainty and resolution

helps remind practitioners that questioning their practice is the way to grow and sustain effectiveness in their work. By sitting with the idea that not all issues will have one 'right solution' further motivates consideration of alternative perspectives (Schön, 1987).

Mentors had also established a new strategy of directing members to the "Pearl Zone," the online Pearl directory, when they were looking for project ideas. Team-G1 talked regularly different ways to give Pearls a presence in the FCC.

"I talked to Lovelyn about how I reflected when I was making a Pearl. First I think about what I meant to do when I created the project. Then I think about what was easy and what was hard. I use some of that in my text. Then I think about what pictures will make the whole Pearl easier to get through for the person reading it. What was really fascinating was her response. It was something like, 'yeah, I do that too but I want my pictures first'. She seemed to use the pictures to help her find the words. I thought it was interesting the different ways we get to the same goals. That was the most profound conversation I've ever had with a member about how she was thinking."

Team-G1 tried their action plan of being more observant and actively involved with members. One strategy was for each mentor to learn the names of three girls they didn't know well and find out what they liked doing at the Clubhouse. At the end of the day, the mentor team met to review the lessons learned regarding their strategy and resolve any challenges that had come up.

Another action strategy was to show them several Pearls and then just have the member talk about their projects, with the hopes of identifying candidate Pearls.

“It is so hard to get their thinking into their Pearls. When we’re talking about their project they seem to have a lot to say. But then when they sit down to make the thing the typing really gets in the way. It’s really slowing things down. I find myself sort of prompting them, just reminding them how they just explained themselves just a few minutes earlier.”

Team-G1 decided the initial goal was to determine possible points of entry for talking about reflection and Pearls. This led to a series of sub-goals that included mentors getting to know all members, not just those members they regularly interacted with. G1 mentors also pledged to become familiar with member old and new projects and project interests.

6.3.3.2 A Mentor’s Transformation

One example of reflective mentoring impacting a mentor’s personal growth in her mentoring was seen with Linda, a mentor at the FCC for two years. Linda is a very popular mentor and her no-nonsense but caring attitude works well with many of the members. However, in her Pearl encounters with one member, Linda noticed her mentoring approach was not effective. She reported being frustrated and she indicated that the member seemed frustrated too. While working with the member she re-evaluated the situation and decided to try a different approach. Linda found her experience to be personally challenging and

shared what she learned at a roundtable session. Her story is representative of other similar mentor reports. Team-G1 mentors had often reexamined their personal mentoring styles and considered how their practice impacted members during the course of the study. Here the mentor, Linda, talks about her experiences with a member, Kat.

"Kat had a lot of negative labels she used to describe her work. Buttface is her favorite. She was even typing in sentences like "this project is a stupid buttface." Then she would delete the text and type something else just like it. I admit it, I was getting frustrated.... Argh. Anyway, this time I just stayed with it. Usually, if the member is doing something I thought was fooling around, I would check around for another member that might need my help.

Linda had reflected-in-action and decided to try another mentoring strategy which she hoped would help Kat. She was staying in the moment gave the member the space and attention she needed to eventually settle into thinking about her project. Later, Linda made another key observation about how Kat went about designing her Pearl.

"God, it was so good to see her take herself seriously. It was funny how she started out with just three sentences about the whole project. Then she would save and exit and look for her Pearl in the directory and then go in and add another sentence or two. She must have done that at least 5 times. Then she insisted I log in and open her Pearl!"

That turned out to be a very satisfying encounter for Linda and a productive one for Kat.

Mentors reflecting-in-action and reflecting-on-action, and meeting to share those in regular roundtable meetings were a goal of the PoW research project. Those were essential components of the RMM model. Team-G1 was four months into the project and a number of mentors had experiences similar to Linda's and felt their mentoring practice had evolved. Their realization of their evolution meant the Team-G1 had matured in their practice and had moved on to the convergence stage.

6.3.4 Stage Three: Convergence of Team-G1

The convergence stage was where Team-G1 was functioning as a coherent team. They had established a rhythm to their practice that consisted of reflection at the individual and group levels, and negotiating meaningful strategies for addressing concerns or new initiatives. As the study continued and through the closing interviews for the study, mentors shared their Reflection-In-Action and Reflection-On-Action discoveries with each other. Many expressed the benefits they felt they were receiving, as mentors, from reflecting on their practice. Here is an interview excerpt from a mentor who had struggled with the project goals when PoW was first introduced.

I didn't really know what you meant by environment. I'm embarrassed to admit I thought it was all a crock in the beginning. Stuff always sounds good on paper, you know. I thought, this is so corny, talking about what I did with the members. That's not what I came to the Clubhouse for. I came to work with the kids. ... I have to say this ended up being a way to talk to them about more interesting things.

She was referring to discussions between the researcher and Team-G1 about what they wanted members to gain from being in the FCC learning environment. Her concerns had been that she would be pulled away from helping kids with their projects. However, during the study she experienced a deeper involvement in Clubhouse projects, both for herself and the members she worked with.

Many such personal reflections were made *in situ* while working with members. In those cases, the mentor examined what worked and what didn't work when helping a member reflect on her project. Mentor reported the biggest challenge proved to be staying "in the moment" while working with members. That meant working with members and at the same time reviewing and analyzing how the session was progressing. But mentors also reported that the practice was most productive for focusing them on issues they could bring to the roundtable meetings. One mentor reported how the exercise of Reflection-In-Action helped the mentor focus on her mentoring in a deeper way.

"I guess I had mainly focused on it from my point of view... thinking back now, that doesn't make a whole lot of sense. I mean, members are the ones who should be deciding how the Pearl should look. But it seems like the first thing they want to do is change everything around. The headings are the first to go. And, of course, the colors are a given."

She had adjusted her focus from herself and how *she thought* members should be engaging the Pearl. Instead, she moved toward paying closer attention to how Pearl making and learning related.

"To be honest I really didn't pay much attention to what they were saying. I mean I listened to them but I didn't read between the lines. That's sort of what you expect anyway, I mean even at work that happens most of the time. Everything gets to be so automatic after a while... This is definitely more interesting. I feel like I'm always "on" and by the end of the day now my brain is pooped." (laugh)

She realized she had been in the room with the members but not present in the same way that she was when reflecting on how things were going, "in the moment." The intensity of focus was imparting a hyper-sensitivity to the mentor experience. Her experience was not unique. Mentors reported that they had gone through a process of self-examination of their mentoring and in some cases, decided to try other strategies to better support member learning.

Roundtable sessions served several important functions. First, they set aside time and space for mentors to interact and bond. Second, mentors could

help one another make sense of the days events. The convergence onto “next steps” became a process of actively constructing new ways of mentoring and shaping the learning environment, based on their personal and group experiences.

Another series of observations revealed how G1 mentors bonded during team building. G1 mentors began to refer to the day’s successes as belonging to the entire team, not just individuals. They converged on the idea that the effectiveness of their mentoring was a function of their collective mentoring practice. They also converged on the idea that effective mentoring was a function of their collective preconceptions of what they thought they knew about mentoring. Individual perception changed as they combined, developed, and rejected some of their preconceptions as mentors negotiated action plan.

“Let’s not lose all this stuff we’re learning from these kids. I’ve learned so much listening to how we deal with the issues that come up during the day. I certainly don’t think I can figure out all the right answers by myself. Besides, I think we’re doing a better job when we all know what the other is doing and we all go in with the same overall goal in mind.”

“When it came to my own learning with the other mentors, I got a lot from hearing their hands-on ideas and problem solving. It was nice getting to know them better too, its so hard while the members are here to do that, unless you just ignore the members but that’s not why I’m here.”

These mentors reported they were changing their view of their role at the Clubhouse from being volunteers to being educators.

"I'm here to learn how to be a better mentor. I'm not going to stay late every week if I'm not going to get something out of it. I see this team as our time to practice for next Monday. We're more professional that way. All this reviewing and planning we do. I think that says we're serious about learning in the Clubhouse. I feel like I really know what I'm supposed to be here for and I like that better."

The process of establishing overreaching goals and negotiating appropriate sub-goals became a common strategy the G1 mentors devised. The main goal was easiest to agree on. What needed addressing was often quite clear to everyone. Determining the sub-goals that mentors could realistically accomplish was the point of great debate and personal sharing.

A surprising result of Team-G1 RMM activities was how their practice impacted their mentoring in non-PoW areas. Team-G1 lessons learned about engaging members in Pearl activities were also useful for mentoring in other areas of interest. Mentors reported their mentoring style had transformed over time across the board, not just for PoW-related mentoring. Most credited Reflection-In-Action with being the most valuable asset in their mentoring toolkit. These were reported by several mentors:

"I'm better at listening now. I mean, they really are the experts you know. And they want to be helpful. They obviously know what they're talking about. Kids always know what they want or at least what they don't want. I just try to listen more and talk less. I'm realizing as we keep doing this (mentor team discussions) that I had been telling them too much about what to do in their projects instead of just listening more. I feel bad about that but at least I'm trying to pay more attention now."

"Working with the PoW study made me more careful about my mentoring"

"I do so much more now as a mentor. I'm doing different kinds of things with the members than before."

...

"I'm not just showing them how to use software or come up with project ideas. I feel like we're thinking more. I help them a lot with that, mostly by listening more. It takes time to talk around to what they really have on their minds... Sometimes I talk about how I think about my projects and they seem to get more comfortable "thinking" about theirs."

"I really like interacting with the group. I got so much out of that. I think we did a good job of thinking before we commented on stuff and we're definitely better at listening that way. I know this experience gave me some insights into what to do in different mentoring situations."

"I had a chance to really reflect on my mentoring and how I feel about the way we help kids here. Having to understand how the others were thinking about mentoring sure made things look different."

"I realize now I'm more focused, even when they aren't doing the pearls. I'm always thinking, will this make a good pearl?"

Reflection-In-Action, Reflection-On-Action, and roundtable sessions were powerful tools mentors had appropriated in their support of intentional-reflection activities at FCC.

Summary

The mentoring strategies and action plans that grew out of personal and group reflections provided a coherent and responsive roadmap for mentors to follow each week. On occasion, strategies were devised for accomplishing specific mentoring goals. The focus was on teasing out the *practical things* they could do to promote Pearl creation and use. On other occasions, strategies were more personal, requiring personal choices to change. Mentors reported they felt

their negotiated strategies and action plans enhanced their mentoring in areas not related to the study, as well. That served to motivate the majority of mentors to consistently participate after the study concluded.

By the end of the study, Group G1 mentor team had evolved along several key dimensions.

- Mentoring practice. They felt they operated as a team, and often characterized themselves that way during discussions.
- Personal growth. Individual mentors reported they felt more alert and “in the moment” while mentoring.

The result was a coherent, cohesive team with a consistent vision for their mentoring practice within the FCC. The G1 mentor team engaged in reflective practice by using their mentoring experiences explicitly to transform their practice to fit new situations and challenges. That represented mentoring in the spirit of Papert’s constructionism. Mentors were learning through their building of practice. Their construction process was influenced by the social and material resources available to them within their learning environment.

In theory, there is no difference between theory and practice.
But, in practice, there is.

Jan L. A. van de Snepscheut

7 Cooperative Constructionism – Revisited

This chapter contains a discussion of the findings of the PoW empirical study. The purpose of the study was to explore the effects of social and computational scaffolds in promoting learner reflection on their design-for-learning experiences. Specifically, the study investigated 1) how does construction of reflective artifacts enhance the ways people reflect on their learning processes, and 2) what scaffolds are most important for engaging a community in reflective practice? To answer those questions, the Cooperative Constructionism framework, which was presented in this dissertation, was implemented at an after-school technology center. The results of that

investigation were used to identify influences and activities that led to emergence of a Constructionist Cooperative, a community of learners who share their projects and reflections on their design and learning experiences. Insights gained from this study will contribute to future refinements of the Cooperative Constructionism framework.

Section 7.1 presents the analysis of the Pearls corpus, the collection on Pearls constructed at the FCC over the course of the study. Section 7.2 presents the treatment group outcomes. Section 7.3 presents the PoW study findings relevant to the first research question. Section 7.4 presents the PoW study findings relevant to the second research question, including a discussion of the impact of the PoW software. Implications of the research are discussed in Section 7.5.

7.1 The Pearl Corpus

The Pearl corpus was populated during a one-year period from September 2004 to October 2005. Seventy-eight Pearls were created over the course of the study. Pearls were scored as described in Chapter 5. Table 22 below summarizes the Pearls by rubric score, which rated the overall effectiveness of the Pearl. Specifically, the rubric instrument measured the extent to which the aspects of three pillars of cooperative constructionism were represented within the Pearl. The construction pillar is associated with formative aspects of Pearl design. The communication pillar is associated with communicative aspects of Pearl design. Finally, the critical reflection pillar is associated with the learning

and reflective aspects of Pearl design. A rubric score of 3 or 4 indicated a Pearl was useable. In that case, the Pearl was in a condition where most FCC members could glean enough information to recreate whatever tasks the Pearl was intended to support. Unusable Pearls did not meet those criteria. Causes may be lack of adequate or accurate content. Table 22 illustrates that 89% of the Pearl corpus was in useable condition.

Table 22. Pearl Rubric Scores (n=78)

Number of Pearls	Mean Pearl Score (Scale: 1 to 4)	% Scored at or above Proficiency Level	Standard Deviation
78	3.013	89%	0.57

Preparing a Pearl required time and effort. In some cases Pearl construction took as much time as the original Clubhouse project. Planning, organization of resources, and articulation of thought were all part of the Pearl construction process. Members were free to engage in those FCC activities that interested them. Members were not required to construct Pearls. The fact that Pearls were made implies those Pearl designers chose to take the time and make the effort to gather the necessary resources to produce Pearls of useable quality.

7.1.1 Characteristics of FCC Pearls

The Pearl rubric provides a consistent mechanism for measuring various Pearl characteristics. The categories of characteristics are content, design, cooperativeness, communication, and critical thinking. The pedagogical goal for making Pearls was to stimulate reflection by posing design challenges that require reflection for resolution. Construction activities require consideration of

content development, design decisions, cooperative and communicative abilities, and critical thinking as part of telling their learning story. As Bruner (1986) argues, relating such learning stories provides a mechanism for learners to organize their experiences.

7.1.1.1 *Pearls and Content Development*

Post-study surveys and Pearl assessment were performed on the Pearl corpus to analyze how Pearl designers used the Pearl interface to represent their reflections. Pearl Content attributes identify how members organized their ideas within the Pearl and what media was used to augment their narrative, for example. The first content attribute presented is the Primary Pearl Type. This attribute marks whether the member focused on giving instructions, sharing experiences, or both within the content of their Pearl. Table 23 below details assigned values for this attribute.

Table 23. Values for the Primary Pearl Type Content Attribute.

Attribute Value	Description
Introspective	Pearl content consist of only introspective comments
Instructional	Pearl content consist of only how-to instructions
Combination	Pearl content contains combination of how-to instructions and introspective comments

In general, members chose to put both instructional and introspective content into their Pearls (see Figure 41).

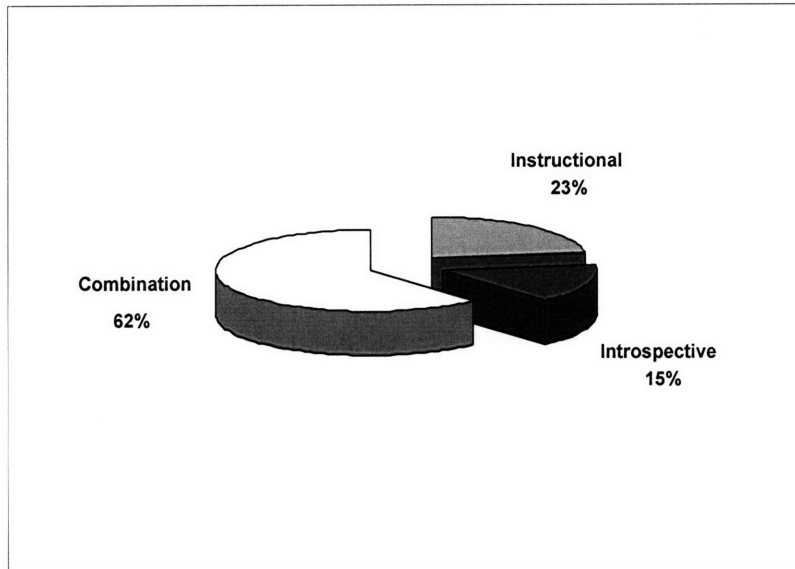


Figure 41. The majority of Pearls included both Instructional ("How I Did It") and Introspective ("What I Was Thinking") content.

In particular, introspective comments focused on how ideas the project ideas were developed or why the project was worked on (one reason reported was to give the project as a gift to a friend or family member). Figure 42 shows a Pearl that is a combination of instructional and introspective.



Back to Pearl Zone

Page 1


Page 2

Poetry and Beauty
Pearl Designer: jngayle

This page is about: Making a collage

Pearl Talk
Pearl Topic Page
Printer Version

My Project!



My Inspiration

my favorite season is spring. It smells so good outside and everything seems bright and fresh. I guess my favorite part is when butterflies start to come out. I wanted my project to celebrate God and spring and my favorite things that they bring. I'm going to make some greeting cards with this project for my nana and mom.

Here are my project ideas

I used a poem I like thats about spring and God.

Then I used Painter to make a collage of things that remind me of spring. I used the Painter brush to stamp different images. There are lots of them that come with Painter.

Then I put the poem in a different layer than the pictures. In another layer I put a picture of the sun.

Figure 42. Pearl with "Combination" Primary-Pearl-Type value.

The Pearl designer chose to briefly describe the steps she used to complete her project. She also included her motivations for making the project and future plans for other projects using the Painter software.

Post-study surveys show that overall, Pearl designers felt they were able to use the Pearl interface to represent the ideas they wanted to convey to others. They were able to choose the amount of detail to provide and the scope of the Pearl's subject matter, for example. Their choices were made clear in the Pearl rubric scores for content. Detailed content attribute descriptions can be found in APPENDIX 1.

Pearl breadth was the first content attribute examined. In the Pearl rubric developed for this study, the breadth attribute is defined as the scope of the Pearl's subject matter. Pearl breadth can range from covering an entire Clubhouse project to just covering a single feature of a software program. Table 24 summarizes Pearl breadth classifications.

Table 24. Pearl Breadth Attributes.

Value	Pearl Content Focus
Low	single software feature or activity
Medium	several software features or activities
High	complete project

Figure 43, Figure 44, and Figure 45 show examples of Pearls with high, medium and low breadth ratings, respectively.

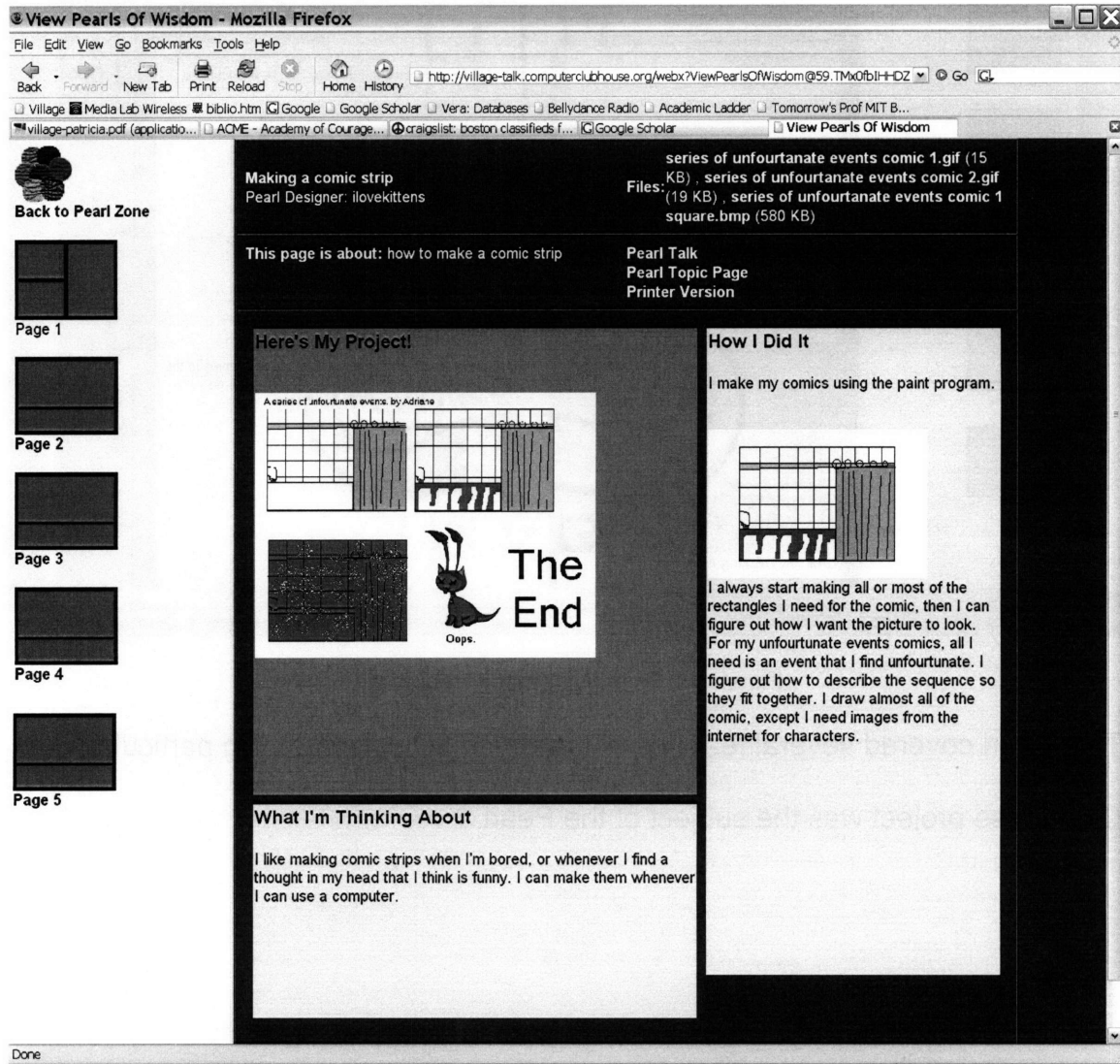


Figure 43. Pearl with high breadth rating.

The breadth of this Pearl was high because it covered an entire project. The Pearl was two pages in length.

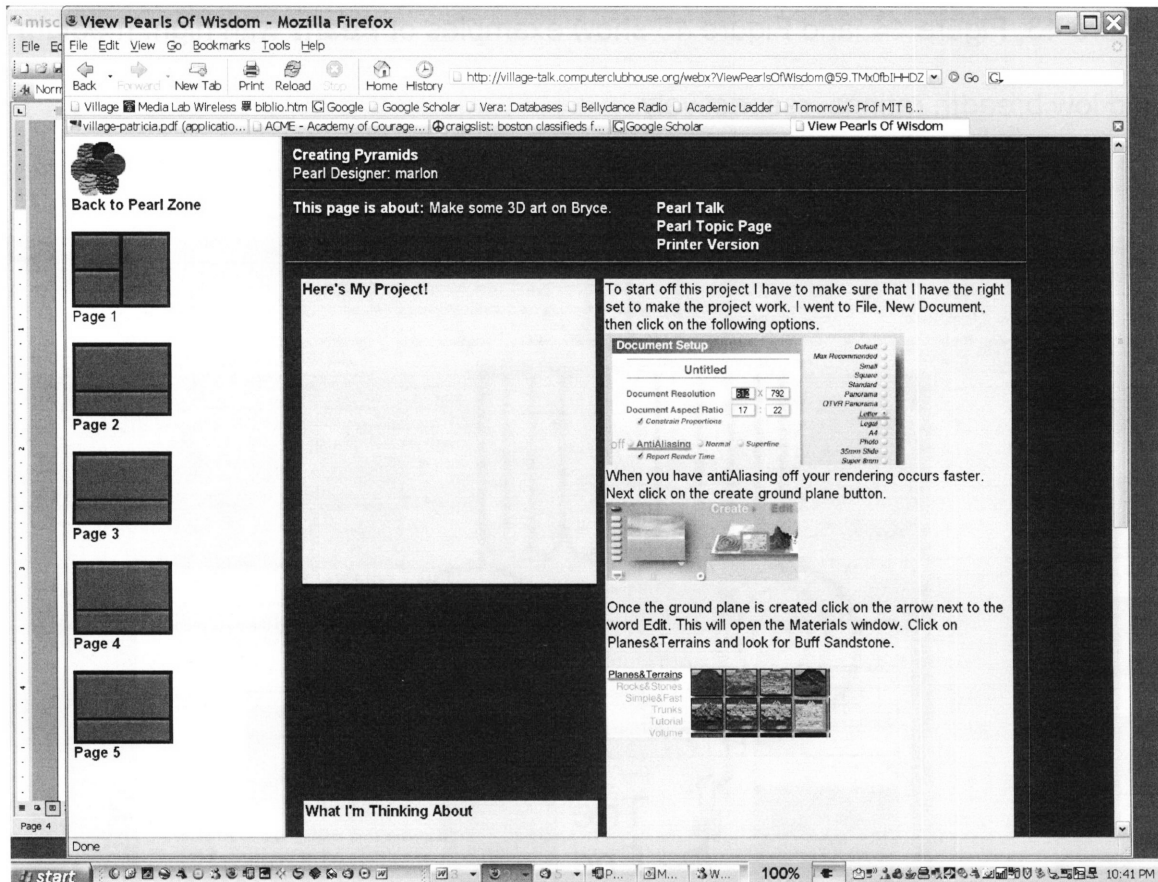


Figure 44. Pearl with medium breadth.

This Pearl covered several features of the Bryce 3D software. No particular Clubhouse project was the subject of the Pearl.

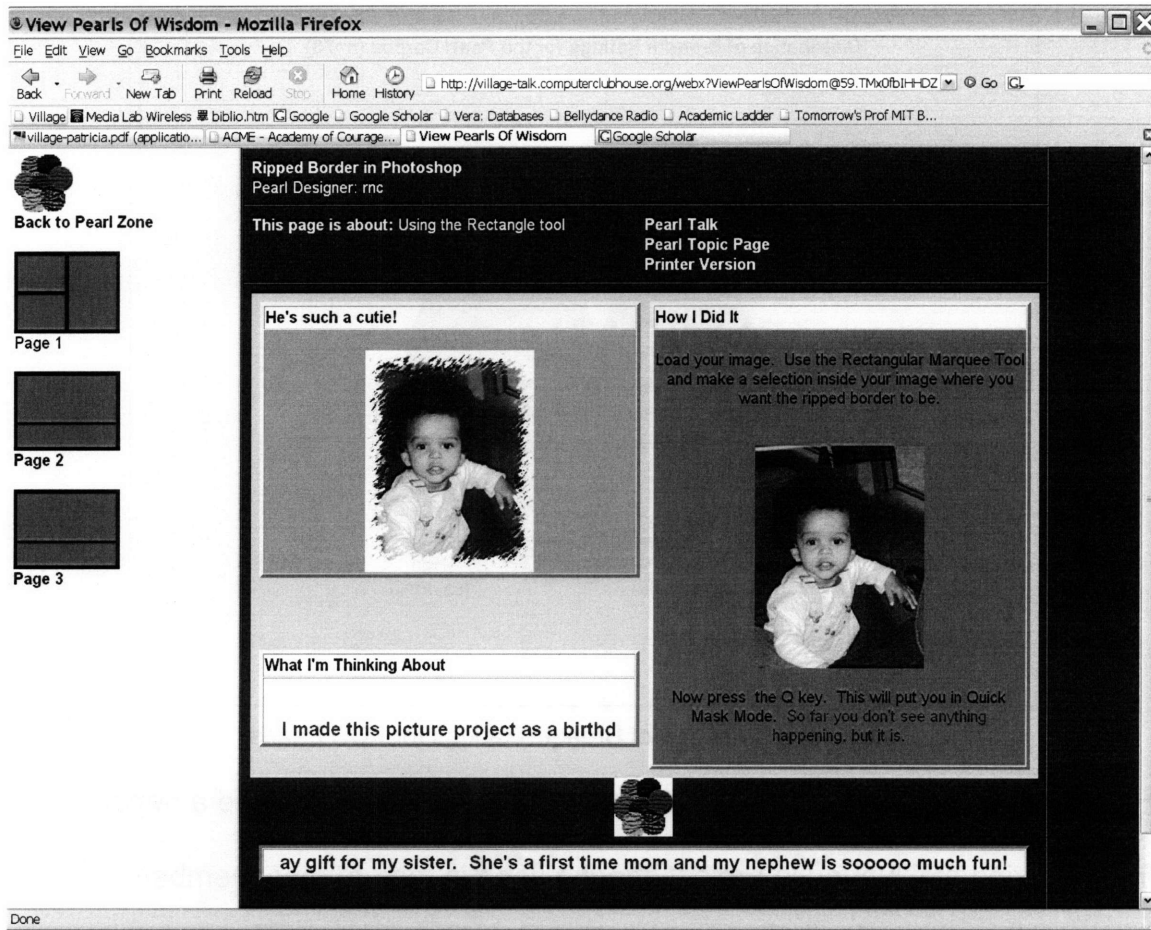


Figure 45. Pearl with low breadth rating.

This Pearl focused on the use of the Photoshop rectangular tool for masking images. It covered details of that particular software feature but did not include additional information to complete the project.

Of the 78 Pearls constructed during the study, 63 (81%) rated high, 11 (14%) rated medium, and 4 (5%) rated low for the breadth attribute. That indicated members were motivated to provide the necessary content so users could reproduce an entire project, not just a particular software feature or sub-set of the project. Figure 46 shows the final distribution of breadth ratings for FCC Pearls.

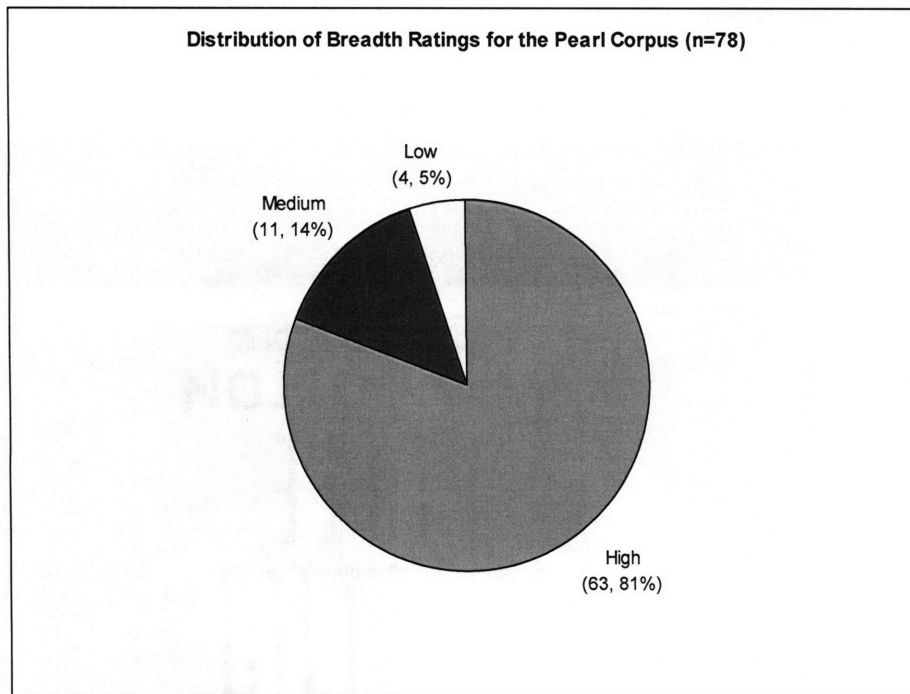


Figure 46. Distribution of Breadth Ratings for FCC Pearls.

High breadth was considered a favorable rating because it marked a departure from the kind of Clubhouse project sharing seen in face-to-face member interactions. Traditionally, FCC members helped one another with specific software features, primarily. In some cases, members also helped with parts of a project, however, assisting with the completion of the entire project is extremely rare. With so many Pearls rated high for breadth that indicated a new way of sharing their Clubhouse projects with the rest of the FCC.

Pearl depth was the second content attribute examined. The depth attribute referred to the richness of detail of the Pearl content (see Table 25). Low depth indicated a minimal amount of explanation, medium indicated a reasonable amount, and high indicated detailed, comprehensive explanations were provided.

Table 25. Pearl Depth Attributes.

Value	Pearl Content Focus
Low	A short list of steps with sparse or no explanations.
Medium	May have a list of steps with some explanations included.
High	Includes comprehensive list of steps with rich explanations, supporting sub-steps and suggestions for filling in field values, etc. There may also be images or descriptions of intermediate results.

Figure 47, Figure 48, and Figure 49 are examples of Pearls with high, medium and low depth ratings, respectively.

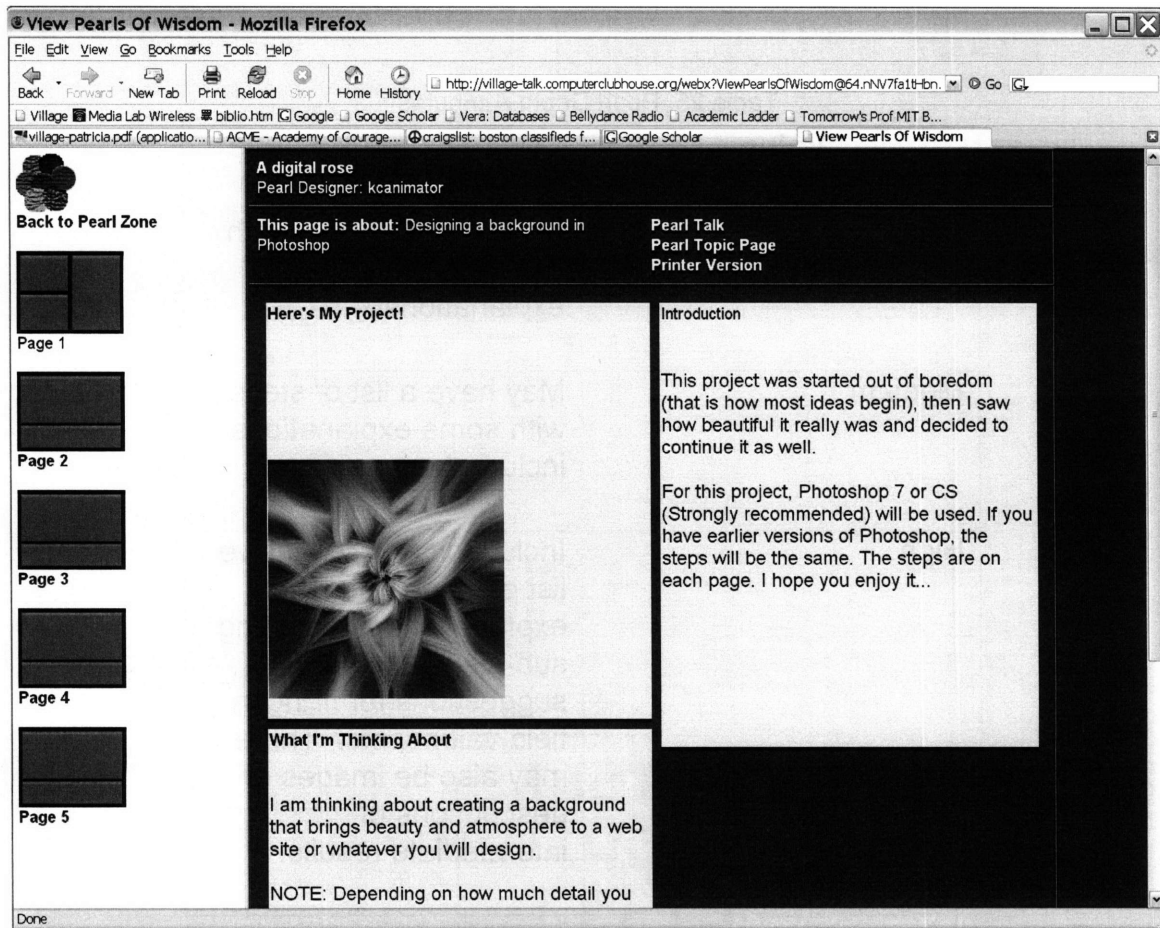


Figure 47. Pearl with high depth rating.

This Pearl used all five pages, with detailed explanation of the actions needed to complete the project. At each stage of the project, intermediary project images and screen captures of the Photoshop design software interface are included.

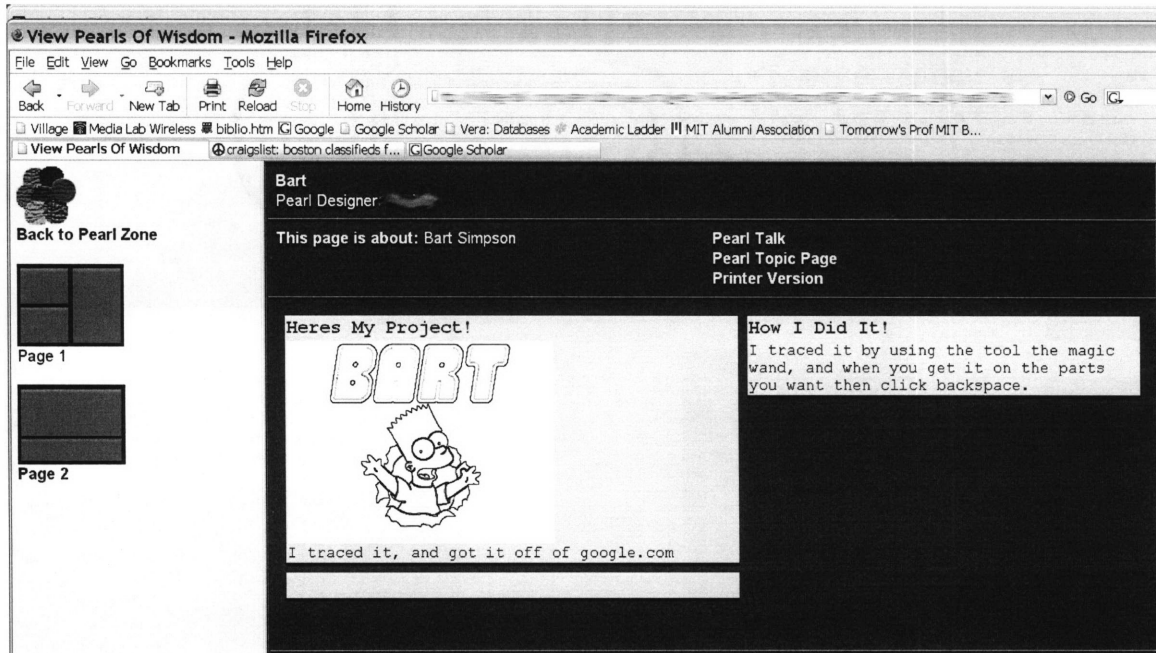


Figure 49. Pearl with Low Depth Rating.

This Pearl has low depth and contains sparse information about how to complete the project. Figure 50 shows the distribution of depth ratings for the Pearl corpus. Of the 78 Pearls constructed during the study, 11 (14%) rated high, 50 (64%) rated medium, and 17 (22%) rated low for the depth attribute.

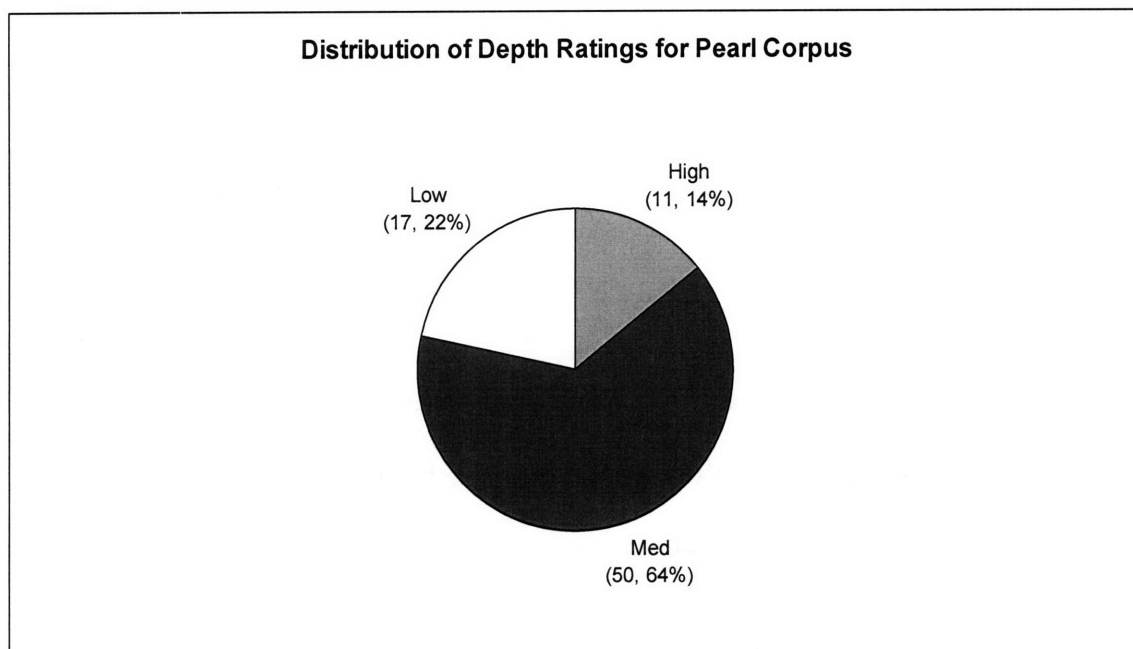


Figure 50. Distribution of Depth Ratings for Pearl Corpus (n=78)

There are four additional content attributes that were used to rate Pearl content. These are described in Table 26.

Table 26. Remaining Pearl Rubric Content Attributes.

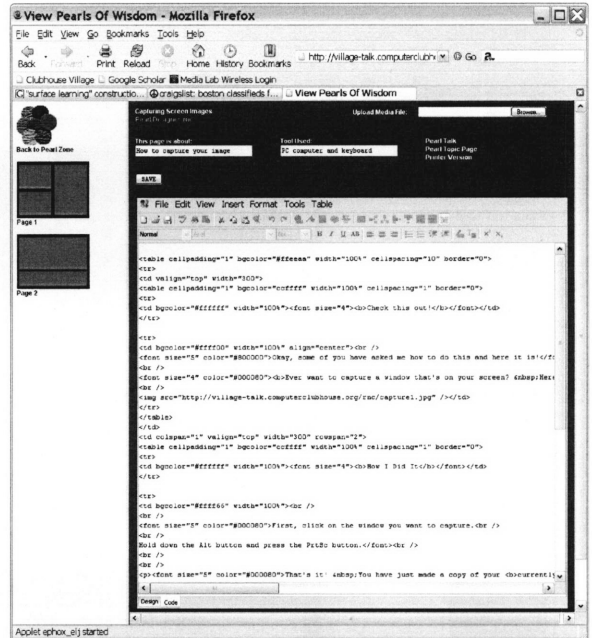
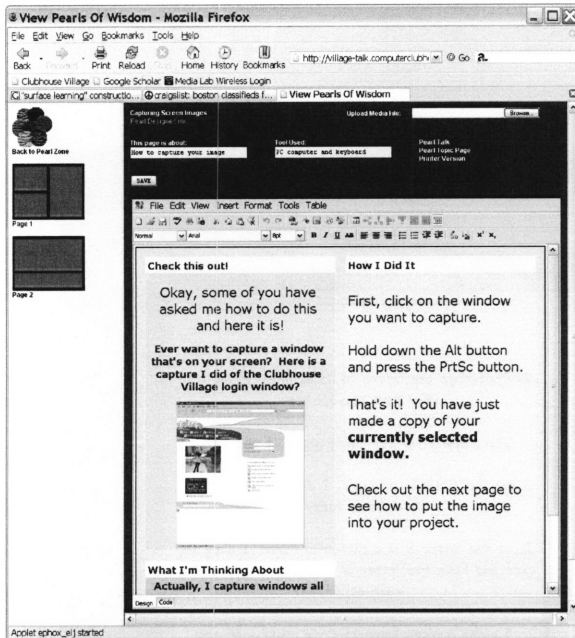
Content Attribute	Description
Pearl References	Designer references her Pearl or other member's Pearl.
Final Project	The final project that is subject of Pearl is shown or provided within the Pearl.
Relevant Media	The media included in the Pearl helps understanding of Pearl content.
Media Types	All types of media used in Pearl are noted.

10 (13%) Pearls included references to other Pearls. 49 (63%) Pearls included their Clubhouse project or information about where to find their Clubhouse

project. Finally, the percentages of Pearls that included media other than text were: images (86%), audio (0%), video (6%), uploaded files (62%), Pearl references (13%), URLs (9%), and screen captures (19%).

7.1.1.2 Pearls and Design Decisions

Post-study surveys and Pearl assessment were performed on the Pearl corpus to analyze the design attributes of the Pearls. Design attributes included panel layout customization, panel prompt changes, and color, font, or panel border customization. The panel layout and prompt changes required the member to edit the underlying html code that generated the Pearl view. Members accessed this code by clicking on the CODE tab at the bottom of the Pearl workspace. They returned to the regular display by clicking on the VIEW tab. Figure 51 shows a Pearl (left) and its underlying html code (right).



Pearl View of Capturing Screen Images Pearl.

HTML View of Capturing Screen Images Pearl.

Figure 51. A Pearl (left) and its underlying html code (right).

Facilitating access to the underlying html code of a Pearl was a software design decision (see Chapter 4 for details). Html manipulation was used by members primarily to change the default Pearl Panel heading text. That text was intended to prompt reflection, but it was hoped that members would change, or fade, the prompts when they were no longer needed. The results showed that this was the case for some members. Figure 52 below shows a Pearl with customized layout and heading.

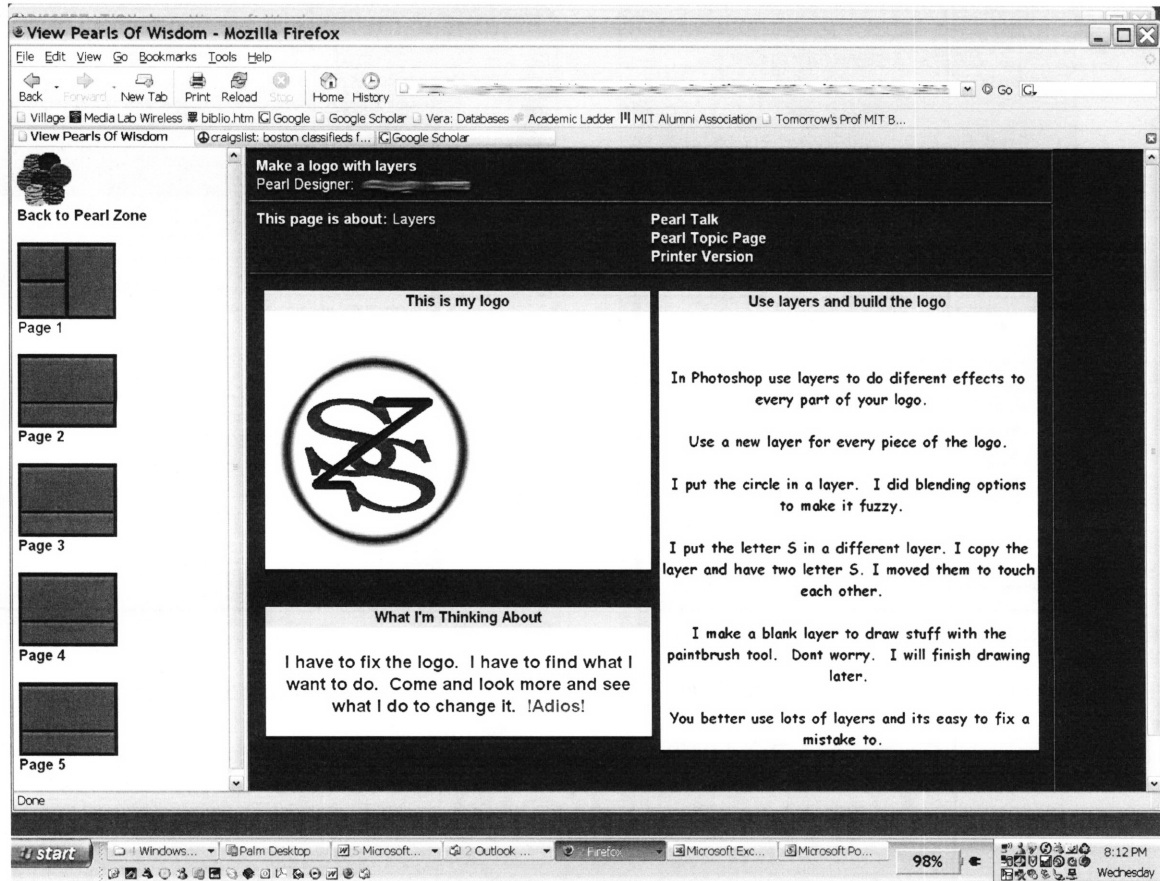


Figure 52. Pearl with HTML Changes to Panel Prompts.

The member edited the html code that generated her Pearl and changed the default panel prompts from "Here's My Project" and "How I Did It" to "This is my logo" and "Use layers and build this logo," respectively. Figure 53 shows a Pearl with the panel payout altered using html.

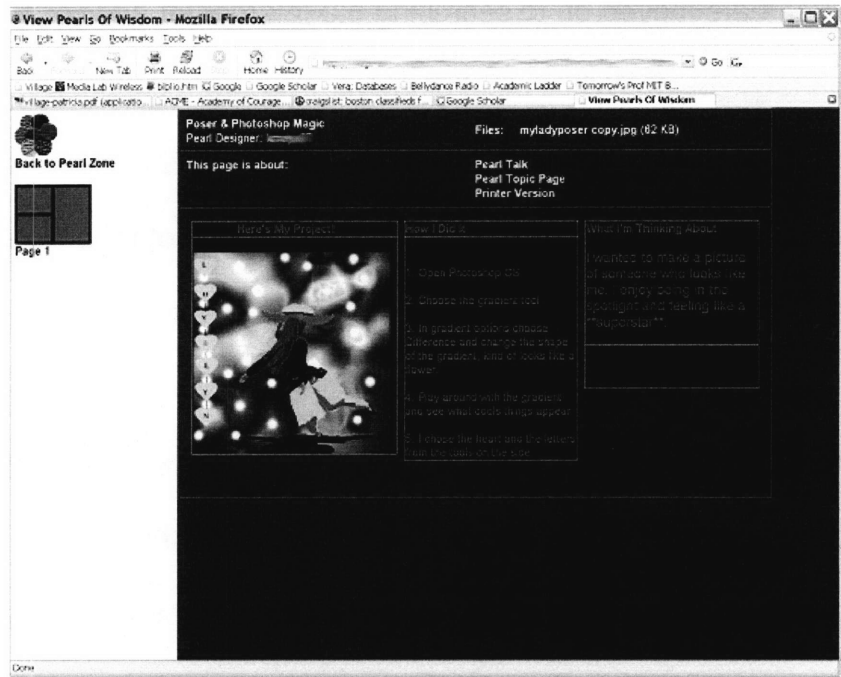


Figure 53. Pearl with customized colors, fonts, and panel structure. The panel customization required editing the underlying html that generated the Pearl view.

This member chose to layout the Pearl panels in a horizontal pattern, instead of using the default pattern. She also reduced the panel width.

Access to the underlying html was included in the Pearl interface to encourage member exploration of html programming. Html was seen as a good entry point for ideas about programming and because html changes immediately affected the Pearl appearance, it was also amenable to tinkering with the code. In the study, many members edited their Pearl's html. What began as one or two pearls with layout customizations quickly spread to 19 (24%) of the 78 Pearls made. This is a significant change in the frequency of programming seen at FCC. Usually, little programming occurred, generally because there was not consistent support. Although html programming was not supported explicitly by mentors, several Pearls were made that passed on the “secrets” to working with html.

Also, some members moved on to searching the Internet for additional html customization techniques. While most of the html program changes were not advanced in nature, the activity still provided a point of entry into programmatic thinking. It may have also motivated members to look into other programming software that is available at the FCC, although that was not investigated in this study.

The remaining design attributes included Pearl coloring, font selection, and other miscellaneous customizations such as lines, symbols, etc. Those customizations were available as Pearl menu functions. The percentage of Pearls with those design attributes was: fonts (79%), panel color (40%), and other (4%). See figure 51 for an example of font and panel color changes.

7.1.1.3 Pearls and Cooperativeness

Post-study surveys and Pearl assessment were performed on the Pearl corpus to analyze the cooperativeness attributes of the Pearls. Cooperativeness focused on how much sharing of ideas, insights, and projects the member included in the Pearl. Also, it was noted if the Pearl was shared off-line, for example, on the FCC Walls. Cooperativeness attributes included sharing design insights, learning insights, referencing other member's Pearls, referencing other members, including new project ideas, and off-line sharing. Figure 54 shows the levels of the various cooperativeness attributes for the Pearl corpus.

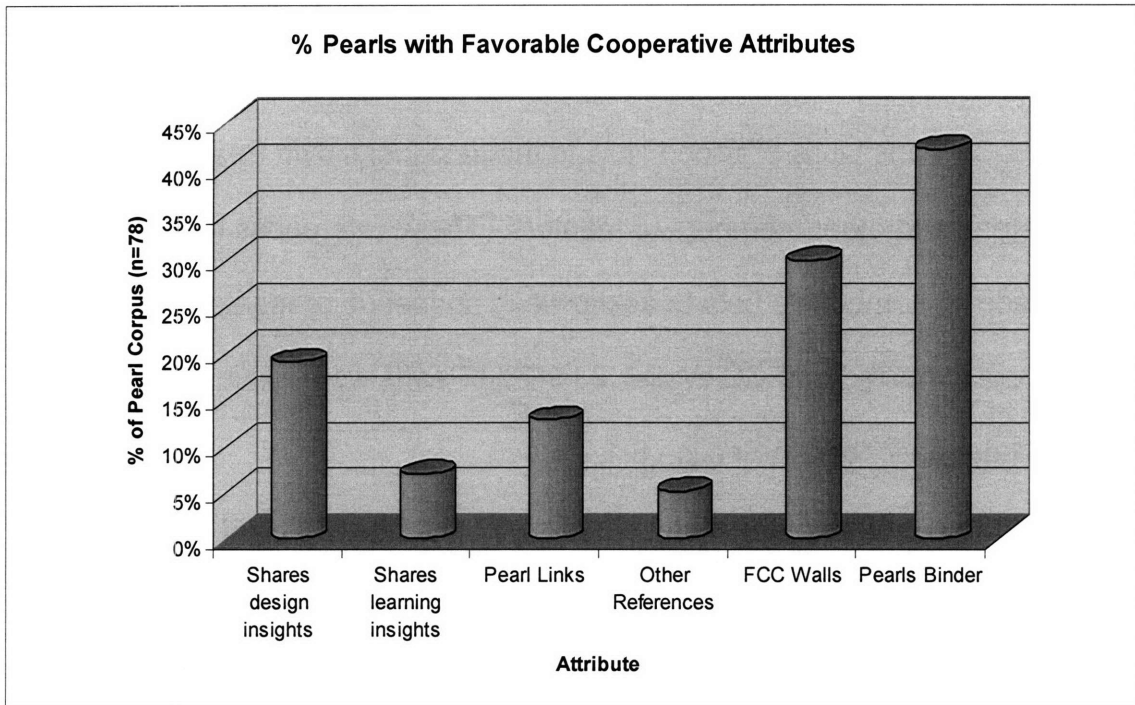


Figure 54. Pearls With Favorable Cooperative Attributes.

15 (19%) Pearls shared design insights. For example, one member described how he came up with ideas for his comic strip characters. Learning insights were shared in 5 (7%) Pearls. This was lower than expected at the beginning of the study. Also, the result was smaller than that for sharing design insights; however, talking about design is a regular FCC practice. 10 (13%) Pearls contained Pearl Links, referencing other Pearls. At the start of this study, I had hoped to see a great deal of Pearl linking, however, that did not happen. Members reported they did not know enough about the different kind of Pearls that were in the Pearl Zone, especially at the time they were making their own Pearls. Conversely, the members who did include Pearl Links in their Pearls reported that knowing what Pearls were in the Zone made it easier to recall what

Pearls they could link to. Linking, in those cases, was considered a time saver because the designer could put less original content in her Pearl. Most of the 13% of FCC Pearls Links provided links to the designer's own Pearls. 9 (12%) Pearls referenced other members or mentors. These references ranged from acknowledging someone's help to acknowledging friends or mentors. 23 (30%) Pearls were exhibited on FCC Walls. 33 (42%) Pearls were exhibited in the Pearls Binder described in Section 6.1.2.5.

Over the course of the study the majority of members used Pearls to get project ideas. A secondary motivation was to get help making a project they had seen in a Pearl. In most of those cases, the FCC Walls were the primary source of idea generation by Pearls. The Pearl Zone was the secondary source.

7.1.1.4 Pearls and Communication

Post-study surveys and Pearl assessment were performed on the Pearl corpus to analyze the communication attributes of the Pearls. Communication attributes included personal sharing, asking for feedback, offering ideas, and offering opinions. Figure 55 shows the levels of various communicative attributes for the Pearl corpus.

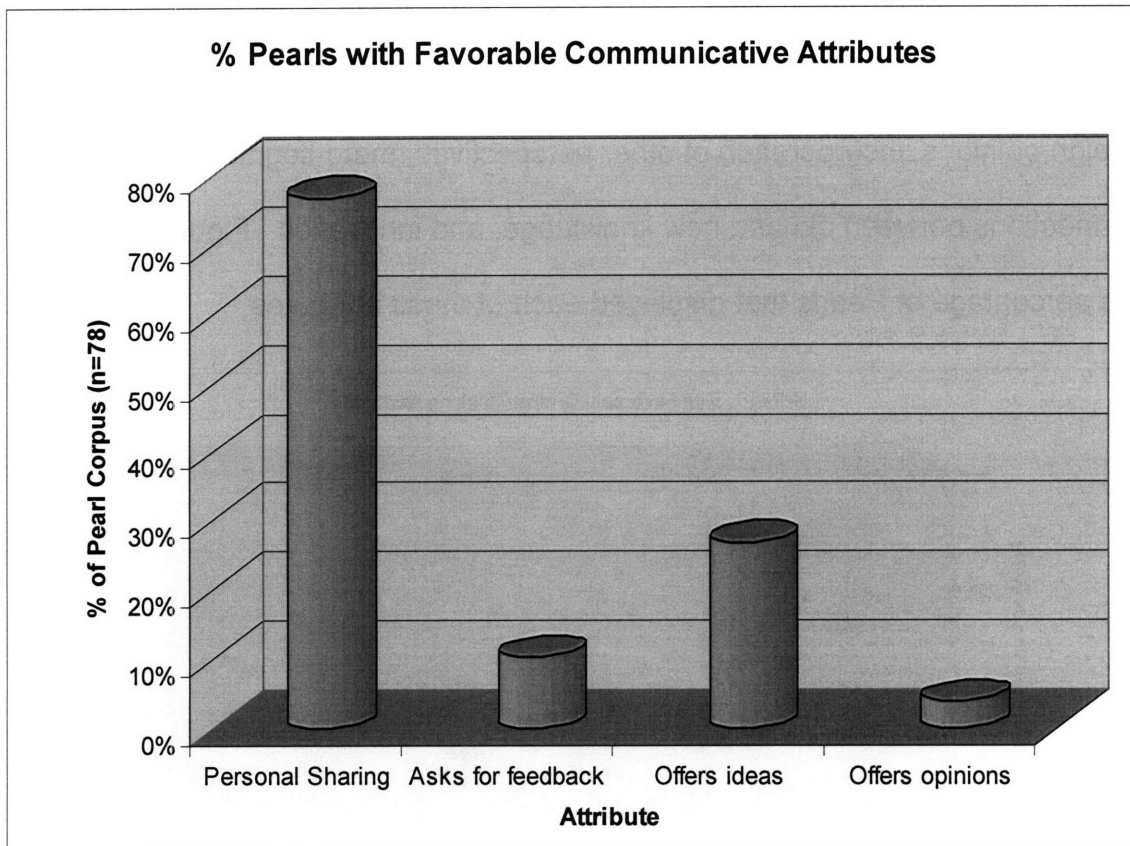


Figure 55. Pearls with Favorable Communicative Attributes.

60 (77%) of Pearls included some kind of personal sharing, either in the “What I Was Thinking” section or elsewhere in the Pearl. 8 (10%) Pearls solicited feedback from members, often asking for how-to information or asking members for alternative ways of accomplishing some design task. 21 (27%) Pearls asked for ideas from others. 3 (4%) of Pearls offered opinions, usually in a form that suggested theirs was the better way to accomplish some design task.

7.1.1.5 Pearls and Critical Thinking

In post-study surveys, Pearl designers reported they felt they had improved their learning skills as a result of their Pearl experiences. The Pearl

rubric scores for critical thinking also showed some aspects of critical thinking was present in their Pearls. Critical thinking attributes included problem solving, design opinions, incorporation of other perspectives, meta-cognition, making connections between old and new knowledge, and innovation. Figure 56 shows the percentage of Pearls that displayed each of these attributes.

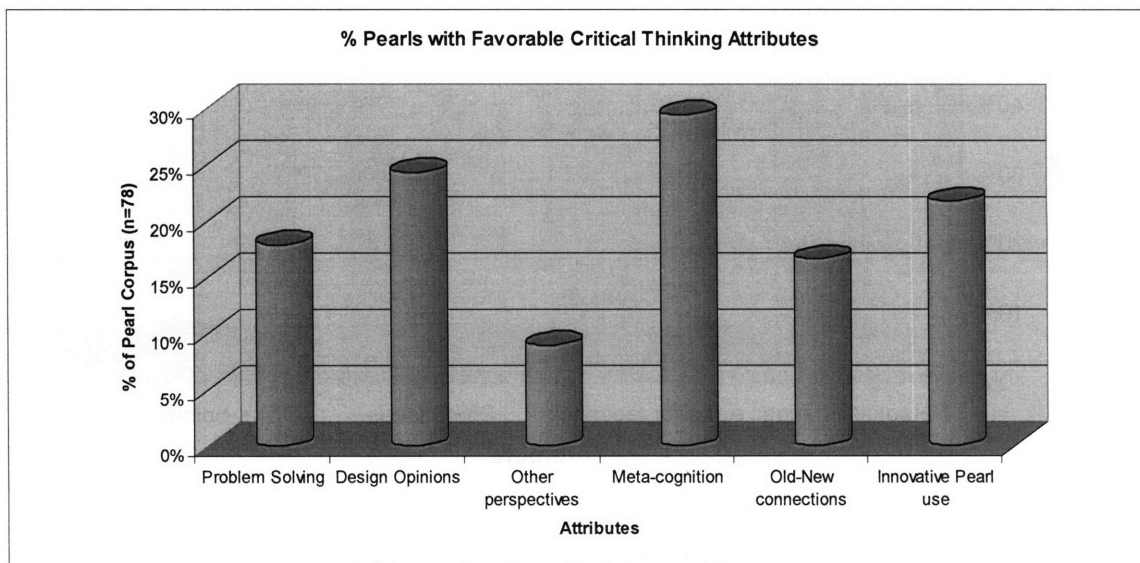


Figure 56. Pearls that Exhibited Critical Thinking.

Results showed articulation of problem-solving strategies during their Clubhouse project design was seen in 14 (18%) of Pearls. Statements about what inspired the Pearl design, why the design is important, or what kind of designing the member likes to do was included in 19 (24%) of Pearls. In 7 (9%) Pearls, members considered or acknowledged others' points of view within the Pearl narratives. Members described how they went about thinking about problems or thinking about their Clubhouse projects in 23 (29%) Pearls. Connections were made between old and new knowledge in 13 (17%) Pearls. Finally, innovative uses of Pearls were seen in 17 (22%) Pearls.

7.2 Treatment Group Outcomes

There were differing levels of participation in and acculturation of Constructionist Cooperative practice across the three treatment groups. The levels of participation of the three mentor team greatly impacted levels of Pearl construction with each group. Different outcomes for Pearl construction, use, and other Pearl practices are discussed in this section. Table 27 reviews the different group treatments.

Table 27. Treatments and General Outcomes for Groups G1, G2, and G3.

	G1	G3	G2
	Complete Treatment	Partial Treatment	No Treatment
Treatment Difference	PoW Software Training IRA Support and Training RMM Implementation	PoW Software Training IRA Support and Training	PoW Software Training
Mentor / Environment Disposition	High mentor participation Rates	Low mentor participation High Project development rates	Low mentor participation Low project development rates
General Outcomes and Differences	High Pearl Creation Rates High Mentor Team Development Constructionist Cooperative Emergence	Low Pearl Creation Low Pearl Use	No Pearl Creation Low Pearl Use

As a baseline, all three mentor groups had received Pearls of Wisdom and Village software training. Also, all three groups had Village accounts set up for their mentors and members.

Group G1 mentors (Team-G1) conducted regular meetings to reflect on productive strategies for better supporting their members in making Pearls. They became a functioning reflective-mentor team based on the Reflective Mentor Model. Group G2 mentors did not promote Pearl software or practices, or form a reflective-mentor team. Group G3 mentors promoted the PoW software but did not establish a reflective-mentor team. Group G1 exhibited the greatest degree of emergence of practices, artifacts, and relationships as outlined in the Cooperative Constructionism framework. Group G1 members also contributed the bulk of the Pearls made during the study. Figure 57 shows Pearl creation activity for the 78 Pearls created.

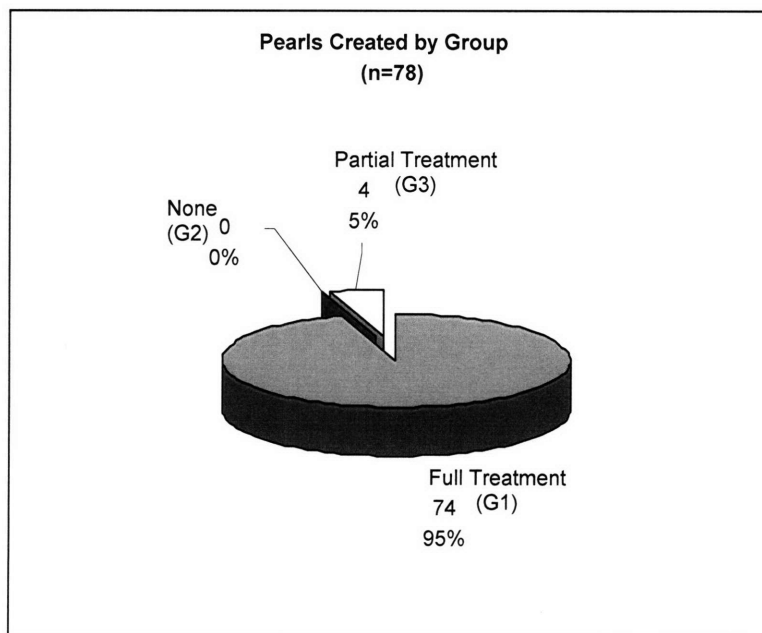


Figure 57. Pearls Created by Group.

The impact of Team-G1 on Pearl construction was evidenced by the large number of Pearls Group G1 members produced. Team-G1 had developed ways of working together that made them responsive to challenges that arose during the study. As a result, they were able to come up with innovative ways to motivate and support their members.

Group G2 produced no Pearls during the study. In follow up conversations with members, a common response to inquiries about making Pearls was:

“Why should I?... I don’t care about that.”

This reaction does not imply that G2 members were not part of the FCC community, in general. On the contrary, like members on other days, they created projects and shared those projects with others. However, without mentors modeling the construction and use of Pearls, the members were not motivated to allot their FCC time to making Pearls. Their primary concern remained working on their Clubhouse projects. Also, low mentor interest resulted in most Group G2 members remaining unaware of Pearls or the PoW software. When asked about Pearls that were exhibited on the Clubhouse Walls, most Group G2 members responded they thought the Pearl was a Clubhouse project.

Group G3 contributed four Pearls during the study. Group G3 participated marginally in using Pearls. All but two mentors initially showed interest in the PoW software and promoting Pearls. They expressed the opinion that having members reflect on Clubhouse projects could help them learn more. Mentors were encouraged to help members with their Pearls. Still, the mentors were not

willing to invest additional time by staying after-hours for roundtable meetings. Even on quiet days, mentors fielded my suggestions to play around with the PoW software or meet to discuss strategies for member support, etc. with responses like “I’ll get to it a little later.” Although reflective-mentor team support was provided, only one mentor made use of that support. However, on his own, he was not able to be very effective.

Group G1 members conducted 85% of the total Pearl page views during the study. Figure 58 shows Pearl page views for the 78 Pearls created.

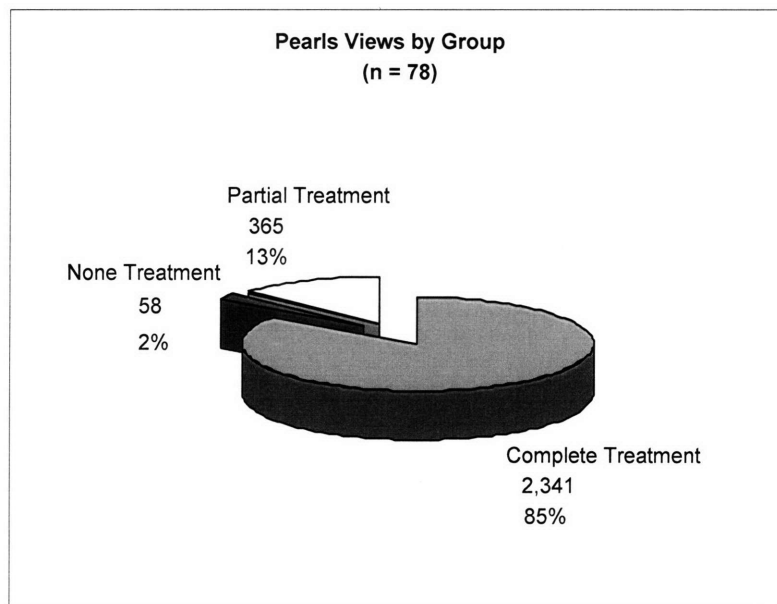


Figure 58. Pearl Views by Group.

As a regular practice, Team-G1 directed members to the Pearl Zone and connected members with similar interests in face-to-face exchanges around related Pearls. As much as possible Team-G1 directed member questions about software or projects to Pearl designers rather than immediately fielding questions themselves. G2 members conducted 2% of the total Pearl page views during the

study. G3 members conducted 13% of the total Pearl page views during the study.

Next, Sections 7.3 and 7.4 provide further discussion of the results reported in this Section.

7.3 Research Question One: How does construction of reflective artifacts enhance the ways people reflect on their learning processes?

This question focused on how construction of intentional-reflective artifacts impacted learners' reflections on their learning experiences. It was hoped that at FCC, where constructing projects was a regular learning activity, that constructing Pearls would become a regular learning activity, as well. The Computer Clubhouse Guiding Principles, detailed in Table 9, state that members work on projects of their own interest. This made construction of Clubhouse projects an authentic activity that members' performed as part of their participation in the FCC community. In accordance with Computer Clubhouse Guiding Principles, FCC members could not be compelled to make or use Pearls. Therefore, when members did so, they were signaling an interest and willingness to engage in that activity (Jonassen, 1991). That engagement casts Pearl activities as authentic within the FCC environment and meaningful to members making and using them.

7.3.1 Learning Through Intentional Reflection

Reflection, as defined in this study, is thinking about our thinking. Through reflection, learners make meaningful connections between their current knowledge and new learning experiences. Integration of Pearl construction with reflective thinking about Clubhouse projects brought Pearls directly into the heart of FCC learning activities. Members were engaged in an ever-deepening process of thinking about their learning as they became enmeshed in resolving the challenges and obstacles encountered while designing their Pearls.

7.3.2 Development of Learning Awareness

Developing an awareness of learning involves not just doing an activity, but talking about it and understanding the meaning of the activity. Engaging in intentional reflection requires the learner to slow down and deliberately focus on reexamination of his learning experience. In particular, the learner must identify significant learning moments and make sense of the learning that occurred. The benefit of this type of reflection is learners engage in activities that can lead to an awareness of their learning strategies.

Scardamalia (1996) showed how posing critical thinking challenges within software environments can guide learners through a process of meta-cognition. Similarly, learning awareness was made possible for FCC members while they were using the PoW software. Software elements were incorporated that led learners to use cognitive and meta-cognitive strategies to resolve incongruities.

An example is Pearl Panel prompts. The “What I Was Thinking About” prompt encouraged members to stop and think about aspects of their projects related to motivations for doing the project. Another example, the “This page is about:” prompt, asked learners to think about what they would put on the Pearl page and even if they should be staging their content on several pages instead of one. Resolving those issues requires the member to think about the organization of what they plan to put in the Pearl. As the member discovered which strategies were effective for resolution incongruities, she was gaining awareness of her learning strategies, and therefore, her learning.

7.3.3 Revisiting Learning Episodes

Re-visiting learning episodes is a well-established descriptor of deep reflection (Brown, 1997; Collins, 1990; Vygotsky, 1978). FCC members engaged in reflection while constructing their Pearls. They frequently returned to their Clubhouse project design experiences, recollecting the important process points for inclusion in their Pearls. This was also evidenced in comments made during closing interviews. One 17-year-old, female member reported on her Pearl building process:

*“You could think back to you did and then it pretty much comes together ...
Sometimes you remember another piece later but then you just add it in and
write something to explain it until its good.”*

She was connecting to her Clubhouse projects and her learning in a deeper way than she had before making her Pearl about the project. By revisiting her project

experiences, she was able to consider where the important conflicts in understanding were resolved. By creating a Pearl, a persistent artifact, she was able to revisit and refine her reflections, over time.

Another member pointed out that reviewing how he did his Clubhouse project was necessary to make his Pearl. This type of review was a practice commonly reported by Pearl designers.

"I ended up looking at a lot of things two times. I just wanted to make sure I got it right. Besides, that made it go faster. "

This member saw his re-examination of his process as a way to organize this Pearl. He had developed an efficient design strategy for constructing Pearls.

Members engaged in Pearl construction reported they liked to "take their time" when adding content to their Pearls. They slowed down to review the software they used to make their Clubhouse projects or think about what motivated the project. Many members insisted on reviewing how their Clubhouse project software operated. Besides checking software operation, some members also reported they also checked other features available in the software in the hopes of being able to add extra "goodies" into their Pearls. This protracted software review process slowed members down which gave them the time think more deeply about what they knew about making their Clubhouse project. Some members reported they made the decision to add more detailed information or to include alternative methods or project design ideas after the initial Pearl construction. They revisited their Pearls to refine or add to the content. This

attention to detail was evident as Pearls were scored for clarity, accuracy, and content, among other attributes.

7.4 Research Question Two: What scaffolds are most important for engaging a community in reflective practice?

Intentional reflection scaffolds took two general forms during this study: social and software. Social scaffolds included reflective-mentors and other members. The software scaffold was the PoW software used for making Pearls and for viewing or printing Pearls. Members engaged in multiple forms of Pearl-based interaction. Those included member-to-member, member-to-mentor, and member-to-Pearl.

7.4.1 The Member as Scaffold

Members assisting other members represented a social scaffold. Those member-member interactions were useful in influencing Pearl development. During the Pearl development process, members offered each other suggestions, negotiated ideas and Pearl content, and shared learning experiences with one another. Some members reported the benefits of collaboration with another when making their Pearl. In those cases, scaffolding occurred when one member supported the other in extending her understanding of some aspect of her learning or design experience. One member described her perception of those benefits in her closing interview:

"Like when you say 'Oh nice, this is what it means' and then she didn't even think of it and goes 'Yeah, yeah' and then you take it further when that happens"

In her closing interview another member showed considerable understanding of the concept of scaffolding and how it related to her learning:

"If you're working with somebody else, then you help each other. That helps me think, like I'm learning and stuff. If I was by myself I might just have kept going."

Members were very positive about the supportive role their Pearl partner played, and clearly associated their efforts with their teamwork. Most reported they felt the partner was useful for problem-solving.

The importance of the member-member scaffold was an unexpected finding of the study. It was expected that members would only work on their own Pearls. However, the findings support Vygotsky's (1978) notion of the 'zone of proximal development', where learners are supported by 'more capable peers'. In that case, however, members were more likely to be operating within each other's zones.

Bruner argued that meaning is negotiated and all knowledge is transactional. The members were well aware of that when making or sharing their Pearls with others. One member reported the process for her:

"I asked him what he thought of my Pearl and if he agreed I kept it, if he didn't agree I thought about it more first, then I kept it. (laughing) I think we worked good together."

Conversely, the same member later pointed out what was hard about negotiating:

"I suppose sometimes if you don't agree on how something's to be done you could just take it. There's no point arguing because you'll never finish. There's lots of times I suppose where you've got your own idea, you want to do it this way and he doesn't. Then it's hard to agree. Sometime I left something out when it got too hard. "

Collaboration on projects is a part of FCC culture and members depend on each other for elements of their Clubhouse projects. Members were generally very positive about working collaboratively on their Pearls, as well, described the process of working together as joint-problem solving. Most of the partner scaffolding provided more content and meta-cognitive support

7.4.2 The Mentor as Scaffold

Mentors were important scaffolds along two dimensions: they were a scaffold for members and a scaffold for the reflective-mentor team.

7.4.2.1 Scaffolding Members

When they served as a scaffold for members, mentors often initiated assistance by moving around the Clubhouse asking members if they wanted any help with their Pearls. At times, a member would call over a mentor for Pearl assistance. In most cases, the mentor's assistance was procedural in nature, for

example, helping a member operate software. The reflective-mentor role in supporting Pearl development was viewed by members the same as how mentors support Clubhouse project development. Mentors were asked to help because it saved the member time and helped them avoid frustration. One member highlighted the importance of having the mentor available to help with her Pearl:

"I had this project I was stuck on, but then I got help from Chris (mentor). If you have a problem and you can't work it out yourself, she can help. I like her to help me with my Pearl too sometimes. Or else I just sit there and that's a waste of my time. "

Sometimes mentors assisted with member thinking around Pearl organization. In those cases, the mentor gave enough guidance to permit the member to continue working on their own again. This was also in line with the FCC learning culture. One member reported what he felt the mentor's role was in regards to his pearl making:

"Just for moral support, I guess. She comes around and just hangs out and that's reassuring ... I like that she doesn't say anything bad because I don't know some part. "

In general, Pearl designers and users indicated they were adequately supported by mentors and reported that mentors supported their Pearl construction the

same way they supported their Clubhouse project construction. In this study, the mentor provided mostly procedural scaffolding.

7.4.2.2 Scaffolding the Reflective-Mentor Team

One of the critical ways that mentors scaffolded the reflective-mentor team was by attending the roundtable sessions and participating in the development of action plans and strategies. Team-G1 supported their development of a common mission for the team of consistently exploring new ways to engage members in reflection and facilitate member connections through Pearl activities. Mentors also supported each other while actively mentoring, often working as a team with a member or taking time to hold a mini-brainstorming session.

7.4.3 Software as Scaffold

Chapter 4 described the development of the PoW software, which was designed to support members construction of intentional-reflective artifacts called Pearls.

7.4.3.1 Motivation for Using PoW

In discussing aspects of using PoW, members frequently mentioned its motivational ability. Generally, they attributed that motivation to four factors:

- Members felt that the fact that they could work at their own pace was motivating.

- Members mentioned the motivating influence of their peers. They used Pearls for reputation building, especially as they began to get feedback from other members. Peer pressure has always been a motivator for improving design skills within the FCC culture. It also proved a motivator for development Pearl skills, as well.
- Members mentioned the authentic design task of making a Pearl was a motivating factor. It was a familiar activity and of value in the FCC community.
- Members described being able to “get to the html” that generated their Pearls. For many, that provided an entry into html programming and web design. It should be noted that web design has great social value within the FCC, so members who know any html are highly regarded.

7.4.3.2 Software Scaffold for Member Learning

Scardamalia (1989) suggested educational software with scaffolds that engage learners in authentic activities presented the opportunities for promoting learning. The Pearl construction software was designed to scaffold member learning by providing design challenges in the forms of text and structural prompts. In closing interviews, a member reported what working with PoW brought to her learning experiences:

I have never used anything like that before so it was interesting, yes so that was pretty motivating. I think the thing that we'd never done it before and it's not like my other projects ... I mean I have to think more while I'm doing it. Well I have to think of a name and what to put in and what pictures I want and stuff. I added some html to change some of the colors too."

She reported Pearl making was different from Clubhouse projects. She talked about having to "think more" while making her Pearl. Other members endorsed her comments. Members used the word "fun" when they talked about PoW. It seemed as if the fun was hard but worth it. This was reminiscent of Papert's "hard fun." During their closing interviews, members made statements like the following:

"PoW was fun, it was something different."

"It's fun, it gets you a bit more into what you were doing in your project... That part is kinda hard sometimes."

Many of the students reported the PoW software helped them reflect on their projects:

“Having the Pearl made meant I had to go ‘What did I do in this bit of my project... how can I write that so its quick?’ I just put in what I remember and then later I added more if I had too. Yeah I think making my Pearl helps me to reflect.”

Members also liked the page navigation schema, which were little page icons, one for each Pearl page. One member reported when asked how the icons help her reflect said:

“Well it was easy to go back in forth. I felt like those little pages were bugging me to fill them up. I just spread out some of what I said to another page. At least I used two of them... I liked that if I needed more room later, I could just use another page.”

The Pearl interface was designed to look like a graphics design program in its layout. The design and development of the PoW interface was described in detail in Chapter 4. Members responded positively to the interface. They reported that they appreciated the panels and the prompts, and found the interface layout logical. They seemed to conceptualize the Pearl Panels as separate canvases that were for thinking in different ways about their project. Also, as an open work area, the panel metaphor was familiar to members because of their work with other similarly-organized design software. Generally,

members adapted very quickly to the layout of the interface, and found the insertion of images and attachment of files easy to access and use.

7.5 Implications of the Research: The Spread of Intentional Reflection

Pearls mediated numerous learner connections and became a conduit for the spread of projects ideas throughout the FCC community. Cooperative and communicative attributes of Pearls were presented in Section 7.1.1.3 and Section 7.1.1.4. Those results highlighted the ways that members used Pearls to share and connect with each other. A review of Pearls created over the course of the study by topic presented a snapshot of the ideas that resonated in the community at various times during the study. For example, Table 28 gives an example of two Pearl topics that appeared in the Pearl corpus after software workshops occurred.

Table 28. Pearls were beginning to reflect the ideas and projects that were popular

Design Concept	Workshop Date	% of Related Pearls over 2 month period
Painter (graphic arts software)	August 2005	17%
RGB GameMaker	March 2005	18%

This illustrates how an increase in new Pearls on a given topic was preceded by Clubhouse workshops on that topic. For example, over a two-month period and following a series of Painter workshops, seven Painter Pearls were created. Later, following a series of Scratch workshops, there was an increase in the

number of Scratch Pearls created. This was an indication that new Pearls were becoming a barometer of project ideas and trends spreading throughout the FCC community.

In order to use Pearls, Clubhouse members needed to learn to use the PoW software, be motivated to make Pearls, and find help when they needed. In the post-study survey, members were asked how they first learned about Pearls and the Pearls of Wisdom software. More than 50% of respondents indicated a mentor introduced them to the software and helped them get started with their first Pearl (see Figure 59).

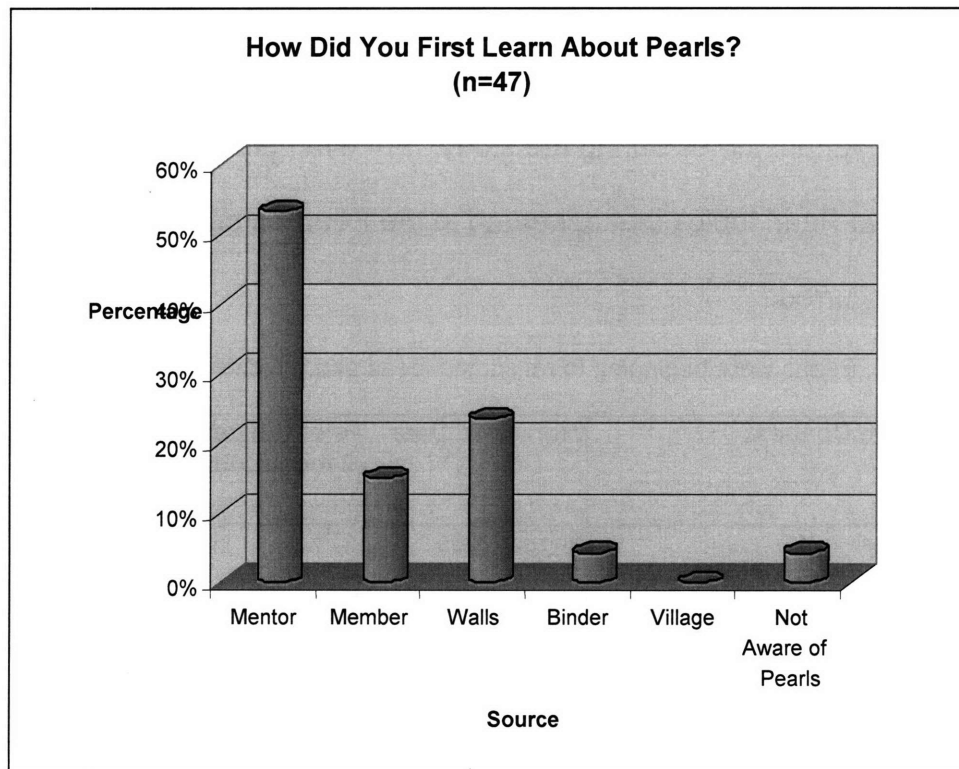


Figure 59. Source of Member Introduction to PoW.

This indicated active mentor involvement was critical to member the Constructionist Cooperative. Reflective-mentors were the primary engine driving

regular intentional-reflection practices at the FCC. Most also reported in follow-up questioning that a mentor helped with their first Pearl, further editing or subsequent new Pearls were easier to do. The exceptions were a few of the youngest (10-12 year old) FCC members.

Summary

The study findings suggest that a Constructionist Cooperative environment did develop for Group G1. Constructing Pearls allowed them to reflect on their learning by providing them with the social and computational tools to express their thinking about their projects. Pearl designers were able to return to and re-evaluate their learning experiences. The PoW software enabled member reflections to be shared while they were involved in authentic design activities.

Collins (1991) argued that by putting the learner in control of their problem solving, they also gain control of their thinking process. The objective of intentional reflection at the FCC was to give members control over their design and learning through Pearl construction and use so they might take control of their reflective process.

Learning communities like the FCC are groups of individuals who support each other in their learning activities (Rogoff, 1994). In a sense, learning communities like FCC are intentional. Coming to the FCC is an intentional act by the member. How learning happens at FCC and what learning practices members engage in is intentional because members choose to participate in

learning activities there. Therefore, what holds the FCC community together, over time, is member and mentor interest in maintaining their learning environment.

Whether you think you can or think you can't
You're right.

Henry Ford

8 Epilogue

The goal of this dissertation was to integrate reflective practice into a constructionist-learning environment. The Cooperative Constructionism framework established a design approach to reflection with a set of tools and methods that supported reflection on learning. Critical to the success of the framework were both social and computational scaffolds designed to aid learner negotiation of reflection. The social scaffold, the Reflective Mentor Model, promoted regular practice of intentional reflection within the learning environment by building a mentor community of practice around supporting learner reflection. The computational scaffold, Pearls of Wisdom, provided prompts and other design challenges that motivated learner reflections on specific aspects of the learning and design process.

In this dissertation I have argued that young learners are able to engage in reflection on their design and learning by creating artifacts expressive of their reflective process. Furthermore, I have argued for the importance of social and software scaffolds that are intended to support such reflection within the learning-by-design paradigm. In this way, learners can deepen their understanding of

their cognitive skills and strategies while immersed in a meaningful activity that is also valued within their learning community. The capabilities of the Pearls of Wisdom software developed for this study will surely evolve over time as we learn more about reflection through artifact design. This research represented the first steps toward a closer examination of what learners and their communities need to leverage the benefits of constructionist learning.

8.1 Barriers to Intentional Reflection

A number of challenges to Constructionist Cooperative development were observed over the course of the study. Some were internal to the individual (i.e., self-confidence, pre-existing assumptions about learning). Others were external (i.e., environmental factors, community members). The discussion of these barriers is organized in three sections: member, mentor, and software challenges.

8.1.1 Member Challenges

A member challenge was how to approach designing his first Pearl. In general, once a member had created a Pearl, they were able to revise that Pearl or create a new one with some degree of independence. However, their first encounter with having to think about their Clubhouse projects so deeply was difficult. The mentor's role was a critical factor that got members past this first challenge. The mentor helped the member to move through their zone of proximal development to where he could independently engage in Pearl design

and reflection. How to best support member traversal of this zone of proximal development was a recurrent topic at reflective-mentor roundtable meetings.

Another member challenge was use of the Pearl Links feature. Pearl links are calls to another Pearl. The concept of linking was not the source of confusion; members relate Pearl links to html links, which is an accurate conceptualization. However, user motivation for using Pearl links in their Pearls was not achieved in this study.

8.1.2 Mentor Challenges

Mentor challenges were centered on how best to support intentional reflection and how to sustain the reflective-mentor team over the long term. On any particular day, the levels of mentor team development directly impacted whether members engaged in intentional reflection practices. Therefore, building a robust and resilient reflective-mentor team was critical for continued Constructionist Cooperative growth.

8.1.3 Software Challenges

There were a number of software challenges, most having to do with design issues related to the using WebCrossing as a development platform. For example, PoW menu icons included several icons that were not related to PoW. These could not be removed, however, because of customization limitations of the WebCrossing software. This led to confusion for many first time users.

Another challenge was one we were happy to encounter. The collection of Pearls had grown to a point where it was difficult to browse the Pearl Zone.

Pearls were being “buried” in the busy display, which was a simple list structure. Some members became frustrated as a result and created their own indexes by constructing Pearls contained links to their favorite Pearls.

8.2 Future Explorations

At the onset of this dissertation, I mentioned further research was necessary to examine how to deepen learning outcomes within constructionist learning environments. This research has contributed to that effort. The ideas presented in this work converge at the intersection of community, cognition, and computation to provide a window into ways in which we can help learners take greater control of their learning. More needs to be done. Additional research directions to explore within the context of this work include:

- More studies examining Constructionist Cooperative emerge. This will make it possible to tease out a minimal set of criteria for promoting Constructionist Cooperative growth.
- The Cooperative Constructionism framework should be tested in other kinds of learning environments as well, for example, in the classroom. This will permit an examination of how the Cooperative Constructionism framework operates within learning environments based on other educational models.
- Refinement of the RMM is a rich area of exploration, especially in the context of supporting constructionist learning environments. The nature of the mentor team was a key factor in the quality of the Constructionist

Cooperative at the Flagship Computer Clubhouse. More investigations into additional methods for engaging and training reflective mentors are needed.

- Refinement of the PoW software to address issues of usability. Users expressed frustration at not being able to get a sense of what was in the Pearl. One design addition, for example, would be a suggestion module that predicts and displays similar Pearls list of Pearls that have the same genre and/or design tool as what the Pearl designer is entering into the meta-data fields. That would acquaint members with Pearls similar to theirs. This could serve to connect members with similar design interest and acquaint the Pearl designer with potential Pearls to link.

8.3 Reflections

My interest in this work continues to grow with every new discovery I make about the interdependencies of learning, reflection, computation, and community. I believe reflection can be made explicit in a learner's design process. This work represented the first steps in the exploration of that belief. As a researcher, a concern in my work was making meaningful connections between theory and practice. The practitioners, who on a day-to-day basis support youth development and learning, are our colleagues in this journey of discovery. Only through a true partnership of researcher and practitioner can we ensure that our efforts lead to learning and reflection processes.

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APPENDIX 1. Pearl Scoring Rubric and Rubric Instructions.

Pearl Rubric

Rater:

Date:

General Information

Pearl Title:

Pearl Designer:

Community Role (Member, Mentor, Staff, Alum):

Gender: ____

Age: ____

Member Since: ____

Pearl Summary Statistics

Number of Pages (1-5):

Number of Blank Pages (1-4):

Pearl Genre (check one): image audio video web
 multimedia animation writing

Tool:

Analytic Scores

A. CONTENT

A.1. Depth: Low Med High

A.2. Breadth: Low Med High

A.3. Does Pearl designer reference their own Pearls? Yes No

A.4. Primary Pearl Type: Instructional Introspective Both Equally

A.5. Is Final Product Shown? Yes No

A.6. Is Media Relevant? Yes No

A.7. Media Types (check all that apply): text image audio video
 files Pearl-references URLs screen captures

B. DESIGN

B.1. Panel Layout Customization: Low Med High

B.2. Panel Headings Changed? Yes No

B.2.a. If so, which ones? *What* *How* *Why*

B.2.b. If so, were changes meaningful? Yes No

B.3. Customized Colors? Yes No

B.4. Customized Fonts? Yes No

B.5. Customized Borders? Yes No

C. COOPERATIVENESS

C.1. Shares Design Insights? Yes No

C.2. Shares Learning Insights? Yes No

C.3. Pearl-Refs to Member Pearls? Yes No

C.4. References other Members? Yes No

C.5. Pearl Augmented With Additional Ideas? Yes No

C.6. Off-Line Instances of Pearl: Clubhouse Walls Pearl Binder
 Village Project Gallery Other (specify) None

D. COMMUNICATION

D.1. Offers ideas to audience? Yes No

D.2. Offers opinions to audience? Yes No

D.3. Asks audience for ideas? Yes No

D.4. Asks audience for opinions? Yes No

D.5. Personal Sharing? Yes No

E. CRITICAL THINKING

E.1. Does the Pearl designer express opinions about design?
 Yes No

E.2. Does the Pearl designer make debugging suggestions?

Yes No

E.3. Pearl Mentions Earlier Skills and Knowledge? Yes No

E.4. Does the Pearl designer present or explain their insights (moments of understanding or illumination)? Yes No

E.5. Does the Pearl designer consider others' points of view? Yes No

E.6. Does the Pearl designer think about his/her own thinking? Yes No

E.7. Does the Pearl designer connect things they already know with new things presented in the Pearl? Yes No

E.8. Does the Pearl designer make innovative use of the Pearl?

Yes No

E.9. Is Pearl title descriptive to project or topic? Yes No

Holistic Score

The holistic score reflects your overall impression of the attached Pearl. Before beginning this section, look through the Pearls in the Pearls Binder or the online Pearl Zone. This will give you a clearer sense of where the attached Pearl fits within the context of the larger "Pearl universe." Ask yourself if you feel Pearl promotes the 3 C's of the project: construction (designing), communication (with others), and critical reflection (on learning or design insights). Read the criteria below for each score and assign the score that most closely matches your assessment of the Pearl.

Score	Explanation
Excellent <i>You feel this Pearl is a good example Pearl.</i>	<ul style="list-style-type: none">• Accurate information with detailed explanations, including suggestions for variations.• Pearl design choices boost Pearl usability.• Highly communicative and engaging.• Shows awareness of audience.• Includes reflections on design or learning insights.• Use of page headings or custom panel headings to group concepts.• Well organized with good flow of ideas.
Good <i>You feel this Pearl is good, but could use some more work.</i>	<ul style="list-style-type: none">• Accurate information with good explanations.• Pearl design choices boost Pearl usability.• Some attempts at communication.• May show audience awareness.• Includes reflections on design or learning insights.• Use of page headings or custom panel headings to group concepts.• Well organized.

<p>Fair</p> <p><i>You feel this Pearl is adequate but needs a lot more work.</i></p>	<ul style="list-style-type: none"> • Some inaccurate information. Minimal or no explanations. • Pearl design choices more ego-centric than designed to boost Pearl usability. • No attempts at communication. • No sense of audience awareness. • No reflections on design or learning insights. • Use of page headings or custom panel headings unrelated to grouping concepts. Also, headings may be empty. • Minimal organization, if any.
<p>Poor</p>	<ul style="list-style-type: none"> • Pearl is in a condition that renders it unusable.

Holistic Score: _____

Additional Comments

Pearl Rubric Instructions

Thank you for evaluating the attached Pearl. Your evaluation will be made using the Pearl Rubric. Please annotate distinct areas of the Pearl with their corresponding question number. Also, before beginning your evaluation, go online and load this Pearl so you can experience it that way other users do.

What is a Rubric? A rubric is a set of criteria for capturing information about various Pearl properties and performance levels. This results in a finely-detailed characterization of the Pearl and ensures its characteristics are described in a consistent way. Later, an analysis of the rubric data can tell us how the Pearl was used, thought with, and constructed.

What will we learn from scoring Pearls? We can learn about how the Pearl practices are “filtering down” into the kind of work members do with Pearls. For example, we may be able to gain insight into how members organize the information in their Pearls or what thinking strategies went into making the Pearl. Coupled with other study data, rubrics can help us understand how learning happens with Pearls and how Pearl practices spread throughout the Clubhouse.

Please note this sheet may not contain instructions for some rubric questions. Please see me if you want additional information about this rubric.

Pearl Summary Statistics

Number of Pages: total number of pages, whether utilized or not.

Number of Blank Pages: total number of blank pages

Pearl Scoring

A. CONTENT

A.1. *Depth* refers to the level of detail incorporated in subject explanations. Low means only a “bare-bones” explanation given. This may be a minimal list of steps with no other supporting information. The user would need to have substantial prior knowledge for the Pearl to be easily used. Medium means there is a more comprehensive list of steps with some supporting sub-steps, as well. The user would need little prior knowledge to easily use the Pearl. High means there is a very comprehensive list of steps with some supporting sub-steps and

suggestions for filling in field values, etc. There may also be images or descriptions of intermediate results. The user would need no prior knowledge to easily use the Pearl.

Breadth refers to the scope of the Pearl subject. Low covers a single software feature or activity as the subject of a Pearl. Medium covers a number of software features as the subject. High covers an entire project as the subject of a Pearl. Low and Medium focus on sharing some feature or activity rather than sharing a project.

A.2. *Does Pearl designer reference their own Pearls?* Does the Pearl designer talk about other or provide links to other Pearls they have made?

A.3. *Primary Pearl Type.* There are three primary Pearl types. The first contains how-to instructions but no other insights. The second contains no how-to instructions. The third may contain a combination of both.

A.4. *Final Project Shown?* Does the final project appear anywhere in the Pearl?

A.5. *Is Media Relevant?* The media used in the Pearl either helps understanding of Pearl content or helps in understanding of Pear designer.

A.6. *Media Types.* Put a check mark next to each type of media found in the Pearl.

B. DESIGN

B.1. *Panel Layout Customization:* Low means default layout maintained. Med means panel location, shape, or number-of-panels are different from default. High means panel changes are highly creative or unusual.

B.2. *Panel Heading Customization?* Select “yes” if panel headings were changed.

Which Panels Were Customized? Indicate which panel heading(s) was changed.

Were Customizations Meaningful? Does the new panel heading help further overall organization or understanding of Pearl content?

C. COOPERATIVENESS

C.1. *Shares Design Insights?* Does pearl designer talk about her design process or inspirations?

C.2. *Shares Learning Insights?* Does Pearl designer talk about how he went about learning new things or how he debugged problems?

C.3. *Pearl-Refs to Member Pearls?* Does Pearl designer use the Pearl-referencing feature to incorporate other member Pearls into her Pearl?

C.4. *Other References to Member Pearls?* Does the Pearl designer mention other members or other member projects.

C.5. *Pearl Mentions Earlier Skills and Knowledge?* Does the Pearl connect or bridge older knowledge to new ideas?

C.6. *Pearl Augmented With Additional Ideas?* Does Pearl contain ideas for future projects, things to try, or ideas for exploration?

D. COMMUNICATION

D.1. *Audience Solicited?* Does the Pearl designer pose questions to the audience or attempt to solicit audience feedback?

D.2. *Personal Sharing.* Does the Pearl designer is revealing something about their feelings, personal background, customs, etc.

D.3. *Off-Line Instances of Pearl.* Take a walk around the Clubhouse before answering this question. Check off other locations where you've seen this Pearl.

E. CRITICAL THINKING

- E.1. *Does the Pearl designer present his/her opinion about design?* For example, are statements made about what inspires designs, why design is important, what kind of designing they like to do, etc.
- E.2. *Does the Pearl designer make design or debugging suggestions?*
- E.3. *Does the Pearl designer ask for design or debugging suggestions?*
- E.4. *Does the Pearl designer present or explain their learning insights?* For example, are statements made that indicate an “ah-ha” moment in solving some problem or arriving at some design decision.
- E.5. *Does the Pearl designer consider other points of view?*
- E.6. *Does the Pearl designer think about his/her own thinking?* For example, are statements made about how they go about thinking about problems or their Pearl? Do they mention what kind of learning process works best for them?
- E.7. *Does the Pearl designer connect what they already know to new activities associated with their Pearl?* For example, does something they know about making web pages help them figure out something in using Photoshop.
- E.8. *Does the Pearl designer make innovative use of the Pearl?* For example, using the Pearl as a bulletin board or as a Pearls Table of Contents or anything unusual.

APPENDIX 2. The Computer Clubhouse Code of Conduct.

The Computer Clubhouse Code of Conduct

The Computer Clubhouse strives to provide a safe, comfortable atmosphere, in which members of the Clubhouse Community may explore their own creativity. To that end, we all agree to the following:

1. All members of the Clubhouse Community are encouraged to explore their own creativity. I will help this happen by not doing anything to disrupt or discourage another's creative expression.

2. I know that the Clubhouse is everyone's space. If I choose to play music or sound files, I will play it so that it does not disturb others. In addition, I will not play any music containing profanity. I will also adhere to the Clubhouse Internet Safety Guidelines so that no one in the Clubhouse will be exposed to inappropriate material and/or people who wish to misuse the Internet (the Internet Safety Guidelines are on the other side of this paper).

3. In an attempt to make everyone feel comfortable in the Clubhouse, I will not use profanity and/or discriminatory language. In addition, I will not use language that purposefully offends another member of the Clubhouse.

4. In an effort to ensure the safety of everyone in the Clubhouse Community, I will not steal, pirate software, or engage in any other illegal activity, including possession and/or use of narcotics or weapons.

5. I realize that the Clubhouse is limited in resources and we are lucky to have all the equipment that we have. I will do my best to respect the Clubhouse space. I will not purposefully destroy or vandalize any property of the Clubhouse or of another Clubhouse Community member. I will also help to keep the Clubhouse clean by picking up after myself.

6. The Computer Clubhouse is filled with different kinds of people from various backgrounds. I will help create a feeling of community by respecting everyone I come in contact with and treating them how I would want to be treated. Both physical and verbal fighting will not be tolerated. If I have a problem I can not solve peacefully myself, I will talk to a staff member and allow them to handle it.

APPENDIX 3. COUHES Consent Forms.

Committee on the Use of Humans as Experimental Subjects Consent Forms

PARENTAL CONSENT TO PARTICIPATE IN PEARLS OF WISDOM RESEARCH PROJECT

We are inviting your child to participate in a research study conducted by Robbin Chapman, Ph.D. student and Mitchel Resnick, Professor, from the MIT Media Laboratory at the Massachusetts Institute of Technology (M.I.T.). The results of this research study will contribute to the dissertation, Pearls of Wisdom: Learning in Distributed Constructionist Cooperatives. Your child was selected as a possible participant in this study because of his or her membership in the Computer Clubhouse community. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

• PARTICIPATION AND WITHDRAWAL

Your child's participation in this study is completely voluntary, and your child is free to choose whether to be in the study or not. Your child can decide to withdraw from the study at any time without penalty or consequences of any kind. The investigator may withdraw your child from this research if circumstances arise which warrant doing so.

• PURPOSE OF THE STUDY

The MIT Media Laboratory proposes to conduct a research study of how knowledge is shared among the community of Computer Clubhouse members. The goal of this study is to gain a better understanding of how children might learn through the use of a new technology called Pearls of Wisdom (PoW), which is a software program designed to support knowledge-sharing between Computer Clubhouse members. The study will take place from October 1, 2005 to May 31, 2006. Your child will use the PoW software to create Pearls, which are web pages that document his or her design know-how. These Pearls will be accessible to the Computer Clubhouse community through the Computer Clubhouse Village intranet. The Clubhouse Village is available only to Computer Clubhouse members and staff with valid password access.

• PROCEDURES

The study will begin with a series of interviews with selected Computer Clubhouse members and mentors, leading to the placement of Pearls of Wisdom software on the Computer Clubhouse Village intranet and available to members from sixty-plus Clubhouses worldwide. All PoW activities will take place at the Computer Clubhouse. The investigators will provide further assistance with PoW through email and on-site mentoring.

The researchers are interested in developing a better understanding of how PoW, as a supportive community technology, supports an evolving culture of knowledge sharing within a community. During the audio taped interviews, researchers might ask questions such as:

- How did you come up with the idea for your project?

- Did community feedback from influence your Pearl design?
- What would you change about the technology you used?
- How is it different for you to explain how to do your project to someone in person versus through a Pearl?

- **POTENTIAL RISKS AND DISCOMFORTS**

There are no potential risks or discomforts.

- **POTENTIAL BENEFITS**

By participating in this project, your child will learn to create digital representations of their expertise gained at the Computer Clubhouse. In particular, child will create her or his own Pearls of Wisdom using the software developed at the MIT.

- **PAYMENT FOR PARTICIPATION**

There is no payment for participation.

- **CONFIDENTIALITY**

All information and data (handwritten notes, audiotapes, videotapes) obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission or as required by law.

In any external documents (research reports, journal articles, etc.), participants will be identified only by pseudonyms. Audio and videotapes of participants will not be available publicly without written consent from the participants (and their legal guardians). All audio and videotapes will be archived in project files at MIT (and not accessible to any outside parties).

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about the research, please feel free to contact Professor Mitchel Resnick at 617-253-9783 or mres@media.mit.edu

- **RIGHTS OF RESEARCH SUBJECTS**

Your child is not waiving any legal claims, rights, or remedies by participating in this research study. If you feel your child has been treated unfairly, or you have questions regarding your child's rights as a research subject, you may contact the Chairman of the Committee on the Use of Humans as Experimental Subjects, MIT, Room E32-335, 77 Massachusetts Ave, Cambridge, MA 02139 (or phone at 617-253 6787).

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

I understand the procedures described above. My questions have been answered to my satisfaction, and I give my consent for my child to participate in this study. I have been given a copy of this form.

Name of Subject

Name of Parent (or Legal Guardian)

Signature of Parent (or Legal Guardian)

Date

SIGNATURE OF INVESTIGATOR

In my judgment the subject is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

Signature of Investigator

Date

CONSENT TO PARTICIPATE IN PEARLS OF WISDOM RESEARCH PROJECT

We are inviting you to participate in a research study conducted by Robbin Chapman, Ph.D. student and Mitchel Resnick, Professor, from the MIT Media Laboratory at the Massachusetts Institute of Technology (M.I.T.). The results of this research study will contribute to the dissertation, Pearls of Wisdom: Learning in Distributed Constructionist Cooperatives. You were selected as a possible participant in this study because of your membership in the Computer Clubhouse community. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

• PARTICIPATION AND WITHDRAWAL

Your participation in this study is completely voluntary, and you are free to choose whether to be in the study or not. You can decide to withdraw from the study at any time without penalty or consequences of any kind. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

• PURPOSE OF THE STUDY

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- Did community feedback from influence your Pearl design?
- What would you change about the technology you used?
- How is it different for you to explain how to do your project to someone in person versus through a Pearl?

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There are no potential risks or discomforts.

- **POTENTIAL BENEFITS**

By participating in this project, you will learn to create digital representations of your expertise gained at the Computer Clubhouse. In particular, you will create your own Pearls of Wisdom using the software developed at the MIT.

- **PAYMENT FOR PARTICIPATION**

There is no payment for participation.

- **CONFIDENTIALITY**

All information and data (handwritten notes, audiotapes, videotapes) obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law.

In any external documents (research reports, journal articles, etc.), participants will be identified only by pseudonyms. Audio and videotapes of participants will not be available publicly without written consent from the participants (and their legal guardians). All audio and videotapes will be archived in project files at MIT (and not accessible to any outside parties).

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about the research, please feel free to contact Professor Mitchel Resnick at 617-253-9783 or mres@media.mit.edu

- **RIGHTS OF RESEARCH SUBJECTS**

You are not waiving any legal claims, rights, or remedies by participating in this research study. If you feel you have been treated unfairly, or you have questions regarding your rights as a research subject, you may contact the Chairman of the Committee on the Use of Humans as Experimental Subjects, MIT, Room E32-335, 77 Massachusetts Ave, Cambridge, MA 02139 (or phone at 617-253 6787).

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

I understand the procedures described above. My questions have been answered to my satisfaction, and I give my consent for my child to participate in this study. I have been given a copy of this form.

Name of Subject

Name of Subject

Date

SIGNATURE OF INVESTIGATOR

In my judgment the subject is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

Signature of Investigator

Date

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Committee on The Use of Humans as Experimental Subjects

Application for Approval to Use Humans as Experimental Subjects

PART I.

DATE October 5, 2005

Title of Study: Pearls of Wisdom: Learning in Distributed Constructionist Cooperatives

Principal Investigator: Mitchel Resnick, Media Laboratory, MIT

Department: Media Laboratory

Room No.: E15-020a

E-mail address: mres@media.mit.edu

Telephone No.: (617) 253-9783

Associated Investigators (name & telephone number):
Robbin Chapman (253-6739)

Collaborating Institution(s), if applicable:
Intel Computer Clubhouse Network

Financial Support:
MIT Media Lab – Lifelong Kindergarten Group

Anticipated Dates of Research:

Start Date: 10/15/05

Estimated Date

of Completion: 05/30/06

Purpose of Study:

The MIT Media Laboratory proposes to conduct a research study of how Pearls of Wisdom (POW), a suite of computational tools, can facilitate the sharing of expertise within a community center of 10-18 year olds. The PoW software supports the creation and dissemination of Pearls, computational artifacts containing how-to project-design information in the form of web pages. These Pearls include specific how-to design information, personal reflections of the author's learning experience, and mechanisms for communication between users of the program. We will examine how using PoW helps the learner express his thought process as part of his design activities. Our goal is to gain a better understanding of how children might learn through the use of technologies that support the sharing of their design skills in a more structured, formal way. We expect this study will influence our designs of future technologies for supporting learning in community settings.

Historically, a hindrance to the knowledge-sharing process has been the difficulties in connecting those with the knowledge to those who need it, particularly when physical or temporal constraints prohibit such sharing. In this study, we will use a technology and educational approach suited to support a community of

young learners. Users can construct Pearl artifacts and in the process enter a cycle of constructing, reflection, and re-constructing which is an essential part of the individual learning experience.

The software developmental cycles of the PoW system will be informed and driven by feedback from study participants. Their ideas for program features will be examined and considered in attempts to extend system capabilities and relevance.

PART II. **EXPERIMENTAL PROTOCOL:**

The Computer Clubhouse Network is a network of after-school technology centers where underserved youth participate in constructionist, project-based learning activities with the support of adult mentors. The Computer Clubhouse was founded in 1993 by The Computer Museum (now part of the Boston Museum of Science) in collaboration with the MIT Media Lab.

The network of Computer Clubhouses is connected via an intranet called the Computer Clubhouse Village, which is accessible only to Clubhouse members and staff with valid passwords. The Village aims to facilitate new types of activities and collaborations, support reflection through discussion of design motivations and processes, and support development of new understandings about technology, youth, learning, and social empowerment. There are now more than 50 Computer Clubhouses worldwide, with 8 in the Boston area. This research project will focus on two or three of the Boston-area Clubhouses.

We will record baseline measurements of the Computer Clubhouse social and learning environment before the introduction of PoW system. Some measures will include the following metrics: 1) member perception of how knowledge-sharing happens at their Computer Clubhouse, 2) the ways members share personal knowledge, and the levels and mechanisms of project design proliferation throughout their Computer Clubhouse, 3) the degree of Computer Clubhouse involvement in individual members' learning process, 4) member perception of their own control over their learning process, 5) the role of member status in the community and what enhances that status, and 6) member perception of their ability to articulate their ideas. These data will be gathered via one-on-one interviews with study participants, on-site observations, and web logs. I will make these measures again at the end of the study for comparison to the baseline. I will also conduct case studies in order to obtain a broader perspective on the impact of the PoW system. I will select at least three case study participants from the Computer Clubhouse community of varying age, gender, and demographic. In particular, we will be examining the impact of knowledge sharing in each of these cases, including: 1) circumstances that encourage knowledge-sharing, 2) motivation to transfer knowledge from project designs to Pearls, 3) member perspective of self-efficacy in the articulation of ideas, 4) relative quality of Pearls and associated community discussion, and 5) the impact of PoW on members' expertise development.

The unique and open-ended learning environment of the Computer Clubhouse makes it particularly suited for this type of study. Participation in the Computer Clubhouse activities is strictly voluntary, as will be participation in our studies. The constructionist-learning model that defines the Computer Clubhouse learning environment is based on research that shows the importance of interpersonal relationships and community in the learning process. We expect that participants will develop reasoning and organizational skills as they play out and realize their ideas in concrete ways.

Collaborators

The Computer Clubhouse Network staff will help us identify the members and adult mentors who will be participating in the study.

Technology Placement

The PoW system will be hosted on the Computer Clubhouse Village intranet, providing each participant with secured access. We will visit several Boston-area Computer Clubhouses to observe and discuss progress over the next six months using PoW. Larger gatherings of all the participants will be held at regular intervals to discuss the process and concerns around constructing Pearls and to obtain further user

interface design input. The participants will be allowed to continue using the Pearls of Wisdom system after the conclusion of the formal study.

PART III.

1. How will subjects be obtained? Number of subjects needed? Age(s) of subjects?

The Intel Computer Clubhouse Network staff will assist us in finding subjects. The applicant pool will be composed of active Boston-area Computer Clubhouse members who have been members at least six months. Participants will be of varying ages, ranging from 10 years to 18 years, for members and over 18 years for mentors. The final number is estimated to be around 10.

2. Will women and minorities be recruited?

Yes, the applicant pool contains significant numbers of minorities since Computer Clubhouses are intended specifically for youth from underserved communities. A significant effort will be made to have an equal distribution of male and female participants.

3. Will subjects receive any payment or other compensation for participation?

No.

4. Will your subjects be studied outside MIT premises?

Yes. As mentioned previously, the latter part of the study will be based at Computer Clubhouses in the Boston area. This will involve the investigators visiting the sites frequently.

5. Will the facilities of the Clinical Research Center be used?

No.

Questions 6 through 8 do not apply to non-biomedical research.

9. Will subjects experience physical pain or stress?

No.

10. Will a questionnaire be used?

Questionnaires may be used at various intervals throughout the study.

11. Are personal interviews involved?

Yes. Extensive one-on-one time will be devoted to observation and discussion of the artifacts that participants create.

12. Will subjects experience psychological stress?

No.

13. Does this study involve planned deception of subjects?

No.

14. Can information acquired through this investigation adversely affect a subject's relationships with other individuals (e.g. employee-supervisor, patient-physician, student- teacher, co-worker, family relationships)?

No.

15. Please explain how subjects' anonymity will be protected, and/or confidentiality of data will be preserved.

Pseudonyms will be used to refer to participants in all logs and reports. All data gathered (video, audio, text notes, photos) will only be used to inform the research. Any documents published or presentations made will reference the subjects through the use of pseudonyms. All materials will be housed at MIT, with no access for the general public.

PART IV.

A. Please summarize the risks to the individual subject, and the benefits, if any; include any possible risk of invasion of privacy, embarrassment or exposure of sensitive or confidential data, and explain how you propose to deal with these risks.

Risks: There are no risks involved to the individual subjects.

Benefits: We expect that individual subjects will experience a new type of interaction with technology and a deeper involvement in their process of design and invention.

B. Detection and reporting of harmful effects: Please describe what follow-up efforts will be made to detect any harm to subjects, and how this Committee will be kept informed.

N/A

Signature of Principal Investigator: _____ DATE: _____

Print Full Name: _____

Signature of Department Head: _____ DATE: _____

Print Full Name: _____

Please return this application with **3 photocopies** to:

Leigh Firm, M.D.
COUHES Chairman
E23-230
253-6787

Definition of Terms

Artifact

An artifact is an artwork or other object created by people. Artifacts created by learners can provide a basis for discussion and reflection on the learning process.

Authentic Design

Authentic design is an activity that engages the learner in creating an artifact within a relevant context or real-world environment. Authentic design situates practice and feedback within realistic scenarios. Cognitive learning theory indicates that the ways in which knowledge, skills, and attitudes are initially learned affect the degree to which these abilities can be used in other contexts. If knowledge, skills, and attitudes are learned in a context of use, they will be more easily applied when needed than if learned out of context.

Cognitive Artifact

Cognitive artifacts are technologies that aid cognition by complementing abilities and strengthening mental powers. Examples are writing, books, and computational tools.

Community

Community can be used in a number of ways to apply to almost any group of individuals. It is often used to describe a geographic group whose members engage in some face-to-face interaction. The term community can also be used in a more meaningful sense to emphasize the common bonds and beliefs that hold people together.

Community of Practice

A community of practice is a group of practitioners involved in a common activity. Communities of practice are defined by the ways people work together, though members may have different roles. Community members enter the community from the periphery and gain status as knowledgeable members through participation.

Constructionism

Constructionism is an educational philosophy recognizing that learners often learn the most when they are engaged in the creative design process. Constructionism emphasizes that learning is a process of active knowledge construction and not of passive knowledge absorption. Constructionism stresses the connection between understanding and experience, particularly with respect to creating and experimenting with objects to learn about abstract concepts. The

term “constructionism” was coined by Seymour Papert, and builds on the ideas about constructivism developed by Piaget.

Constructivism

Constructivism is a school of human learning that sees knowledge as a mental construct. Learners create an image of what the world is like and how it works and they adapt and transform their understanding of new experiences. This theory of learning, developed by psychologist Jean Piaget, has consequences for teaching and learning strategies. By starting where the learners are at, that is, engaging prior knowledge with present learning, an educator can assist learners in building on their understanding of the world.

Cooperative Constructionism

Cooperative Constructionism is a framework that establishes a design approach to reflection with a set of tools and methods that support reflection on learning.

Higher-Order Thinking Skills

Higher-Order Thinking Skills are advanced ways of thinking that go beyond recall and understanding. They are based upon educational psychologist Benjamin Bloom's taxonomy. There are six levels of thinking skills according to Bloom: knowledge, comprehension, application, analysis, synthesis, and evaluation. The higher-order thinking skills are the last four of that list.

Ill-Defined Problems

Ill-defined problems are situations in which there is no clear formulation of the problem to be solved (also called “wicked problems”). Ill-defined problems require that a structure or framework be imposed on the situation before a solution can be found. Design theory suggests that in ill-defined problems, problem definition proceeds in parallel with problem solution. In other words, attempts to solve an ill-defined problem lead to a greater understanding of what the problem really is.

Intentional Fading

Intentional fading permits the user to control the rate and nature of scaffold fading.

Intentional-Reflective Artifact

Intentional-reflective artifacts are projects where learners share their reflections of their design and learning experiences.

Learner Ownership

Learner ownership is a student-centered approach, where young people identify problems, brainstorm, implement solutions and evaluate their projects, while the teacher takes the role of the facilitator.

Lifelong Learning

Lifelong learning is the idea that learning does not end when one leaves school. It is more than "adult education." It is applicable to the educational experience of both children and adults by bringing the child's experience closer to meaningful and personalized work and the adult's experience closer to one of continued growth and exploration.

Metacognition

Metacognition is awareness or knowledge about one's own thinking processes.

Pearls of Wisdom

Pearls of Wisdom is a software program for constructing and sharing intentional-reflective artifacts. The purpose of the Pearls of Wisdom (PoW) software is to scaffold the authoring and sharing of intention-reflective artifacts (IRAs), called Pearls.

Pedagogy

Pedagogy refers to the study of the principles and process of teaching and learning.

Practice

Practice is a view of work that focuses on the tasks workers do, and the understanding needed to do the tasks. The development of new computational tools offers the possibility to change work practice by creating a new distribution of labor between workers, their tools, and their information resources.

Reflection

Reflection describes the process of deriving meaning and knowledge from experience and occurs before, during and after a learning project. Effective reflection engages both teachers and students in a thoughtful and thought-provoking process that consciously connects learning with experience.

Reflective Mentor Model

Reflective Mentor Model is a framework where mentors to engage in their own learning and reflection as part of their ongoing mentor practice with the goal of effectively supporting learner intentional reflection.

Representation

A representation is an explicit expression (e.g., verbal utterance, diagram, computer code) of some idea. People interpret representations within a social context and against their individual background.

Scaffolding

Scaffolding refers to tools that support children while they are in the process of learning new skills or developing new abilities.

Situated Learning

Situated Learning is the idea that the skills and knowledge learned are tied to the situation they were learned in and are difficult to apply in new settings.

Zone of Proximal Development (ZPD)

The Zone of Proximal Development is the distance between a child's current development level for independent problem solving and her level of potential development. That potential is realized with the help and support of a more capable peer. The ZPD provides the theoretical basis for scaffolding. When a learner is at her ZPD for some learning task, the proper scaffold will provide enough "push" for the student to achieve the learning task.