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An Ethnographic Investigation of the Evolving Dynamics of a Learning Ecology

A Dissertation completed in partial satisfaction of the requirements for the degree of

Doctor of Philosophy

in

Cognitive Science

by

Laura Amaya Becvar

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2008



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and form for publication on microfilm:

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**University of California, San Diego**

**2008**



## DEDICATION

*To my sister Katherine M. Becvar, who lent her ear numerous times, as I often attempted to organize my thoughts on the fly during the long journey that is the dissertation writing process.*

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- Becvar, L.A., Poulos, T., Davis, M. "Video Blogging in Dental Hygiene Clinical Training." (for *Journal of Dental Education*)

## ABSTRACT OF THE DISSERTATION

An Ethnographic Investigation of the Evolving Dynamics of a Learning Ecology

by

Laura Amaya Becvar

Doctor of Philosophy in Cognitive Science

University of California, San Diego, 2008

Professor James D. Hollan, Co-Chair

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In the past decade, collaborative technology has become widely integrated into many professional training settings, yet at present we lack a complete understanding of how new technology alters networks of social and technology-mediated interactions present in such environments. Boulos *et al.* (2006) note that many Web 2.0 applications offer many unique and powerful information-sharing features for collaborative clinical practice and learning. However, they point out that much careful thinking and research are still needed in order to find the best ways to leverage these emerging tools to boost teaching and learning efficacy and foster better 'communities of practice' (Wenger 1998).

I have been engaged in a multi-year ethnography-for-design study in a dental hygiene training program in San Diego, CA. In this research project, I performed an ethnographic analysis of instructional practices used in hands-on, clinical instruction, and participated in the design of a new clinical training laboratory. The new lab was equipped with embedded digital media technology, such as flat-panel monitors, computer workstations and overhead cameras, through which students and instructors could access a video blogging ('vlogging') system while in the clinic.

Chapter 2 discusses the field site in more depth, including a detailed account of the negotiation process and my ethical stance towards doing participatory ethnography with an intervention/design component. In Chapter 3, I explore the question of how expert bodies shape the bodies of novices. I look deeply into the special character of what's being learned in hands-on training environments like dental hygiene, and how instructors employ specific discursive practices to help in training the bodies of novices to perceive and act to professional standards

The fourth chapter details the implementation phase of the project, in which I helped design a new clinical training laboratory, equipped with embedded digital media technology, such as flat-panel monitors, computer workstations and overhead cameras. I describe how we implemented a collaboratively built video blog ('vlog') in the fall of 2005. As practitioners adapted to the new technologies and representations that were made available, they transformed their practices. A discussion of how organizational practices shifted makes up Chapter 5. In this chapter, I examine how interactions with videos structured the way students and instructors work with each other in the clinic. In Chapter 6, I investigate some of the organizational factors involved in the appropriation of the new technology implemented in 2005 and 2006.

## Chapter 1. Hands, Expertise, and Ecologies for Learning

Hands are underrated. Eyes are in charge, mind gets all the study, and heads do all the talking. Hands type letters, push mice around, and grip steering wheels, so they are not idle, just unnoticed. (McCullough 1996)

### 1.1. Introduction

Our hands contribute much to our ways of working and knowing in the world. By pointing, pushing and pulling, by picking up tools, our hands act as conduits by which we extend our will to the world. They serve also as conduits in the opposite direction: through hands, we receive knowledge about the world. Hands show life most when they are at work. Hands don't just hold objects: they grasp, pinch, press, guide. In order to lift a car door handle, turn a key in the ignition, and shift gears, we must use a fundamentally different grasp (hook, precision, and chuck, respectively). When we use our hands to apply force they take a different form than when we use them to exercise precision. Hands are versatile also: they give and take pressure, heat, and texture. And for hands that work, taking might be as important as giving – hands get shaped. They may get calluses or develop thick musculature. They are inscribed with scars. Hands gain experience.

Much of what hands know is a kind of knowledge unlike linguistic or symbolic knowledge (excepting the embodied language of interaction like gesture (McNeill 1992) or participation frames (Goodwin 1986)), but something more based on concrete actions, like kneading dough, opening pickle jars, or tying shoelaces. This knowledge is not only physical, but also experiential. Through our hands we can say much more about what we know than we can possibly say in words. Social scientists and psychologists have studied this phenomenon in depth, and have many terms for it: tacit knowledge, enactive knowledge, operative knowledge, knowing-in-action, action-centered skill knowledge.

We can be skillful at anything from a purely mechanical task to a subtle process that takes a lifetime to develop. For example, maybe one can text message very quickly, or play a violin. Maybe one can crochet really well. We often understand 'skill' in terms of our abilities, and for this reason the word has many different meanings; however, to generalize, skill means *the learned ability to do a useful process well*. Some forms of skill have occasioned careful academic study, such as cognitive psychology's detailed study of a kind of hand-eye coordination called tracking – the use of a continuous compensatory feedback

to keep a tool on target, such as in driving, or catching a Frisbee (Schmidt 1998). Similarly, there has been a good deal of research on the skill needed to execute long sequences of discrete events. In contrast, significantly less work has been done on skills that are not so purely behavioral, such as the skills of recognition and appraisal, especially perception mediated through tools. For instance, any mechanic knows the feel of a well-tightened nut and bolt – s/he can recognize the point at which the elasticity of the threads has been fully taken up by the feeling of the screwdriver handle’s ‘recoil’ in his or her palm.

Skill differs from conceptual knowledge (even if it reflects it). Often, concepts come from direct instruction and schooling, but skill is learned by doing. It is abstracted from demonstration and honed by practice. Although skill comes from habitual activity, it is not purely mechanical. This is apparent when we consider that skill can become the basis of a profession. Indeed commitment to skillful practice lies at the heart of traditional concepts of work.

Hands are underrated because their talents are poorly understood. In academia, despite a growing faction interested in embodied knowledge, generally the hands are ignored in epistemological accounts of mind. There are some notable exceptions, say in research on technology for medicine. Surgeons now have access to remote controlled technology to perform surgery thousands of miles away, driving lasers and instruments to do microscale work (Doty 1998). However, even in medicine, researchers seem limited in their ability to formulate much beyond the purely mechanical aspects of manual behavior (see MacKenzie and Iberall 1994).

Furthermore, in many ways manual ability defies explanation, perhaps because it is based not in language but in action (for which we have much poorer representational frames). Moreover, skill develops an intimate relation with certain contexts or tools, which also makes it individual. No two people will be skilled exactly alike.

## **1.2. The Choreography of Experts’ Hands**

Originally, I chose to do ethnographic research in a dental hygiene school because of hands. Intellectually, I’m fascinated by hands - the intricate architecture, the complex structure of tiny bones,

stringy tendons, calloused skin. I love the way hands move: sketching through space as we gesture, articulating micro-movements as we play instruments, darn socks, tie shoelaces.

A few summers ago, when exploring potential dissertation topics, I spent time in the university bookstore poring over medical textbooks. Crouching before shelves in the medical school section, engrossed in the glossy pages detailing hand anatomy, I tried to comprehend how it is that hands move, how they do what they do, and how our brains and nerves execute hand movements. Hands are exquisitely complex, and the kinds of movements they support are myriad. In fact, more of the motor cortex is devoted to hand movements than any other body part (Alexander 1987).

Human hands have a totally unique design when compared to even our genetically most similar relative, the chimpanzee (Wilson 1998). This design affords unique movements. For example, a small modification in the joints of our wrist (flattening of the hamate bone), allows us to roll our thumb into direct opposition with our forefinger. Chimps can only oppose to the side of their index finger. This allows us to grasp and use tools in totally unique ways. This point was perhaps most saliently conveyed to me when I watched video that a primate microethologist had taken, which showed bonobos using sticks as tools. The bonobo used the stick to pull sap out of a ‘termite’ mound at a local zoo exhibit. Though she presented the video segment to illustrate how other primates may exhibit ‘handedness’ (left or right dominance), I could not help but be fascinated by the biodynamic qualities of the bonobo hands. Their manipulation of the stick tool looked like a human who’d had her thumbs taped down. Naively, I had assumed primate hands were primate hands, and they worked the same way. They seem structurally so similar, but there are very subtle distinctions. And apparently just the slightest anatomical difference allows us to have a tremendous advantage in dexterity. Science often attributes the cognitive differences seen between humans and other primates to the structure of brains. But maybe there is something more to these cognitive differences; maybe the architecture of hands, and bodies for that matter, has more to do with it than we now assume.

I’ve done gesture research in the past (Becvar 2005), which has made me somewhat of a seasoned hand watcher. When I was thinking about a possible dissertation topic, I realized I wanted to study more than gesture, but look deeper at the crafting of manual expertise – how the hands learn to act in the world of

a profession. I wanted to better understand how it's possible for surgeons and artists and chefs to attain expertise of movement, the ability to articulate tools with grace and agility. This process is mysterious and elusive to study; it's not solely learned in an explicit way, like mathematical algorithms or spelling words. Rather, it's commonly thought that expert movements are absorbed intuitively, non-verbally. Is this really the case, or is there more at work in the functional context in which expertise develops? It's commonly reported that experts have a difficult time explicating how or why their hands know what they do (Schmidt 1998), but detailed studies of the developmental context of motor skills are few (with notable exceptions (Sudenow 1993; Ericsson 1996)).

If experts can't explain how they do what they do, then how do novices learn? Do some professions rely on a specific set of practices for explicating physical tasks? Professional hands develop in rich contexts. They are shaped by tools, media, and other hands. Of course, hands are shaped by the brain that directs the body they are part of. But also, professional hands are shaped by language, representations, and the actions of others. So how does a profession get into one's hands? What are some of the institutionalized processes that go into the training of hands? Through an ethnographic study of a professional training program where the development of hands is an essential aspect of training, I hoped to begin to understand this process.

As a researcher who believes in the power of ethnographic methods for motivating technology design, I felt it was important to situate my research on professional training technology in a specific domain. My ethnographic quest started out as an investigation of a domain where novice hands begin to grasp the skills of a profession. I chose a dental hygiene training program so that I would have the opportunity to observe the explicit training of highly complex, precision, tool-based manual tasks, accompanied by conceptual learning. I underwent two years of fieldwork, including participatory observation and technology implementation research. In this dissertation, I will describe a learning ecology, the practices in place in this learning ecology, an intervention that I did, and the processes of adaptive change(s) that took place.



### 1.3. Ecologies for Learning

What exactly do I mean by *a learning ecology*? In his article, “Growing Up Digital: How the Web Changes Work, Education, and the Ways People Learn,” Brown (2000a) draws on the metaphor of an ecology to describe an environment for learning. Brown says, “An ecology is basically an open, complex adaptive system comprising elements that are dynamic and interdependent. One of the things that makes an ecology so powerful and adaptable to new contexts is its diversity.” Brown further describes a learning ecology as, “a collection of overlapping communities of interest (virtual), cross-pollinating with each other, constantly evolving, and largely self-organizing.” Brown’s ecology concept requires the creation and delivery of a learning environment that presents a diversity of learning options to the student. This environment offers students with opportunities to receive learning through methods and models that best support their needs, interests, and personal situations.

A learning ecology also supports social learning. Brown and Duguid (2000b) suggest offering technologies for students to form learning teams for collaborative activities, or to self-organize into discussion groups where students can explore learning topics. The ecology also enables people to discuss and share insights within their community of practice. The instructional design and content elements that form a learning ecology are often dynamic and interdependent. The learning environment should enable instructional elements designed as small, highly relevant content objects to be dynamically reorganized into a variety of pedagogical models. This dynamic reorganization of content into different pedagogical models creates a learning system that is adaptable to varying student needs. People learn through a variety of resources and activities. The challenge in developing a learning ecology is to define and create an environment that balances the many resources and methods people may apply to their learning.

Cognitive theory defines knowledge as coming in two “flavors”: explicit knowledge and the tacit knowledge (Schön 1983). The explicit dimension deals with concepts, the “know-whats,” whereas the tacit dimension deals with “know-how.” Know-how is manifested in our work practices and skills. Since tacit knowledge is embodied in action, it comes alive in and through the things we do in the world, and while we are in participation with each other. As a consequence, tacit knowledge is distributed between people in the sense that it is a shared understanding that slowly emerges from working together.

Educators can teach students about an abstract subject matter, for example, chemistry. That is, we can teach them the concepts, conceptual frameworks and facts of chemistry—the explicit knowledge of chemistry. But that does not make the student a chemist. To be a chemist she must also learn the practices of the profession. Learning to be a chemist as opposed to learning about chemistry requires living an experience that begins to create a foundation for the rich interplay between the tacit and the explicit. This interplay is best characterized as "knowing," and it lives in the action of deliberate inquiry where the concepts, heuristics, and algorithms comprising explicit knowledge function as tools for action. Brown (2000a) claims that this is where real expertise lies. Learning to be an expert requires learning the practices of deliberate inquiry of that discipline and how to best utilize the conceptual tools—the explicit—in support of that inquiry. And learning this involves a kind of immersion and enculturation—a way of seeing, interpreting and acting.

The landscape is really little bit more complicated because both tacit knowledge and explicit dimensions of knowledge apply not only to the individual, but also to communities of practice (Lave 1993; Wenger 1998). Much of knowing is brought forth in action, action through participation, participation with the world, participation with the lifeworld of the profession (Goodwin 1994), and participation with other people, i.e., practices. A lot of the knowing comes into being through the practices comprising one's community(s) of practice.

Understanding how intelligence is distributed across a broader matrix of individuals in the world becomes increasingly critical if we want to understand how learning comes from being situated and participating in a community of practice. Learning a profession might be best thought about as becoming enculturated into a community of practice; for instance, a community of physicians, lawyers, writers, pilots, etc. Really, it is this enculturation lies at the heart of learning.

In sum, a learning ecology is an environment that dovetails with how learners learn. An ecology, as an open system, is dynamic and interdependent, diverse, partially self-organizing, adaptive, and fragile.

A dental hygiene school is a special kind of learning ecology. It is a vocational education program, which means that much of what is learned is job-related, practical, and specific to the profession. On the other hand, some of the educational component is conceptual, and is taught in 'formal' settings –

that is, classrooms and lecture-style. However, workplace and professional specifications define the knowledge, skills, and performance students must accomplish to demonstrate proficiency in their professional role. Furthermore, dental hygiene is an institutionalized profession, and students must pass formal licensing exams at both the state and national level. Therefore, individual programs maintain standards of what they teach, so that graduates are well prepared to pass the licensing exams.

The instructional content that supports the role acquisition of ‘dental hygienist’ is maintained by the learning ecology, and is not a property of an individual alone. Here, I will use an anecdote from my experience in collegiate level volleyball to explain what I mean. In my junior year of college, received a good deal of recognition for my volleyball playing at the state and regional level. However, when over the summer, I attempted to try my hand in the beach volleyball scene in California, my performance was unimpressive. I realized that my ability to excel was largely based on context – both the context of players – my team, my setter, especially, who knew exactly where to place the ball so that I could spike it, and the responsive, slick wooden floor of a gymnasium. Though one would think many of the skills might translate from gym to sand, only few did. I had learned to be a star in a particular ecology of artifacts and people, and, to a large degree, I couldn’t “take it with me.” Looking back, even the idea of singling me out was misconceived – really, it was the team that deserved the recognition, as my performance was a resulting product of the team. And what I mean here is subtly different than equating the learning ecology with a community of practice (Wenger 1998), but that the ecology encompasses the entire physical world in which this community is embedded – the tools, the artifacts, the spaces and places that the community inhabits as well.

This dissertation describes a learning ecology of a particular kind – a dental hygiene training program. What makes this an important contribution to cognitive science is that much of what we know about learning and cognition has taken place in highly structured learning environments with peculiar social constraints placed upon them – formal educational environments, classrooms, or laboratories, (the latter being perhaps the most peculiar kind of social framework of all – that of experimental subject and experimentalist). Indeed, cognitive psychology has an empirical foundation, where studies are carried out in experimental situations, and in isolation from all other components included in the learning process.

From the results of these experiments, we are left to infer possible constructs to describe how the human brain works. These are then transferred to the context of an academic learning task, as though the transfer were unproblematic. But the empirical base does little to provide a holistic understanding of student learning in situated context (Laurillard 2002).

#### **1.4. Organization of the Dissertation**

This dissertation is organized as follows: I start out in Chapter 2 discussing the field site in more depth, including a detailed account of the negotiation process and my ethical stance towards doing participatory ethnography with an intervention/design component. In several places throughout the dissertation, I include “portrayals,” which are selections taken directly from my field notebooks.

In Chapter 3, I explore the question of how expert bodies shape the bodies of novices. I look deeply into the special character of what’s being learned in hands-on training environments like dental hygiene, and how instructors employ specific discursive practices to help in training the bodies of novices to perceive and act to professional standards. Members of a profession are highly attuned to specific phenomena in their workplace environment, honing their perception to sense, classify events, and help guide specific actions. For example, consider how oncologists<sup>1</sup> are trained to see mammograms using institutionally organized methods of seeing and interpreting, or experienced golfers can ‘feel’ that a stroke has gone awry long before he sees the ball flying off in an undesirable direction. In “Professional Vision,” Charles Goodwin discusses several important discursive practices that professionals engage in which serve to foreground and categorize phenomena that make up a professional lifeworld (Goodwin 1994). Goodwin notes that new members of a profession are often trained in practical apprenticeships, where experts deploy a set of practices that serve to calibrate the novice’s perception with those of a professional. In Chapter 3, I explore a complementary set of discursive practices that are engaged to scaffold and structure the actions of novices as they learn the tools and practices of a professional domain. By examining videotapes of practical training in a dental hygiene program, I identify three action-scaffolding practices used in interactions between instructors and students. Since perception and action are tightly coupled (Gibson

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<sup>1</sup> See Hartswood *et al.* 2002.

1979; Gibbs 2006), exploring domains where novices are taught to sense and execute institutionally relevant ways of moving their body in synchrony with the tools of the trade provides us with a deeper look into how expert practice develops.

The fourth chapter details the implementation phase of the project, in which I helped design a new clinical training laboratory, equipped with embedded digital media technology, such as flat-panel monitors, computer workstations and overhead cameras. In this chapter, I detail the ethnographic motivations for the design of new technology integrated into the teaching clinic. I describe how we implemented a collaboratively built video blog ('vlog') in the fall of 2005. In this chapter, I describe how the digital video records made available to on the class vlog were used by students and faculty, using data obtained from field notes, interview transcripts, server access logs, and web surveys.

As practitioners adapted to the new technologies and representations that were made available, they transformed their practices, and the social and cognitive networks shifted. A discussion of how practices changed after the video blogging technology was appropriated makes up Chapter 5. Though digital technology has become widely integrated into many professional training settings, at present we lack a detailed understanding of how new technology alters networks of social and technology-mediated interactions present in such environments. In this chapter, I examine how interactions with videos structured the way students and instructors work with each other in the clinic. The findings from this research project provide a deeper understanding of how social and educational processes engaged in a hands-on training program for clinical instruction in dental hygiene changed when a video blogging system was integrated.

As a new kind of mediation enters into a learning ecology, a perturbation occurs. Sometimes, that perturbation is disruptive, and carries political consequences. Negotiations take place, and this eventually leads to a transformation, and "settling" back down to a state of "lower energy." That was what I observed in my research, and this political perturbation and negotiation process is described in Chapter 6. I investigate some of the factors involved in the appropriation of new video blogging technology implemented in 2005 and 2006 in the clinical instruction laboratory of a dental hygiene training program at a local community college. The work's analysis will contribute to the discussion about the impact of social

processes on the perception of usefulness of a technology, which affects the technology's acceptance and future appropriation.

## **Chapter 2. Field Site: A Clinical Training Laboratory for Instruction in Dental Hygiene Skills**

### **2.1. Negotiating an Ethnographic Identity**

In classic ‘how-to’s describing ethnographic methods, one of the early stages of doing ethnography is the stage of ‘negotiating a field site.’ Certainly, immersing oneself in the field is an important prerequisite for doing good ethnography, and this requires a certain degree of willingness on the part of the field site members. Somehow, the ethnographer has to convince field members that their participation is a good idea – mutually beneficial, or in the least, not going to detract from the ongoing work or life practices of the community.

I rarely come across particularly thorough descriptions of how to successfully navigate the choppy waters of field site negotiations. This process is especially underrepresented in the design literature. I suppose as dependent as it is on tacit interpersonal skills, it may not be something that is typically found in academic writings. Frankly, what I’ve learned about the particular challenges of this process is informal and anecdotal: accounts from my dissertation committee members, professors, and other students. I wanted to discuss a bit of my unique process, and some of the challenges (and mistakes) I made along the way.

I will begin some of the practical reasons behind why I decided on dental hygiene as a field site; or rather, I should say, why I arrived on this particular dental hygiene training program as a good field site to work along with. My aunt is a practicing clinical dental hygienist, and also works part-time as a faculty member a local community college’s dental hygiene training program. One Saturday morning when we had planned to hike together, she also invited a fellow instructor to join us. On the route, the two of them began to informally discuss some of the problems they’d been having with students. At first, I attended to their conversation only peripherally, but then I got intrigued as I heard them commenting on the detailed manual and conceptual challenges that particular students faced.

Until that moment, I had many preconceptions about what a dental hygienist actually does, and how they learn to do what they do. What I began to realize is that the set of manual skills a learner must

acquire to perform professionally is quite elegant and complex. Dental hygiene skills are choreographed explicitly, based on constraints spelled out by ergonomics (how to move the body in ways to prevent repetitive stress injury), biomechanics (how to move the body in the most efficient manner to generate force, spelled out by physical principles, or to allow for maximal tactile perception). As my aunt and her friend continued to talk, I asked a few general questions about the process of instruction in the school, and grew more convinced that this site would allow me the opportunity to study a special kind of situated learning process that has not been well documented in the past.

A few months later, I approached the director of the hygiene program about whether the school would be willing to participate in my ethnographic research, which would involve at least two years of fieldwork. Given my aunt's connection and advocacy, I came in with the director having a good deal of trust. I feel it is important to be clear about how I leveraged this relationship to establish rapport from the beginning of the negotiation process, especially because the identity of "Peggy's niece" has been an important part of who I was to the school throughout my fieldwork. With the director, I also discussed my desire to implement some kind of technological intervention, and study its effects on learning. Here I relied upon the director's apparent desire to keep her program "cutting-edge" and competitive as compared to other dental hygiene programs nationwide to get buy-in for the project.

I don't think it's easy to establish trust in a field site. Ed Hutchins has shared several humorous stories with me about how Naval officers at one of his field sites created all kinds of stories about who he was, and why he was there, tinged with paranoia. It's easy to understand why field members would be distrustful of someone unknown who is there to watch them. *What are you doing here? What will you do with the notes you write down, and the videotapes you collect? Why should I help you out by giving you my time?* were all important questions I tried to preemptively answer as I entered the site.

The first contact I had with the faculty, aside from a few individual meetings, was in the late summer of 2004, at a faculty summit where they were making final decisions about the upcoming school year. I was invited to come in and make a 20-minute presentation to the faculty about my ideas and what I hoped to do.



The first contact I had with the students was during the orientation week. During a lecture geared towards safety and the basics of working in the clinical laboratory, I was invited to speak during the final ten minutes, introduce myself, explain what I would be doing, and hand out the Human Subjects forms soliciting an agreement for voluntary participation. As I introduced myself, I explained that I was a student like them, and I was very interested in how would be learning to do what they do. I also explained that by participating in the study, they could help future generations of students, because what I found out would be used to design educational technology. Finally, I described what participation would involve. At the end, I had only one student decline participation – she did not want to be interviewed and take time away from study.

### **2.1.1. Negotiating an Ethnographic Identity – Ethical Tensions**

To some degree, any time we enter a community, we enter a process of identity negotiation. But, negotiating an identity as an ethnographer is a special kind of challenge. By its very nature, the identity of an ethnographer is marginal. There are rarely preordained roles for ‘ethnographers’ in communities, and misconceptions and suspicions about what one is doing and why abound. In the dental hygiene clinic, for instance, I frequently found myself caught between motivations. Should I be an active member of the field site community, shaping the course of events, or should I be a passive observer, carefully recording ‘naturalistic’ events? To a large degree, the design of my research was interventionist: I perturbed a system and watched how it ‘settled.’ But how much do I get involved in this ‘settling’ process? What is my ethical responsibility? Granted, the kind of ethical dilemmas I’m referring to here are not as charged as, perhaps, infant neglect in Brazil<sup>2</sup>, but nonetheless, they highlight a conundrum I felt trapped in quite frequently, especially in the early part of my research. What is my role and responsibility as an ethnographer?

I found it a challenge in the first few months I was at the school. Part of the issue was that I was simultaneously, and neither, a student and an instructor. For instance, during my first week in the school, I was encouraged to take a quiz with the other students by the head instructor, “just to see how I would do.”

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<sup>2</sup> See Scheper-Hughes, N. 1993, *Death Without Weeping*.

She later reported to the program director that she was “delighted” that I had scored 95%. That same week, as I floated around the clinical laboratory making observations, I had a couple faculty members ask me my advice about how they could be better teachers, as though I were an expert on education and cognition. Within the community of the dental hygiene school, I was quickly taking on a role of a ‘learning technology advisor,’ whose role it is to spend time observing in the clinical laboratory, studying teaching practices, and making recommendations for its improvement. Is this really my job, to make the program better if I can? I feel strongly compelled to do so, though a tension exists.

Within the academic discipline of cognitive science, the outcome of my research will help “advance basic science.” The product of this work is primarily textual: academic publications on the nature of communication and instruction in hands-on learning environments, and an analysis of the learning outcomes using new forms of technology. This work will benefit other academics who are interested in learning, cognitive science, and technology. Doing this research requires that I uphold a certain set of methodological standards. Empirical science makes a big commitment to controlled experimentation; that is, trying to minimize the impact of the observer on the observed. I have been criticized before in my research for “affecting the outcome of events” by my presence and “interference” during recording. Therefore, in order to speak to these audiences, I should minimize my involvement in the field site community.

However, as Elizabeth Enslin (1994) points out in an article about the limitations of ethnography, academic disciplines that study culture are often “heavily dominated by textual analysis and criticism, [and] calls for practical action and relevant often appear naïve.” Enslin demands that call for action ethnographies that are driven towards praxis in the culture of study, and not merely directed towards “textual strategies of representation” written for Western academics. Ultimately, I decided to use what Kember (2000) calls an “action research approach,” in which the use of new learning technology is studied in a real-world context. This research approach differs from some traditional ethnographic methods that emphasize observation and strive to achieve minimal involvement in the ethnographic domain (Hammersley 1998). Ethnography has often characterized itself as “non-interventionist,” insisting that its inquiries be conducted in a non-disruptive and non-interventionist manner, but these are principles that

cannot be realized given that much of the motivation for contextual design methods are to reorganize work. In this case, the methodology includes actively shaping the environment of study through the implementation of new teaching technologies, while still maintaining the ecological validity of studying a functional naturalistic learning environment where participants are engaged in meaningful work. By analyzing the use of new technology in detail, we can begin building theoretical constructs grounded in qualitative data (Glaser and Strauss 1967).

Because I found myself driven towards action in the dental hygiene school community, I felt compelled to justify my presence in a way such that the community understands its significance and value. From the start, I presented myself in this way: to the program director, clinical instructors, and students. As I said before, on the consent form for research subjects, I included the following statement:

This study will help researchers learn more about how expertise develops through hands-on learning activities, and will affect the design of new teaching technology, which can be beneficial to both your and other dental hygiene programs in the future.

I reasoned that by presenting myself as committed to similar objectives as the community, its members could see an immediate, tangible benefit to participation in the research study. In my formal and informal interactions with community members, I attempted to further demystify my motivations in completing this research study using terms that I believed they could understand. As a human being, I have a set of perceptual apparatuses that afford me the ability to detect tacit social cues and to derive understanding of when people are openly accepting me, or are wary of my presence, and reluctant to interact. I have an aptitude for social interaction that I enjoy using in fieldwork. Furthermore I believe that in learning to interact and participate in a domain, I can develop an understanding of the way that a community is structured that I could not by passively observing. Interaction is a form of experimentation – trying out what you think you have learned about a social group. You try out your current understandings and see if you get the result you'd anticipated (for instance, see Emerson *et al.* 1995). One might get uncomfortable blank stares when one had intended to get a laugh, but in the surprising result, you've learned something new.

During the first phase of my research, I felt pulled in multiple directions. I was simultaneously trying to learn the skills needed to perform as a hygienist, while trying to learn about the discursive

practices that instructors use in teaching students to execute motor tasks (while also learning in real time how to do good ethnography). One particular instance related to the tension I felt in negotiating an identity stands out. I include it not as a representative case (though, to be perfectly honest, a few other ‘tense’ moments or ‘learning mistakes’ in my ethnographic method did happen), but as an example of a striking opportunity for me to learn where to draw the boundary in my ethnographic sympathies. This was a case where my desire to act or help went too far, and had an unexpected, and ultimately undesirable consequence.

### **2.1.2. Portrayal 2.1: 10/12/2004**

*This morning I sat with a student who I'd developed a close rapport with, Charlotte<sup>3</sup>. Charlotte has hands that are small and quick, with warm golden freckles. She has hands that like to do a good job, and try very hard to do so. During this session, Charlotte was obviously struggling with learning how to operate an instrument called the universal curette, a complexly designed instrument used for scaling tartar beneath the gum level. Part of what makes the curette so challenging to learn is that it is up to the operator to angle the shank and blade of the instrument at the optimal scaling angle of 70 degrees. Other simpler instruments have this property “built in,” so that simply holding the instrument parallel with the axis of the tooth aligns it optimally. It's not easy for students to make that perceptual judgment of 70 degrees, especially in a complex three-dimensional space. Not to mention activating the instrument in a powerful scaling stroke while maintaining that optimal angle through the movement.*

*As I approached her, I noticed that Charlotte's hands were visibly agitated, fumbling around, and she seemed frustrated. She looked up as I came over, then leaned her torso back in her chair to see around me. “Is Professor Pauling coming this way soon?” she asked.*

*“I'm not sure, but I think she'll probably hit you last.” Charlotte was in the workstation at the end of the row.*

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<sup>3</sup> All names used in this dissertation are pseudonyms. While research participants did sign a confidentiality agreement to allow the use of audio, video, and textual materials containing information about them, because of the nature of some of the data, I felt it was important to make every attempt to preserve the confidentiality of participants. However, in some cases, it was necessary to identify the position of the participant within the hierarchy of the program in order to discuss some of the factors at play.

*“What’s going on?” I inquired.*

*She sighed. “I can’t get this instrument to make the noise<sup>4</sup>.”*

*“The universal?” I asked.*

*“Yeah, it’s just really hard. It’s different than the sickle. I feel like I’m just scraping up my typodont<sup>5</sup>.”*

*“Oh,” I said. Having just come from observing other one-on-one student-instructor interactions, I thought to offer her what suggestions I had gleaned.*

*“Maybe try to get up higher on your fulcrum finger.” I pointed to her ring finger and rotated my wrist clockwise, indicating a more vertical orientation. She made a small adjustment to her configuration, but still fumbled around, and still wasn’t able to engage the instrument against the molded teeth of her dental model.*

*“How about if you try to hold the handle more vertically, like this,” I reached over and gently grasped the handle of her instrument, moving it more perpendicularly to the surface of the tooth.*

*Charlotte paused. “Yeah, I can’t really figure out how to hold it like that and still make the noise.” I figured she meant that she was having a hard time achieving the leverage force she needed to scale.*

*“Well, if you kept your middle finger stacked on top of your fulcrum finger, you would have more leverage against the tooth.” I pointed to the small triangular sliver of space between her ring and middle finger that I had learned should not be there.*

*Charlotte made the adjustment, but the finger soon slipped back down out of position as she focused her attention on the tiny, sharp instrument tip. Her movements again became more agitated, and I winced as I saw the curette work against the rubber gums of the dental model. I was glad it wasn’t a live patient that Charlotte was learning to work on.*

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<sup>4</sup> By “the noise,” Charlotte is referring to a particular kind of scraping sound that an instrument makes when it is drawn against a tooth at the correct angulation to remove tartar. Instructors refer to “the noise” as a notable auditory cue that students should achieve in order to recognize that they are angling their instrument blade correctly. I discuss this phenomenon further in Chapter 2.

<sup>5</sup> ‘Typodont’ is what the community calls the mouth models that students practice on.

*I sat there feeling awkward, observing Charlotte grow progressively more frustrated. At one point I stood up and looked for the instructor, who was still making “rounds” with other students in their workstations. When I sat back down, Charlotte looked at me and paused. Exasperatedly, she said, “You think after practicing for so long I’d actually improve.”*

*“I’m sorry, I really don’t know what to tell you. I wish I could help. Maybe you can go watch Professor Pauling working with one of the other students.”*

*She took the curette and went over to the adjacent workstation, where Professor Pauling was working with another student, Deana. As Professor Pauling praised Deana on her grasp and operation of the instrument, Charlotte mimicked Deana’s stroke in the air in front of her. After a few minutes, Charlotte returned to her own workstation, but was still unable to engage the curette. She muddled around, quite agitated. I felt even worse as I realized that my intervention had accomplished the opposite of what I’d intended: instead of giving Charlotte ‘vicarious’ instruction, it appeared to emphasize to Charlotte that she wasn’t performing as well as some of the other students.*

*I continued to sit observing Charlotte, conscious of my presence, but not wanting to abandon the situation. Finally, Professor Pauling came over, and sat down in a chair facing Charlotte. Just then, Charlotte’s head dropped, and she burst into tears: “I just can’t seem to get this right,” she said. I felt like I was a party to something I shouldn’t be, like a guest witnessing a tense family argument. Professor Pauling patted her hand. Finding her student so emotionally worked up that she was impossible to instruct, she sent her on a break.*

*Had my involvement contributed to this frustrated learning experience? Was it because of my lack of knowledge, my desire to interfere, when I should have maintained distance? Though throughout my life I have been an educator, I’m not a dental hygienist, and I shouldn’t use my status as an educational researcher as a mask for an instructor. Or I wonder if part of Charlotte’s frustration came in part from being observed and failing to progress according to an ideal student model.*

*And most importantly, what had been accomplished if by the time the instructor approached her, Charlotte was worked into such an emotional frenzy that she was unable to accept help?*

*If I truly believe in models of education that claim we learn most powerfully by doing, then I should understand my own learning process this way too. Inevitably, as ethnographers, we make “mistakes,” which allow us to establish our methodological practices. Interviewing is largely an improvisational activity, and sometimes we say too much, ask leading questions, fail to comprehend or interpret a subject’s response appropriately, etc. In this case, I established a stance of being too involved, when stepping back and being clear with Charlotte about what I could and couldn’t do for her would have been a more appropriate tack. This was a powerful learning experience for me and helped guide my future interactions with students.*

## **2.2. Field Site Background: Practical Training**

The focal point of this research study was an introductory course in basic instrumentation skills that entering students in the dental hygiene program must take during their first semester. This course has two weekly meetings that last for three hours, and is held in a clinical laboratory. The introductory course comprised the focus of the study for a variety of reasons. This is the first time that students begin to work with their hands and bodies learning dental hygiene instrumentation. This is a significant time in a student’s development because they lay down a foundation for all their clinical skills. Moreover, students experience a dramatic learning curve during this early training period, for instance, learning to grasp, position, and activate several instruments in just a few months. Such large-scale developments may be much easier to observe and document using non-invasive ethnographic methods like video recording than subtle refinements at the higher stages of learning. Furthermore, students in the introductory course practice instrumentation skills on mannequin mouth models, not live patients. Because of patient privacy and human subjects concerns, videotaping at the early stage of training is much less involved.

The curriculum of the ‘Introduction to Clinical Skills’ course includes a set of basic practical skills for dental hygiene. The course syllabus for the semester is shown in Table 1. Initially, students learn how to position themselves and their patient during practice, and how to make adjustments to the dental unit chair and lamp to best access and illuminate the work area. Primarily, students spend the majority of their time and energy focused on learning how properly to employ the basic set of dental instruments (24 total)

used in patient assessment and cleaning procedures. Students practice basic instrumentation skills on a mouth model, which has realistic teeth and roots (with enamel and artificial tartar deposits), and rubber gums exhibiting varying degrees of periodontal disease.

**Table 1.** Course Syllabus for Introduction to Clinical Practice in Dental Hygiene.

Week	Topics Covered
1	Introduction/Positioning
2	Instrument Parts, Grasp
3	Activation, Pivot, Handle Roll
4	Periodontal Probe/Explorer
5	Periodontal Probe/Explorer
6	Principles of Scaling/Sickle Scalars
7	Sickle Scalars/Medical History
8	Sickle Scalars
9	Universal Curette
10	Universal Curette
11	Gracey Curettes
12	Gracey Curettes
13	Polishing/Compressed Air
14	Hoes, Chisels, Files
15	Review
16	Prep for Partner Care
17	Partner Care
18	Partner Care

Students receive hands-on training in instrumentation skills in the clinical teaching laboratory, a large room containing 18 functional dental chairs and workstations. Students are individually assigned a chair and workstation to use during clinical lab for the entire semester. Workstations are designed to simulate those found in typical dental offices. A diagram of a prototypical operator workstation is shown in Figure 1a. Each workstation is equipped with: a counter space with sink, a hydraulically operated patient chair, a dental unit lamp (mounted above chair on swinging arm), an instrument tray (mounted beside chair on swinging arm), operator stool, station with polisher, air, and water nozzles, and mannequin mouth models that attach to the chair via adjustable mounts. The mouth models can be rotated and positioned into a variety of configurations, simulating the degrees of freedom of the human head and neck (Figure 1b).



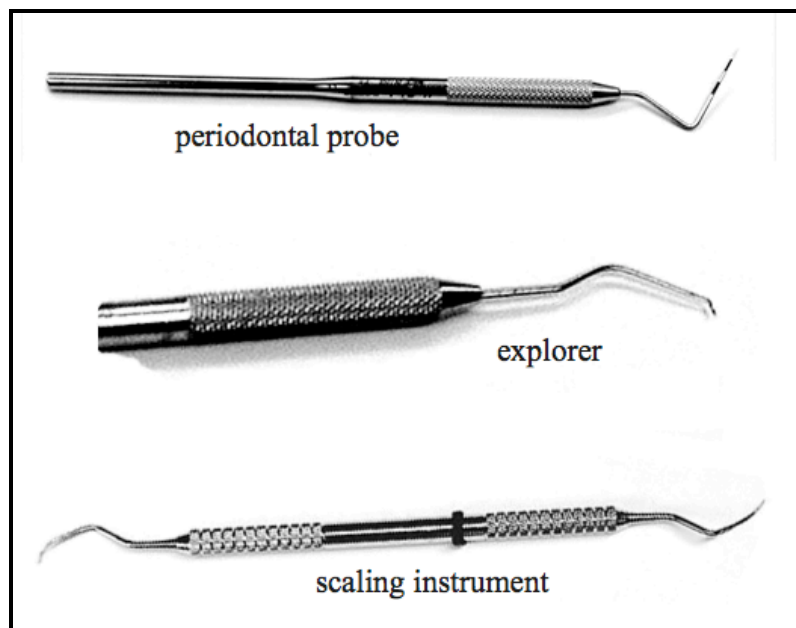


**Figure 1a and b.** (Left) operatory workstation in the dental hygiene clinical laboratory. (Right) mannequin mouth model attached to patient chair via adjustable mount.

There are approximately 18 students in each laboratory section (and two sections total in the program). In a section, students are assigned to one of three small workgroups of six students each. Each workgroup works with an individual clinical instructor. Clinical instructors are all registered dental hygienists, but have varying levels of training in pedagogical practice.

### **2.3. Periodontal Instrumentation**

Dental hygienists are trained in two general sets of skills: detection and intervention. They first learn how to use periodontal instruments to detect calculus (conventionally known as tartar), cavities, and gum disease. Secondly, they learn how to remove calculus from the teeth. Figure 2 below shows photographs of some of the basic periodontal instruments that students learn how to use.



**Figure 2.** Basic periodontal instruments.

### 2.3.1. Detection

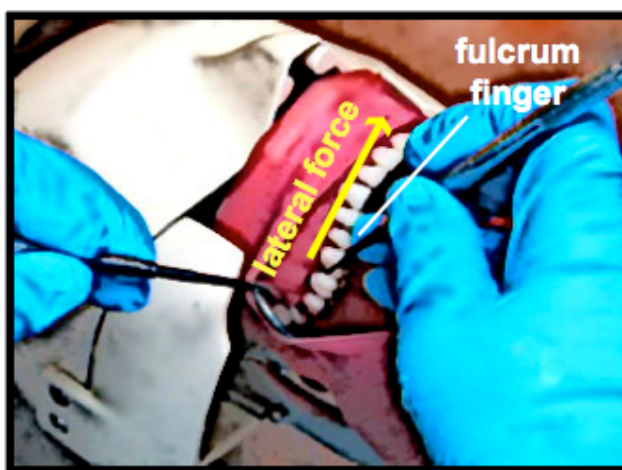
Detection is accomplished through two primary instruments – probes and explorers (see Figure 2). Probes are thin, graded cylindrical rods used to measure the depth of periodontal pockets in order to diagnose gum health. Explorers are light instruments with thin working ends, curved to fit the tooth as they are drawn across the surface of the enamel. Areas with calculus deposits cause minor vibrations in the tip of the explorer, which are translated to the hand of the operator. Practitioners make note of these areas, later going in with scaling instruments to remove the calculus.

### 2.3.2. Scaling

Removing calculus deposits from the enamel of teeth is called *scaling*. To execute this removal, hygienists have at hand numerous periodontal scaling instruments that are each designed to access different regions of the mouth (for an example of a scaling instrument, see Figure 2). The choice of instrument is based upon the specific area a deposit is located. Different periodontal instruments position the blade of the instrument at different angles and bends to assist the hygienist in accessing a particular location. In this way, the instruments are specifically designed to work along with the biomechanical potential of the

hygienist's upper body anatomy in order to efficiently deliver a force along the blade sufficient to remove calculus.

Scaling calculus is fastidious precision work. Hygienists apply a small, sharp blade to miniscule surfaces, they must precisely position the angle of the instrument blade, and they must apply a horizontal leverage force against the tooth surface (i.e. against the calculus deposit) that is large enough to be effective without damage to a patient's oral anatomy (see Figure 3). The power of the stroke comes from engaging the entire wrist and forearm as a unit, pivoting off the ring finger, which serves as a fulcrum. This action requires learning a complex set of fine motor patterns (subtly different for different types of instruments), learning to recognize key spatial relationships between instrument and tooth, and developing a conceptual understanding of the physical principles behind scaling.



**Figure 3.** Periodontal Scaling

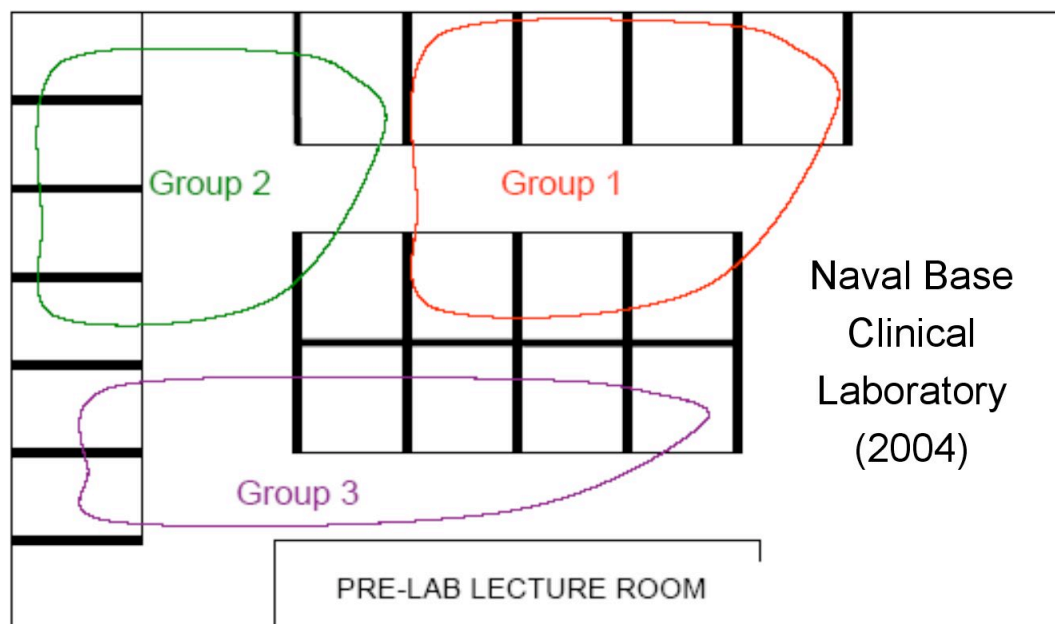
### **2.3.3. Proficiencies**

Much of the course is geared toward *proficiencies*, which are practical exams given in the clinic. Students are expected to pass 18 proficiencies on clinical concepts and instrument use during the course of the semester and before beginning to practice hygiene skills on live patients. Proficiencies are held as one-on-one sessions between workgroup instructors and students, typically lasting for 10-15 minutes. During the proficiency, a student is asked to verbalize various concepts, such as how an instrument is used, what it is used for, or what certain technical terms mean. Then, the student demonstrates how to use an instrument

on specific regions of the mouth, guided by the instructor. After this, the instructor critiques the student's performance verbally and by manually demonstrating refinements. Students have three opportunities to achieve a passing score (at least 75%) on each proficiency, and must pass them all to progress through the course, and earn approval in the last few weeks to begin practicing with live patients (fellow students).

### 2.3.4. Floorplan of Clinical Laboratory

During 2004, the dental hygiene program did not yet have a clinical laboratory space on campus. The program was initiated in 2002, and was still in its infancy. Construction was underway on a higher education center, but would not be complete until 2005. In order to have access to a training facility, the college made an agreement with a nearby naval base, which had a dental teaching laboratory. The Introduction to Clinical Skills course was taught at the naval base. Figure 4 shows the floor plan of the clinical laboratory at the naval base. Note that each operatory workstation is located in a separate cubicle with 4-foot high walls separating each (open on one side). The floor plan also shows how the student groups were subdivided.



**Figure 4.** Floor plan of the clinical laboratory located on the naval base. Individual operatory workstations are designated as boxes. The locations of student groups are also shown.

In spring of 2005, the new clinical laboratory was completed. Figure 5 is a sketch scanned from my fieldnotes, which shows the basic floor plan of the clinical laboratory space at the higher education center (HEC). One of the main design differences between the two layouts is that in the HEC space, all of the operatory workstations are open – there are no walls separating them. While this difference is certainly non-trivial<sup>6</sup>, it was not a large focus of analysis in this dissertation.

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<sup>6</sup> Below is a segment from an interview done with the head instructor of the program in late 2005. After teaching for the first time in the new space, she commented a bit on her impressions of the experience. HI is the Head Instructor of the introduction to clinical practice course, and I am AB.

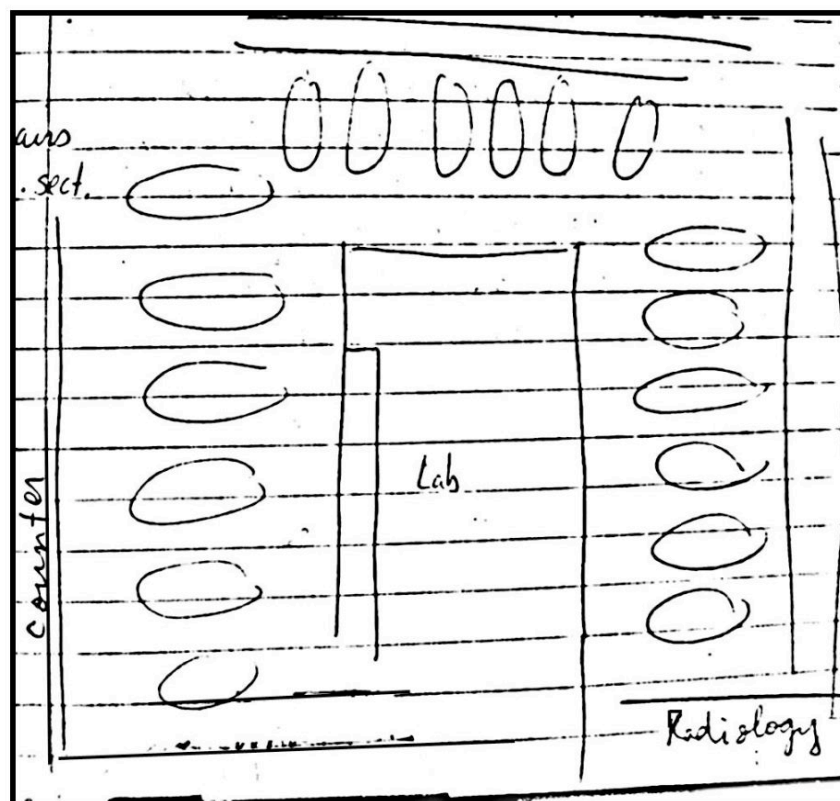
**HI:** I thought being in the new um (0.5) clinical space, you know it was more open, in some ways that was good and in some ways that was bad: but I thought it was really nice because you had an overall look at what everyone was doing. You, instead of, we had separate cubicles before,

**AB:** Uh huh.

**HI:** And that kinda kept you from being able to see everybody at the same time, or kinda look over and see people, so in that concept that was good, I liked that, you could look over the group and see everyone. And bring everyone together, an'--

**AB:** oh, okay,

**HI:** and answer questions without having to go, you know a little bit further over with them. They had, er I thought they had a little bit better access to us as faculty, also, in this space.



**Figure 5.** Floor plan showing the new clinical laboratory space at the Higher Education Center. Individual operatory chairs are shown as ovals. The three student groups are divided six on a side.

One of the major differences I noticed between the two sites was that the movement between activity groupings (e.g. from solo to practicing with a partner) was much more fluid in the newer, more open space. Moreover, peripheral participation (e.g. listening in while a neighboring student receives one-on-one instruction) was more easily facilitated in the newer clinical laboratory.

#### 2.4. Research Methods: A Day in the Life

In order to give a better idea of my research methods and how I conducted myself in the field, I will describe a typical “day-in-the-life” that I would encounter as a researcher. I would typically arrive on the junior college campus at 7:30AM, a half-hour before the morning’s clinical session began (it ran from 8-11AM on Tuesdays and Thursdays) in order to set up camera equipment, review my field notes<sup>7</sup> from the

<sup>7</sup> I kept my field notes in a wide ruled composition notebook, a format I have had more success with than electronic analogues like Tablet PCs or PDAs. My field notes often consist of observations, bits of dialog,

previous session, and briefly consult with the instructors about the plan for the day's session. I rotated between the three clinical instructors, focusing on one instructor and her student group per session, which allowed me to collect more in-depth data than by trying to film and get an overview of the entire class. So, during the pre-session time, I would confer with the instructor that I would be "spotlighting," letting her that I would be observing her group, and discussing any times she'd prefer for the camera to be off, etc.

Each clinic session began with a briefing in which the head instructor gathered all students and went over the plan for the day's session. For example, she might announce which instrument(s) would be taught on that day, if a practical exam were to be administered, and what assignments were coming due. She might hand out photocopied notes or worksheets (which very often she would make an extra copy for me to add to my notes). I would observe the briefing and take notes in order to get a good idea of what material would be covered during the session, and the kinds of activities students would be expected to perform. Based upon her outline of the day's activities, I would create a plan for collecting field data. For instance, if an instrument were going to be demonstrated on that day, I would decide on a student group and instructor to shadow, and begin the process of setting up my video equipment. On the other hand, if the day's session was going to consist of practical exams, I might opt to take fieldnotes, or do individual interviews, so as not to disrupt those students being examined (I did not video record practical examinations, as per the request of field members).

Following the briefing, groups would split off and gather around their group instructor. Sometimes, the individual instructor for a group would demonstrate how to use a particular instrument. Sometimes, she would assign activities to the group, like working with a partner various instruments, or following along with an exercise in the textbook. I frequently videotaped the group demonstration activity, holding the video camera in my hands. Within the frame, I sought to capture a sense of who was present in the interaction, how the participants were arrayed around the instructor, and sometimes, when a linguistic or visual cue uttered by the instructor indicated a detailed focus (e.g. "Look at how the tip of the instrument

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diagrams, cartoons, taped in pieces of scrap paper and class materials, video time codes, etc. The paper-based format of the notebook has many advantages, such as the ability to support multimedia information (diagram and text labels, for instance); it is lightweight and easy to navigate through by date. I often transcribe my handwritten notes into typed text and scanned images, which has the additional advantage of getting me to thoroughly review my field notes.

is oriented relative to the tooth), I would zoom the frame of the camera, which allowed me to capture the fine-grained details of scaling, such as the angle and orientation of the blade of the instrument against the tooth of the mouth model. Unfortunately, this also meant that other aspects of the scene not captured in the frame went unobserved – and I could not even observe them ‘with the naked eye’ because I was actively involved in filming. When I did not actively videotape the group demonstration I would instead take notes, which sometimes allowed me to get a sense of the overall group better than when my sight was confined to the frame of the camera. Here I was interested in how the instructor constructed gestural and verbal descriptions of the scaling activity, such as coded terms, metaphors, and what aspects of the action were foregrounded.

I was also very interested in filming instances where the instructor worked one-on-one with individual students. Again, I attempted to capture the embodied interactions that took place between student and instructor – how the instructor would lay her hands over a student’s and physically reposition the student’s hand, for instance. I made every attempt to capture the entirety of an interaction between student and instructor so that I might potentially observe and record the evolution of a term, description, or student’s progress.

Finally, I filmed many instances of partner activity – where two novices worked together at a single workstation. I hoped that this data would enable me to get a sense of when students use gesture or codified terms in order to describe potential questions to each other or conceptual understanding of scaling activity. I also wanted to see when and what external resources they might draw upon, such as their notes, textbook, or instructors.

At the end of the class session, I often had the opportunity to interview faculty about particular things that had gone on during the class session. The schedule allowed for a two-hour lunch break between the morning and afternoon class sessions, and I was often able to spend a portion of this time talking with faculty. I also often discussed the video blogging system we were in the process of designing, prototyping, or using regularly (depending on when in the course of the study we are talking about). I also used the lunch break time to go back to my vehicle or another quiet place and write up additional field notes. I



would switch out my videocassette and be preparing my equipment by 12:45PM, fifteen minutes before the next class would begin.

In the evening, when I arrived home I went through the process of transcribing my notes from written to typed text. This gave me another opportunity to revisit the notes and add “thicker descriptions; for instance, adding additional thoughts and reflections to what I had recorded in the field.

### **Chapter 3. Professional Perception and Expert Action: Embodied Practices in Clinical Instruction**

"The eye was developed to act. Perception, when it's working, is an action; it's not a passive experience. To experience the world, we must act on it; we must be active."  
-- from an interview with Bonnie Bainbridge Cohen 1993

#### **3.1. Introduction**

In instructional settings where practical training takes place, the body plays an important communicative role. As instructors use 'modeling,' 'demonstration,' and 'guidance,' they must coordinate multiple representational streams: auditory, visual, kinesthetic, and artifactually-mediated. This investigation focuses on interaction in an activity rich and cognitively complex setting - the clinical training laboratory of a dental hygiene program. Studying training-in-progress reveals how novices are taught to see their professional lifeworld and move and act within it. Novices often become competent practitioners 'embodied apprenticeships' (Goodwin 1995), where they develop the perspective, perception, and physical skills of experts. From vocational education to neurosurgery residencies, this type of apprenticeship training is characteristic of how many people are acculturated to a profession. Therefore, studying how the body participates in such training processes is vital to understanding an important aspect of human activity. Indeed, LeBaron and Streeck (2000) point out that such practical and collaborative settings are more foundational and characteristic of human activity for studying complex multimodal interaction than the purely symbolic realms of conversation or narrative monologue (as is the case with McNeill's experimental paradigm (see McNeill 1992)).

Human activity and interaction is accomplished through a variety of means -- spoken, visual and kinesthetic. Often, what is considered to be the primary mode of communication -- speech -- is inseparably reliant upon the material environment and the bodily conduct of participants in order to make sense. Understanding utterances requires coordinating these multimodal streams. Gesture often co-occurs with speech, and conversational turns are coordinated with the participation frameworks of the participants (for example Goodwin 1986). People, while engaged in conversation, point, refer to and invoke objects in gesture; they use tools, artifacts and technologies; and rely upon the immediate environment for sensemaking (for example Heath and Hindmarsh 2000). Touch and bodily contact is also a significant

form of interaction, heavily structured by cultural influences and expectations of behavior. Surprisingly, while so clearly a part of our human communicative experience, tactile contact is rarely alluded to or examined in accounts of human interaction.

In recent years, a fertile vein of research has begun to explore how the body and material environment feature in human cognition, action, and interaction. Of relevance are naturalistic studies of work, interaction and technology, in settings like airline flight decks, scientific laboratories, and control rooms (Hutchins 1997; Goodwin 1995; Heath and Hindmarsh 2000; Becvar *et al.* 2005; Alac 2003). These studies suggest that cognition is a process that occurs when the body engages the physical, cultural world, and thus, should be studied in terms of the dynamical interactions between people and the environment. This is not to say that the brain does not play an integral role in cognition, rather that cognitive processes are partly constituted by physical and bodily movements and manipulations of objects in naturalistic environments. Therefore, a complete understanding of human cognition should include investigations into how the body and the world participate in cognitive processes. The distributed cognition framework provides a useful framing of the issues under examination in this exploration. This framework explicitly encompasses not only cognitive phenomena that might take place in the head (mental representations, human information processing) but also representations and phenomena that take place in the world, between and among people in a social system (Hutchins 1991, 1995; Salomon 1993).

In this chapter, I investigate data from an educational setting that challenges commonly held notions of the role of the body in learning. By examining teaching and learning processes involved in apprenticeship, I will describe the ways in which knowledge is embodied through participation in socially and culturally prescribed systems of meaning. Furthermore, I will describe how such participation serves to systematize sensory experience and orchestrate ways of acting.

In this chapter, I will examine segments of discourse where instructors and students train together on instrumentation. My goal is to explicate the embodied, discursive practices involved in hands-on training. Taking a distributed cognition perspective (Hutchins 1995), this investigation considers bodily, material, and social resources to be relevant players in the process of learning and cognition. I view expertise development as a process of alignment of resources. Note this is not simply (or not at all) a

process of information transfer, as is the conventional model of learning, where a student passively "receives" instruction from an expert. Additionally, learning involves developing coordination schemes with other actors and artifacts in the local ecology. Rather than an information transfer process, this is a process of alignment and simplification. In this chapter, I explore how the deployment of discursive practices in clinical instruction can scaffold and facilitate this developmental process.

### **3.2. Fieldwork**

The primary data in this analysis are video recordings of naturally occurring instructional interactions. The data comprising this analysis are representative segments of classes of interactions that I observed and/or recorded. The warrant for this claim comes from the ethnographic background I obtained from undergoing extensive fieldwork, spending two years in the field site collecting ethnographic data, with the goal of understanding the sorts of activities in which participants engage, the circumstances they typically encounter, and the sorts of tools and technologies they rely upon to accomplish their work.

This chapter focuses on data obtained during my first year in the field. Eighteen students (all in their first semester of the program) and four clinical instructors voluntarily participated in this phase of the study. While in the field, I made extensive observations, and in many cases held lengthy discussions/interviews with participants (both students and instructors). Furthermore, because I wished to understand the events and activities in the dental hygiene school, I felt it was also important for me to develop an understanding of the technical medical terminology, and learn how it is deployed. To this end, I attended a two-unit introductory lecture course with the other first year students, and took the weekly quizzes. I believed it was also important to become familiar with the tools and technologies used by participants. Though I did not participate in the clinical training portion of the program, I was sometimes able to get my hands on the dental instruments that the students use, which gave me the embodied sensation of what it feels like to use them. I will at times provide background explanations for some of the terminology and tacit cultural understandings that appear in the data section. In order to make such claims at interpretation, I relied upon my extensive experience in the field.

I decided to record a portion of my ethnographic data on digital video, capturing moments of instruction in the training clinic. Because many details of human activity and social organization, in coordination with the material world, are tacit and subtle, it can be challenging to capture and scrutinize using only field notes. Yet it is precisely such fine-grained details of human action that are so telling about the nature of human interaction in naturally occurring settings. Using digital video, it is possible to capture segments of interaction and subject them to repeated inspection using slow motion and frame-by-frame viewing.

When deciding where to place the video camera so that the most relevant activities could be captured, I relied upon a background understanding of the domain obtained in fieldwork prior to recording. My placement of the recording equipment was directed by specific concerns; most notably, I typically positioned the camera in order to capture as much of the face and bodies of participants as possible. However, as oftentimes the focus of action was on very miniscule details, I sometimes used the zoom feature on the camera in order to capture small-scale movements of hands, fingers, and instruments. When deciding when to zoom or pan the camera I relied upon both my intuitive understanding of human interaction, meaning, responding to subtle verbal cues. For instance, an instructor might say to a student, "Move the instrument handle like this," and I would then respond by zooming the frame to focus on the instrument handle, which may not be easy to see at the more zoomed out distance. I also relied upon my knowledge of the domain gleaned through fieldwork in order to make these decisions. For instance, knowing what objects or areas of a participation framework were of relevance in the stream of discourse might involve knowing domain specific terminology. This being said, the video records that I obtained were an incomplete representation of a scene. The recordings were taken from a discrete perspective, and as the videographer, I made split-second decisions about what to include and what not to include in a scene. Undoubtedly, zooming the lens caused me to miss other details of interaction that occurred off screen, such as facial expressions, eye movements, or other bodily action. Perhaps a more complete set up might have included multiple cameras - overhead, close-up and panoramic - in order to more adequately capture the scene (though having more video data is not always desirable when analysis of each track is extensive.

One must negotiate a complex matrix of trade-offs when deciding what, and how much information to gather on a scene.)

Furthermore, both during field observation and video recording, I made every attempt to be sensitive to my part within, and influence on the scene (see for example Goodwin 1986, Cicourel 1990; Emerson *et al.* 1995), recording these observations in accompanying field notes. It may be that my presence affected what was said in a scene, or how it was said. There were times when I was asked not to record videotape, such as during one session on instrument sharpening, when an instructor expressed to me not wanting to be “on record” as teaching sharpening in a particular way. To me, rather than indicate that she was distrustful of me as a researcher, it indicated that she had an incomplete model or misconception of what my research was about, what I would be doing with the video records, and who would eventually gain access to them (a standard Human Subjects confidentiality agreement was in place). In this case, it seemed as though she viewed me as being in a position to offer critical commentary on her teaching, or report an assessment to someone in power, neither of which were actually the case, or part of the identity I had hoped to shape for myself within the domain. As I have discussed elsewhere (see Chapter 1), negotiating one’s identity as an ethnographer can be challenging and unpredictable.

I recorded 31 hours of clinical instruction over the course of the fall semester in 2004. Recorded segments included students practicing solo, in partners or small groups, with instructors during training and practical examinations, and in larger group demonstrations. To further explore how embodied interaction and discourse is utilized in the training of professional students, I decided to focus on segments where an instructor worked one-on-one with a novice. These segments were examined, transcribed, and analyzed for discursive practices. In this discussion, I focus on three segments, which were chosen because they reveal aspects of important ways the body is used to guide and represent skills and concepts in hands-on professional training.

### **3.2.1. Transcribing the Data**

In order to analyze the video recordings, I scrutinized particular components, or streams, of multimodal interaction. One mechanism I used to begin to unpack the fine-grained details of interaction

was an orthography for the transcription of talk. I used a modified transcriptional orthography from Conversation Analysis that is similar to that developed by Charles Goodwin (Goodwin 1994). The transcript provided an additional resource through which I could begin to become more familiar with details of the participants' conduct.

Though there exists no formal orthography used for the transcription of visual and tactile conduct, over the years researchers have developed *ad hoc* solutions to locating and characterizing action (see for example Kendon 1997; Goodwin 1986; McNeill 1992). In this study, I have found it particularly useful to rely upon the conventions of comics as a convenient way of representing multimodal data obtained from digital video (Figure 6). In the APPENDIX, I discuss more on my decision to use comic transcripts, and I provide a discussion of how these transcripts were generated.

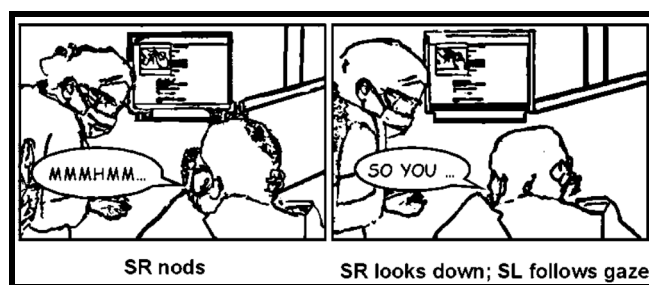


Figure 6. Example Transcript.

### 3.3. Discursive Practices for Shaping Professional Perception: Coding and Highlighting

Dental hygiene students are instructed, from very early on, in authentic physical spaces using the same tools they will encounter in professional practice. They sit at real dental chairs equipped with real appliances (suction, polishers, lamps). They must comply with federal and state guidelines for sterility by wearing gloves and masks, and covering exposed surfaces with disposable barriers. In fact, the only 'simulated' item in the environment is the mouth model students practice upon in early training, until skills are refined enough to be safe on live patients. Training in legitimate material spaces seems to be a hallmark of professional education, and certainly differs from other pedagogical formats in higher education, where often what is done/practiced in a lecture hall differs quite significantly from what goes on

in a professional workplace. Working in an authentic physical space, with the authentic instruments, may help guide the learning process in important ways.

Dental hygiene is a licensed vocation, and practice has been standardized and formalized in many ways. Hygienists perform an established set of duties and use a customary set of dental instruments. Although material things often embody instructions for how they are to be used or regarded (Gibson 1977; Norman 1999), it is only very superficially that one may actually “read” affordances in a dental instrument (for instance, generally where to grip and where the ‘business end’ of an instrument is located). Effective use, both biomechanically and ergonomically, must be explicitly taught as part of the training of a new professional. The dental instruments are designed for specific uses, and learning to properly implement them necessitates formal instruction. For instance, students are instructed to recognize key spatial relationships, engage fine motor movements, listen and feel for auditory or tactile feedback indicating an instrument is being used properly. This training is essential to enter the profession and gain licensure. The training process, among other things, involves learning terminology, concepts, and a specific set of motor patterns to engage the instruments.

Dental hygiene training is a situated, locally organized practice, in which knowledge is constituted through a variety of social processes. Learning to perceive relevant phenomena is a critical aspect of training as a dental hygienist. Traditional accounts of how we perceive describe it as a passive process in which information in the world enters specific sensory apparatuses (e.g. the eardrums and auditory system), and is processed by the brain, which then produces appropriate action sequences. However, recent work in embodiment and cognition indicates that perception happens as the entire human body moves through the world and engages in action, and therefore should be billed as an active, not passive, process. Gibbs (2006) defines perception as “the ability to derive meaning from sensory experience in order to guide adaptive behavior,” and claims that perception is not innate, but rather, “a skilled activity.” Therefore, we should expect to see cultural learning processes at play in shaping one’s perception.

This work resonates well with work done by Charles Goodwin on how novices are trained to perceive like experts in a professional domain (1994). Goodwin talks about how the multifaceted complexity of a professional domain is transformed into the phenomenal categories of a profession using a



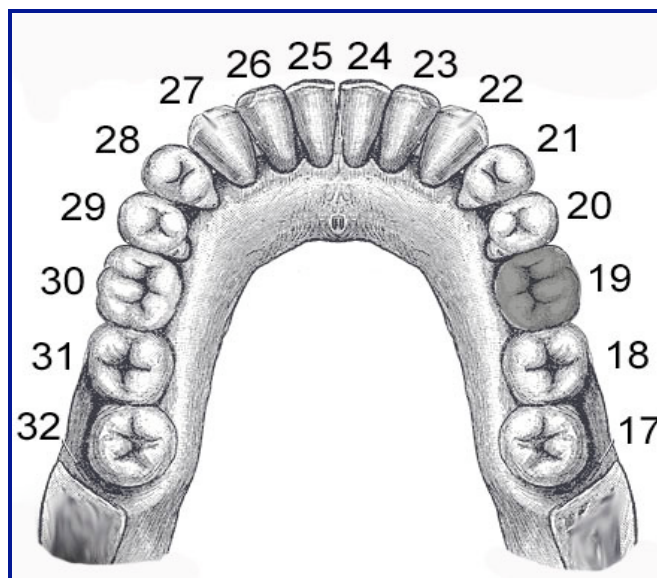
set of important discursive practices. *Coding* is “a systematic practice used to transform the world into the categories and events that are relevant to the work of the profession.” A professional undoubtedly engages in active cognitive perceptual work, but the parameters of that work have been pre-established by an organizational perceptual system (e.g. culture).

For instance, in order to begin to explicate how to use a periodontal instrument, experts must calibrate with novices what it is they are talking about. Local practice has produced a variety of terminology, referring to patient and operator anatomy, instrument components, and diagnostic features. Furthermore, executing a core set of fine motor skills is an essential part of dental hygiene practice. Likewise, the profession engages a coding scheme for the manual execution of instrumentation skills. These terms are used for explicitly describing complex configurations, spatial relationships, and movements<sup>8</sup>. Coding of features, objects, and movements at once classifies these phenomena while calling them into awareness. Below are a set of coding schemes and some example terms applying to phenomena within dental hygiene practice.

- **Anatomical terms & diagnostic features** – For instance, teeth are numbered from 1-32; e.g. tooth #19 as indicated in Figure 7. The surfaces of teeth are divided into *facial and lingual surfaces*. Deposits on teeth are referred to as *calculus*.

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<sup>8</sup> Interestingly, according to interviews with field site members, the terms detailing the execution of instrumentation skills are typically used during practical training only, and not in the professional practice of dental hygiene itself, i.e. in a dental office, as many of the instrumentation skills have been assimilated.



**Figure 7.** Lower teeth, numbered 17-32.

- **Instruments & components** – Each instrument is named according to its use and shape, e.g. *sickle scaler, explorer, universal curette*. The parts of instruments are referred to by specific terms, e.g. *working end, terminal shank*.
- **Motions** – Instructors refer to various motions involved in instrumentation with specific terms, e.g. *fulcrum, handle roll, pivot, lateral pressure*.

*Highlighting* is a class of cognitive practices that consist of “methods used to divide a domain of scrutiny into a figure and a ground, so that events relevant to the activity stand out” (Goodwin 1994). Highlighting, although a visual analogy, presumably applies to other perceptual domains as well. Goodwin shows how experts use gesture and speech within a complex spatial scene to highlight relevant phenomena in professions where making visual distinctions is crucial (e.g. archaeology, criminal justice). But in many domains other perceptual modalities are involved in making judgments. For instance, practitioners may utilize different sorts of discursive practices to delineate relevant kinesthetic phenomena. This is especially relevant in dental hygiene, where instrumentation movements are explicitly spelled out, and recognizing effective instrumentation involves auditory, kinesthetic and tactile feedback.

### 3.4. Professional Perception and Expert Action

Traditionally, in cognitive science perceptual processes are regarded as distinct from action processes. However, recent work indicates that perception and action are, in fact, inseparable – perception is not solely located in brain activity, but must always be situated in terms of more complex dynamic couplings involving the entire body in action (Gibbs 2006). As paraphrased from Noe and O'Reagan (2001), perception is not something that happens to individuals; it is something that they do. People don't perceive the world statically, but by actively exploring the environment. Noe and O'Reagan remind us that though vision seems “passive,” it is truly an action-based skill. We must be trained where to focus our eyes, direct our gaze, and how to interpret sensory information. Similarly, dental hygienists explore the surface of teeth using hand-held dental instruments, which yield reliable information about deposits on the surface. Nothing can be perceived unless an instrument *is in motion, in specific ways*. That skilled movement generates haptic and auditory information, perceptual feedback that a trained practitioner can use to infer topology. By taking an embodied approach to perception and action, we understand that the physical properties of the world are not entities to be perceived statically, but are instead opportunities for action (Gibbs 2006).

Donald Schön (1987), in his work on expert practice and expert learning, identifies a key relationship between perception and action: being able to self-assess one's own actions while performing them. He terms this ability *reflection-in-action*. In the educational literature, ‘reflection’ is traditionally considered to be a retrospective, analytical process, a conscious reexamination of one's past actions; however, Schön notes how expert practitioners are often able to think about and assess what they are doing, while they are simultaneously doing it. Schön claims that it is the process of reflection-in-action which enable experts to gracefully deal with situations that are novel, uncertain, or unique. Engaging in reflection-in-action might be considered as a developed skill of experts, and achieving that skill might be a crucial step in progressing towards expertise. Moreover, experts may be able to simultaneously engage in an action and maintain an awareness of the efficacy of that action – i.e. engage in reflection-in-action. Maintaining that reflective stance involves developing a level of awareness of effective practice – a

professional perception to guide action in a domain, and also self-assessment skills to determine the efficacy of that action.

Just how important is this perceptual awareness? Schueneman and Pickleman (1993) performed a longitudinal study of surgeons-in-training, from medical school through residency, looking at which factors are most predictive of achievement in their surgical career. Interestingly, they discovered that, contrary to popular belief, inborn manual dexterity is not a major dimension distinguishing adept surgical performance from mediocrity. Rather, results indicated that the most successful surgeons can rapidly organize a perceptual field, distinguishing essential from nonessential detail, particularly when the signal to noise ratio is high. The authors emphasize that though manual dexterity and verbal abilities are important to surgeons in performing activities, the distinguishing features of the superior practitioner are:

"his/her ability to 'see' the relevant anatomy of the operative site, even when this might not immediately be visible; to quickly identify important 'landmarks' in the incision; and to mentally organize multisensory data and actions at any given point of the procedure..."  
(p. 189)

Schueneman and Pickleman's interpretation of this data is that, "Pure motor ability is not the critical factor in surgical proficiency...rather, relatively innate, nonverbal, perceptually based cognition about complex spatial information appear to play a more central role in the operating room." Their interpretation implies that the body, material and social world have nothing to do with a surgeon's visual perception.

But, as Goodwin points out (1994), 'seeing' as a surgeon sees is a social process involving the integration of conceptual, social, *and* perceptual information. Through training (i.e. acculturation) as a surgeon, novices learn how to project conceptual structure into/onto the world. Perhaps, instead, it is a surgeon's ability to acquire professionally structured perceptual skills, and integrate these with manual action, that accounts for the data. If this is the case, understanding the relationship between socially structured perceptual training and expert skill development is of great importance.

### **3.5. Results: Discursive Practices for Shaping Professional Perception**

In domains where experts must perform sophisticated motor skills, perception has an important role in action. Training a novice involves not only teaching them how to perceive relevant phenomena, but

to perform relevant actions as well. Using examples from video segments of real-world training in dental hygiene instrumentation, I propose a set of discursive practices found in settings where performance is highly regulated.

### **3.5.1. Guidance – Molding and Directing**

The first discursive practice I will discuss is *guidance*. In literature on motor learning, guidance is defined as “a series of techniques in which the behavior of the learner is limited or controlled by various means to prevent errors (Schmidt 1998, p. 419).” A prototypical example of guidance would be an instructor teaching a student how to swing a golf club by wrapping his arms and hands around the student’s, and engaging a stroke. Rather than focus on error prevention, as Schmidt emphasizes (1998), I will focus this analysis on how guidance techniques are used as discursive strategies to endow a novice with *the perception of legitimate action*. Two ways that professionals can engage guidance strategies in the practical training of novices are through molding and directing.

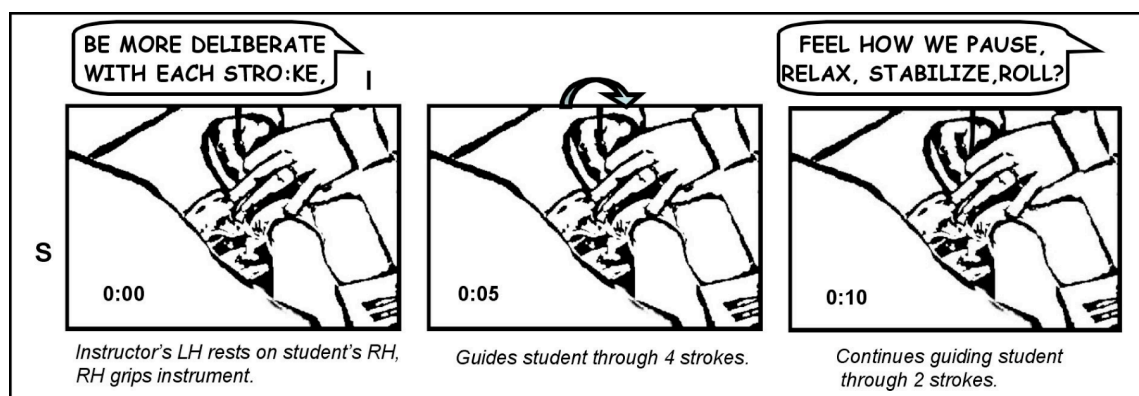
*Molding* refers to a practice in which a teacher physically manipulates the body of a novice into institutionally established configurations and movement patterns. The term molding derives from literature on sign language instruction in blind and autistic children, and non-human primates (Gardner *et al.* 1989).

*Directing* refers to “the act of talking a learner through a new procedure” (Schmidt 1998, p. 419), using speech and/or gesture.

### **3.5.2. Guidance: Examples**

### *Hands-On Instruction*

In the example<sup>9</sup> shown in Figure 8, an instructor uses guidance to help a student to perceive what a scaling stroke looks, sounds, and feels like. Stephanie, the student, sits at a dental chair, and Ingrid, her instructor, sits across from her, looking on and offering assessment. Stephanie holds a scaling instrument over her mouth model, and engages scaling strokes. Ingrid lightly grasps the protruding part of handle in her right hand, and lays her left over the top of Stephanie's right. Together, Ingrid and Stephanie slowly perform several scaling strokes, while Ingrid issues the directive, "Be more deliberate with each stroke."

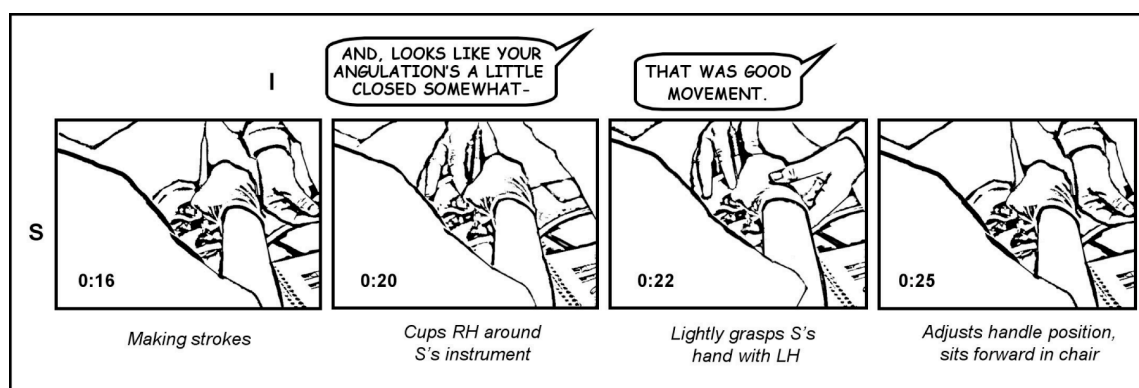


**Figure 8.** Example GUIDE1

Note how in order to guide Stephanie's stroke, Ingrid orients and organizes the material environment so that it structurally complements Stephanie's body – similar to how one's non-dominant hand often structures space so that the dominant hand can operate upon it (Guiard 1987). Ingrid's pulling action on the end of the instrument helps move the instrument up the tooth as they engage a stroke together. The forefinger of Ingrid's left hand physically prevents Stephanie from flexing her fingers during a stroke, and the other fingers rest lightly on the top side of Stephanie's hand, guiding her to use her wrist and forearm to generate the force of a stroke. Her guidance illustrates to Stephanie what appropriate scaling looks, feels, and sounds like – in essence, providing her with a set of practical "training wheels."

<sup>9</sup> A word on the participants: **Ingrid** is a clinical instructor with over 20 years of teaching experience, as well as formal training in vocational education instruction. **Stephanie** is a first-year student who, at the time of videotaping, had been a student in the program for about a month. During the class session when this segment was filmed, the students were practicing scaling strokes for calculus removal. In general, during clinical instruction, instructors spend a period of time working individually with each student on correct positioning and activation of dental instruments, which is what's happening here. Note however that although Stephanie is the primary subject of the instructor's attention, other students stand in the periphery looking on (as well as me, behind the video camera).

In this segment, molding, directing, and coding practices interact in important ways. Note how Ingrid uses molding to shape Stephanie's hands into scaling configuration and motion, while simultaneously directing her to recognize key kinesthetic features of the movement, as she says, "Feel how we pause, relax, stabilize, roll," (here she is referring to coded segments that compose a scaling stroke). Note how she uses the plural pronoun "we" to refer to the action, which could be in reference to their collaborative stroke production, or in regards to the more esoteric "we" of the profession of dental hygienists. In either case, Ingrid uses coding terms to delineate relevant kinesthetic phenomena. Ingrid instantiates appropriate scaling strokes in interaction, while concomitantly presenting linguistic terminology for each referent motor component. Ingrid directs Stephanie's perception of appropriate scaling behavior, explicitly issuing the command, "Feel..." to her student. In the process Stephanie herself experiences what conventional scaling strokes 'feel' like, while simultaneously being socialized as a dental hygienist through Ingrid's use of coded professional language. Speech synchronously references the actions that are collaboratively executed in a molding performance.



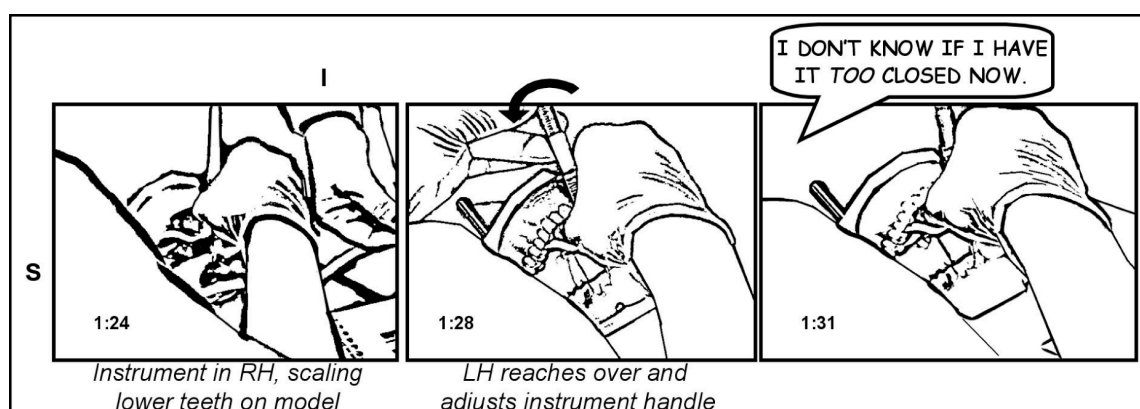
**Figure 9.** Example ANGULATION

A few seconds later, as shown in Figure 9, Ingrid reaches over and cups her thumb and forefinger around the handle of the instrument, highlighting it, while declaring, "And, looks like your angulation's<sup>10</sup> a little closed somewhat." During the utterance, she pushes Stephanie's hand with her left hand, physically adjusting the handle of Stephanie's instrument. In order to use what an instructor says to pursue the task, the student relies upon a tacit knowledge of what the focus of attention should be on when the coded term

<sup>10</sup> Here she refers to the angle that the blade of the instrument makes with the surface of the tooth.

angulation is used, and how a subtle adjustment to the handle of the instrument can cause predictable changes in the angle that the blade of the instrument makes with the tooth. Furthermore, by describing the angulation as “closed,” Ingrid assigns Stephanie’s behavior to an error category. At the same time, Ingrid molds Stephanie’s instrument and hand, which communicates an appropriate, albeit unspoken, correction. The instructor’s visual assessment and correction, offered while Stephanie is *engaged in action*, serves to expand the student’s understanding of the spatial relationship that must be maintained between instrument and tooth. Ingrid hones Stephanie’s perceptual abilities to judge angulation in future work, while simultaneously teaching her a strategy for correction should she perceive her angulation is offset.

For instance, nearly a minute later (Figure 10), Stephanie self-corrects the angle of the blade. As she scales alone, she reaches over with her left hand and adjusts the instrument handle so that it is more vertical.

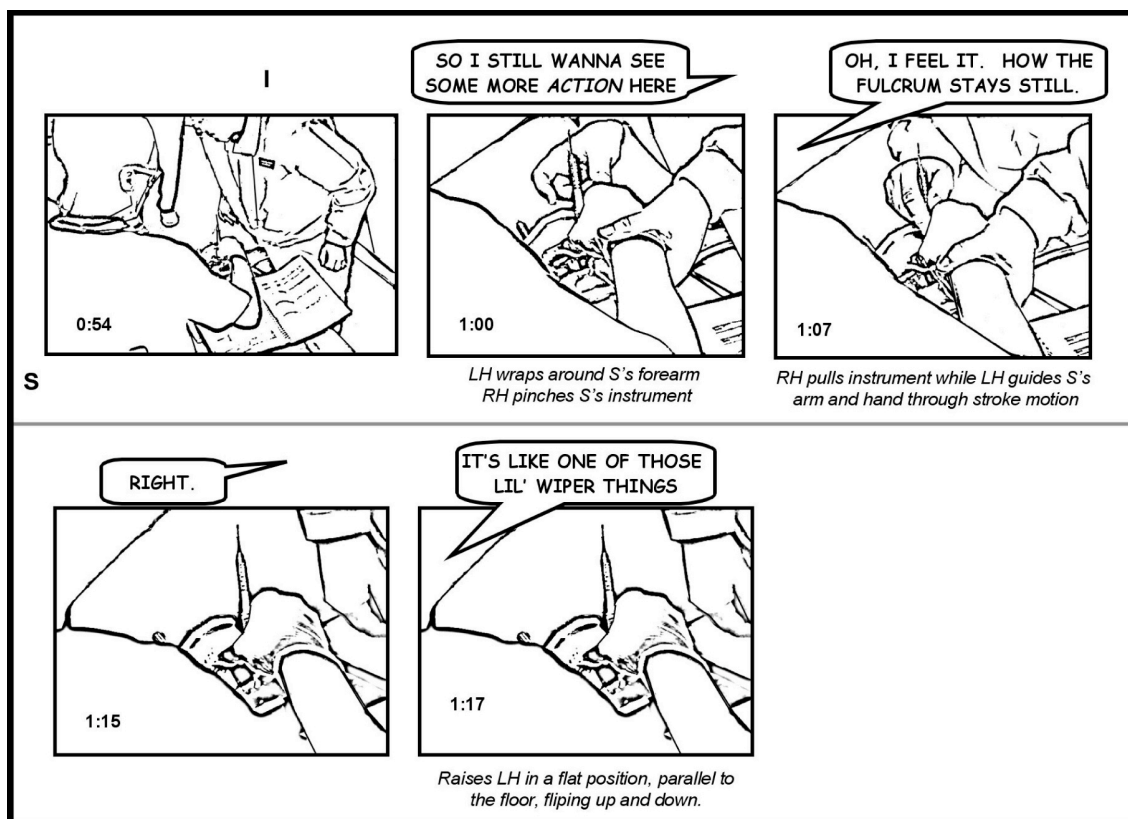


**Figure 10.** Example SELFCORRECT

Stephanie mirrors Ingrid’s correction and adjustment of the instrument handle, which occurred earlier in Figure 9. It is interesting that Stephanie shifts her instrument by grasping the handle in her left hand pulling it more vertical, just like her instructor did, instead of subtly shifting the handle with her working hand, which is more characteristic of what an expert might do. Notably, what Stephanie is doing here is publicly displaying her ability to perceive, evaluate and perform a correction. Her utterance, “I don’t know if I have it too close now,” is a rhetorical offer for feedback (to which Ingrid does not respond). While indicating her developing ability to perceive and self-correct, it also acknowledges her position as subordinate to the instructor, who is in a position to evaluate the student’s success.



The next segment (Figure 11) occurs approximately a half-minute later. It starts with Stephanie scaling alone as Ingrid looks on. Soon Ingrid reaches over and takes Stephanie's wrist and instrument into her hands, offering the suggestion that she wants to "see some more (1) *action* here."



**Figure 11.** Example OHIFEEL

She verbally pauses for a full second, synchronizing her utterance "action" with the power stroke, which emphasizes this term. Many researchers who study multimodal discourse, such as McNeill (1992) and Kendon (1990), note that speakers often synchronize spontaneous gestures with speech in meaningful ways. As an active bodily display, understanding what Ingrid is communicating about necessitates integrating both her utterance and her action with Stephanie's hands. To what "action" is Ingrid talking referring? The synchrony of these two displays serves to indexically tie gesture and speech.

But Ingrid's manipulation of Stephanie's hands is not technically a *gesture*; it *acts* on the world. Yet it simultaneously *represents* something: a quality of movement. When is an act a gesture, and when is it an action? When bodies are engaged in the world, delineating gesture and action is not as clear-cut as

experimentalists would have us believe (Becvar *et al.* 2005; Goodwin 2007). A person can gesture with a pencil over a page, but as soon as they place it on the page and make a mark, is that movement categorically different? Perhaps our conception of what constitutes a ‘gesture’ is limited because so often spontaneous gestures are studied experimentally, in white rooms, rather than in the complex, messy world of human action and interaction.

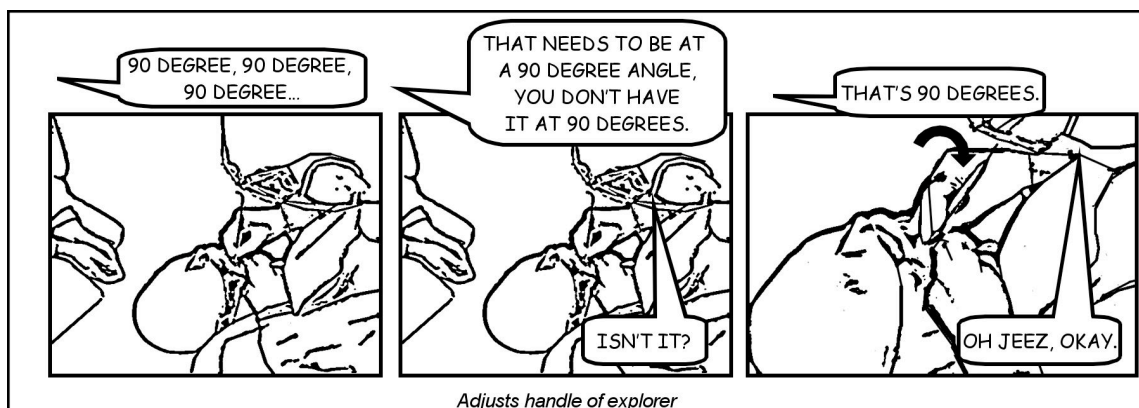
They continue to make strokes together for 10 seconds, then Stephanie offers a confirmation, “Oh, I feel it...” This serves as a public declaration of Stephanie’s ability to perceive the quality of performance that she and Ingrid jointly achieve.

### *Molding and Directing*

Directing and molding often act in synchrony. As a novice begins to develop perceptual judgment, and such skills become codified into the discourse of the profession, an expert can begin to call upon those actions in directions. Moreover, an action previously done via molding can be codified as a direction.

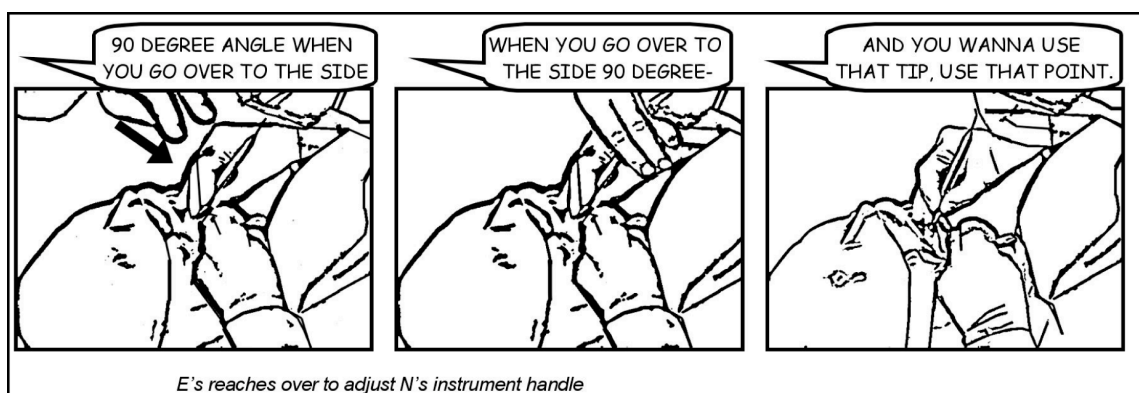
We see this happening in Example 90DEGREE, shown in Figure 12. Here, a dyad of students work on learning the skills involved in using the Shepard’s hook explorer, a detection instrument. One student, Emily, has taken on the ‘Expert’ role, and sits across from the other student, Natalie, who is acting as a Novice. Sarah sits at a mouth model and holds the Shepard’s hook, using it to practice exploring with her mouth model.

Emily begins by saying to Natalie, “Ninety-degree, ninety-degree, ninety-degree. That needs to be at a ninety-degree angle, you don’t have it at ninety-degrees-.” Here Emily is referring to the angle that the tip of the instrument is making with the surface of the tooth that is being explored. In this utterance, Emily uses the imperative mode as she directs and corrects Natalie’s action. Natalie offers a challenge in reply: “Isn’t it?” as she moves the handle slightly. After adjusts it a degree more, Emily says, “*That’s* ninety-degrees.” This interchange is doing an important thing: serving to calibrate Sarah’s perception of what ninety-degrees looks like with Emily’s. The two students undergo a negotiation, which results in Sarah’s modifying not only her perception of ninety degrees, but also her action with the instrument.



**Figure 12.** Example 90DEGREE1

In Figure 13, as Natalie explores another region of the mouth, Emily uses both molding and directing to guide Natalie's instrument. Emily says, "Ninety-degree angle when you go over to the side, when you go over to the side ninety-degree," while simultaneously reaching over to grasp the handle of the instrument, and shifting it slightly. Here we see a simultaneous coupling of verbal direction and molding of the instrument handle in action engaged in the world. Emily's utterance draws attention to the spatial relationship that the tip of the instrument is making with the tooth. Natalie molds Emily's hand/instrument into a configuration with respect to the mouth model that is more in alignment with professional practice. Acting as the operator, Natalie is able to maintain physical connection with the authentic tools of her professional lifeworld, while concurrently hearing Emily's use of the coded professional terms as they are instantiated in practice.



**Figure 13.** Example 90DEGREE2

During guidance, an instructor engages in the practice of shaping a novice's perceptions. Molding and directing scaffold the perceptual development of novices by emphasizing certain features and

movements so that some are made salient, whereas others fade into the background. Such training practices constitute an important part of maintaining the professional craft. Though the perceptual features and associated terms are particular to the profession, the cognitive strategies utilized are characteristic of professional activity in general. These practices can organize the perceptual field and prime the motor system of a novice. As described by Moshe Feldenkrais (1981), one of the 20<sup>th</sup> century's most prominent somatic psychologists:

"Through touch, two persons can become a new ensemble; two bodies when connected by two arms and hands are a new entity. These hands sense at the same time as they direct. Both the touched and the toucher feel what they sense through connecting hands. The touched person becomes aware of what the touching person feels and alters his configuration to conform to what he senses is wanted. (p. 11).

Talk that co-exists with hands-on interaction in the material world interleaves symbolic action with instrumental action, as hands and bodies seamlessly move between gesture, guidance, and manipulation of tools. By examining hands-on interactions within a setting of practice and instruction, we see the processes of guidance and gesture as two sides of the same coin. Engaged in bodily displays, hands can simultaneously organize social interaction and shape perceptual and motor development. Hands can manipulate physical objects and referentially anchor experiences. They can move and wrap around the hands of novices, moving them in appropriate ways. They can simultaneously direct and monitor, demonstrate and assess.

### **3.5.3. Demonstration and Modeling**

In the dental hygiene clinic, instructors use a variety of embodied representations to facilitate the development of their students' professional competence. We have discussed how instructors use guidance techniques to give students first-hand experience with instrumentation. Another strategy instructors often use is *demonstration* – constructing gesture-based models of actions (situated in discourse).

During the time I observed instruction in the clinic, I frequently saw instructors using *pantomime* gestures while demonstrating features of instrumentation skills to students. McNeill defines a pantomime gesture as a gesture invoking an invisible, imaginary tool (McNeill 1992). From the instructor's lifetime experience of handling dental instruments, they can abstract a spatio-dynamic pattern of movement, and

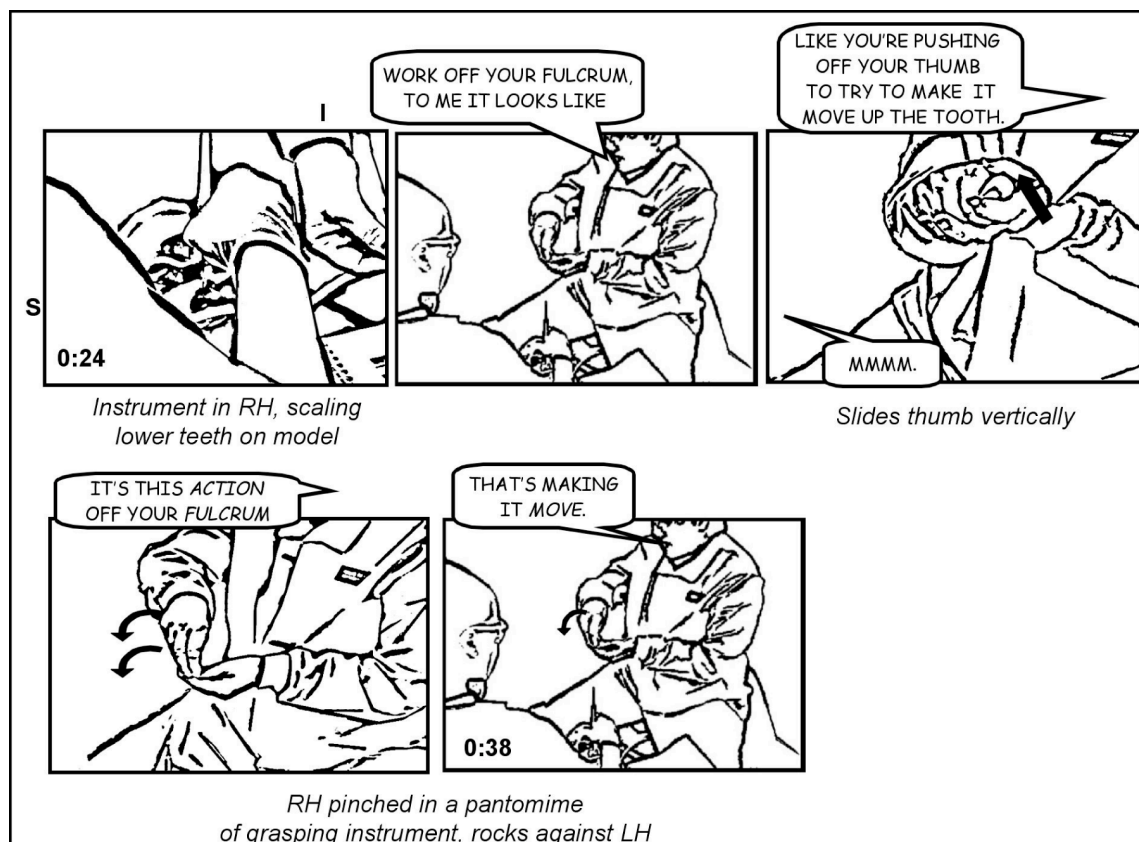
enact it in gesture. Through the gestural performance, instructors reference experiential knowledge of the world, and produce a contextually relevant representation upon which additional information may be layered through speech (LeBaron and Streeck 2000). However, categorizing the instructor's action as simply a pantomime gesture does not do justice to its complexity. We cannot extract the gesture from the context of its production to analyze it; rather, a complete analysis requires simultaneous attention to the co-occurring speech, the complex material ecology in which the gesture is located, and the hand of the actor moving in a shared perceptual field (Goodwin 1994, 2007; Hutchins 2005). Via the process of demonstration, a student is not merely being taught isolated definitions in gesture, rather she is being taught a mode of practice. The cognitive activities engaged here are situated, distributed, and interactively organized.

From a very early age, we learn new ways of using our bodies by watching the behavior of others and enacting similar movement patterns (Tomasello 1999). Learning new motor skills by observing and reproducing that behavior is a type of social learning called imitation (Byrne and Wilson 1988). Recent research in neuroscience has suggested that the motor system may be involved even when we observe actions of others (Craighero *et al.* 1996). These results indicate that a combination of perceptual and motor processes may be involved in how we understand, imitate and learn motor skills of all kinds, from microsurgery to walking. Imitation relies on the ability to recognize others' actions and transform the observed patterns into motor activity. Presumably, imitation processes are involved in when learning from the demonstrations of experts; though language, tool use and other complex social factors also play an integral role.

However, Schmidt (1988) indicates that empirical evidence on the learning benefits of demonstrations is mixed. He cites several experiments on the acquisition of controlled motor skills from demonstration. Nonetheless, Schmidt fails to discuss the *social* role that demonstrations play in the training of novices in naturalistic contexts. Goodwin (1994) describes demonstrations as being built through the "interplay between a coding scheme and the domain of scrutiny to which it is being applied" (p. 21), obviously heavily interrelated with social processes. In that sense, as instantiations of institutionally

relevant phenomena, demonstrations can reveal the underlying structure of a coding scheme, disclosing how actions and perceptions are interconnected and lead to socially legitimate activities.

### 3.5.4. Demonstration: Examples



**Figure 14.** Example DEMO1

In the segment shown in Figure 14, occurring a moment after the segment in Figure 9, Ingrid uses demonstration strategies in an assessment of Stephanie's work and to instantiate kinetic principles of stroke production. As the segment begins, Stephanie holds a scaling instrument over the mouth model, and engages scaling strokes. As Stephanie practices, Ingrid reminds her to "work off her fulcrum" -- the ring finger of her right hand, which serves as the anchor point that the scaling stroke pivots upon. Ingrid raises her hands as she tells Stephanie, "to me, it looks like you're pushing with your thumb...". Holding up the gesture at eye level, she commands visual attention, and Stephanie looks up from her work. Ingrid models

her right hand as though she were grasping a dental instrument, and moves her thumb upward, as she says “pushing with your thumb.”



**Figure 15.** Close up of Ingrid’s hands from in Figure 14 as she says, “pushing with your thumb”. Image is a video still overlay.

She then offers a correction, “it’s this *action* off your *fulcrum* that’s making you *move*,” synchronizing the downward gestural strokes<sup>11</sup> with “action,” “fulcrum,” and “move” (Figure 16). The timing of gestural strokes within the sequence of talk index the particular movements to these speech terms.

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<sup>11</sup> McNeill defines the stroke of a gesture to be the point of heightened activity in a gesture phrase, and it carries the imagistic content of the gesture (McNeill 1992). In multimodal discourse, the timing of the gestural stroke within an utterance carries important semantic content. When performed in synchrony, gesture and speech should be analyzed as inextricably interdependent systems.



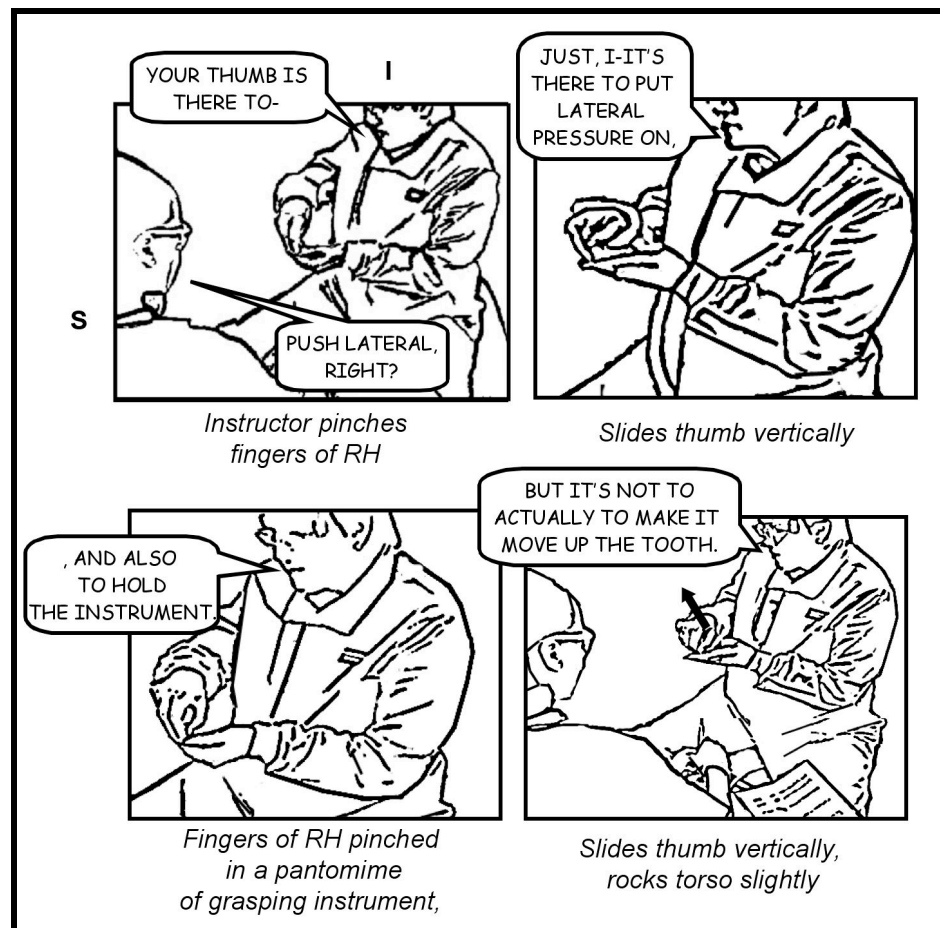
**Figure 16.** Close up of Ingrid’s hands, taken from Figure 14 as she says, “It’s this *action*...” Image is a video still overlay.

To make sense of demonstrations, novices must be able to interpret subtle aspects of the representation. In this instance, the student has to “see” the instructor’s left hand as an iconic representation of an oral cavity and then, on the basis of locally produced knowledge recognize that her right hand is configured in a certain way because it holds an imaginary dental instrument. The instructor evokes a complex of action, position, and instrument by simply lifting her hands with a recognizable shape. Also, it is interesting to note how the instructor constructs gestural demonstrations so as to preserve the relationship between her hand and the student’s hand. In fact, the instructor in this instance is naturally left-handed, while the student is right-handed. The instructor performs the demonstration as though she holds an instrument in her right hand, modeling what the student does (though it would not be how she herself would practice). Does this matter? Motor learning literature indicates that the perspective of demonstrations **is** important: motor facilitation while observing hand actions was found to be selective for instances when the perspective of a demonstration matched the perspective of the performer, as indicated by both performance outcomes and measures of cortico-spinal activity (Maeda *et al.* 2002).

Demonstrations can indicate both what a student should do *and* should not do in a hypothetical future event. While providing a particular quality of representational content, gestures interrelate and depend on accompanying speech to provide essential grammatical content. For instance, Murphy notes how architects often gesture over models to indicate what could be, as they engage in a sort of collaborative



imagining of hypothetical future events (Murphy 2005). Hutchins and Palen (1997) note that gestures by themselves are always in the present tense, and it is co-gesture speech that applies grammatical markings to the utterance. In the case of the demonstrations seen in Figure 17, occurring in time immediately following Figure 14, the instructor's gestural demonstrations pertain what the student is doing: exhibiting proper use, observed mistakes, and exaggerated actions (such as when the instructor bobs her entire torso as she demonstrates "not to (0.5) actually try to make it move up the tooth"). While the gesture represents possible configurations and motions of the thumb, it is the speech that carries negation or affirmation of demonstrated actions.



**Figure 17.** Example DEMO2

Through demonstration-in-interaction, instructors enact professional knowledge and train novices to recognize appropriate action. Interestingly, in my observations, I frequently saw instructors using

guidance techniques to indicate correct motion, whereas frequently they evoked *both* correct and incorrect motions in demonstrations.

### 3.5.5. Embodied Conceptual Metaphors for Scaffolding Action

Research in cognitive science indicates that we formulate abstract conceptual knowledge in concrete terms, using reasoning strategies based in the sensory-motor system. For example, when talking and reasoning about time, we almost exclusively use spatial metaphors. According to Lakoff and Johnson (1987), many of our reasoning processes are based on basic patterns of understanding called *image schemas*. Image schemas emerge as meaningful structures at the level of bodily movements through space, our manipulations of objects, and our perceptual interactions. Whenever a schema is instantiated in a number of different experiences or images, the same parts and relations recur. In general, image schemas fall into three categories: schemas that structure our experience of topology, schemas that structure our experience of orientation, and schemas that structure our understanding of force and dynamics.

A key notion in this theory is that these kinds of bodily-based schematic structures also are used in human abstract thinking by the means of metaphorical projection from the world of bodily experience into abstract domains. The mechanism through which abstract thought is conceptualized in terms of the concrete is called conceptual metaphor. Conceptual metaphors are composed of unidirectional mappings from entities in one conceptual domain to corresponding entities in another conceptual domain. Research and theory in cognitive linguistics has shown that abstract concepts are typically understood, via metaphor, in terms of more concrete concepts. These metaphorical mappings are systematic and not arbitrary. A conceptual metaphor is an *inference-preserving cross domain mapping* (Lakoff and Johnson 1987).

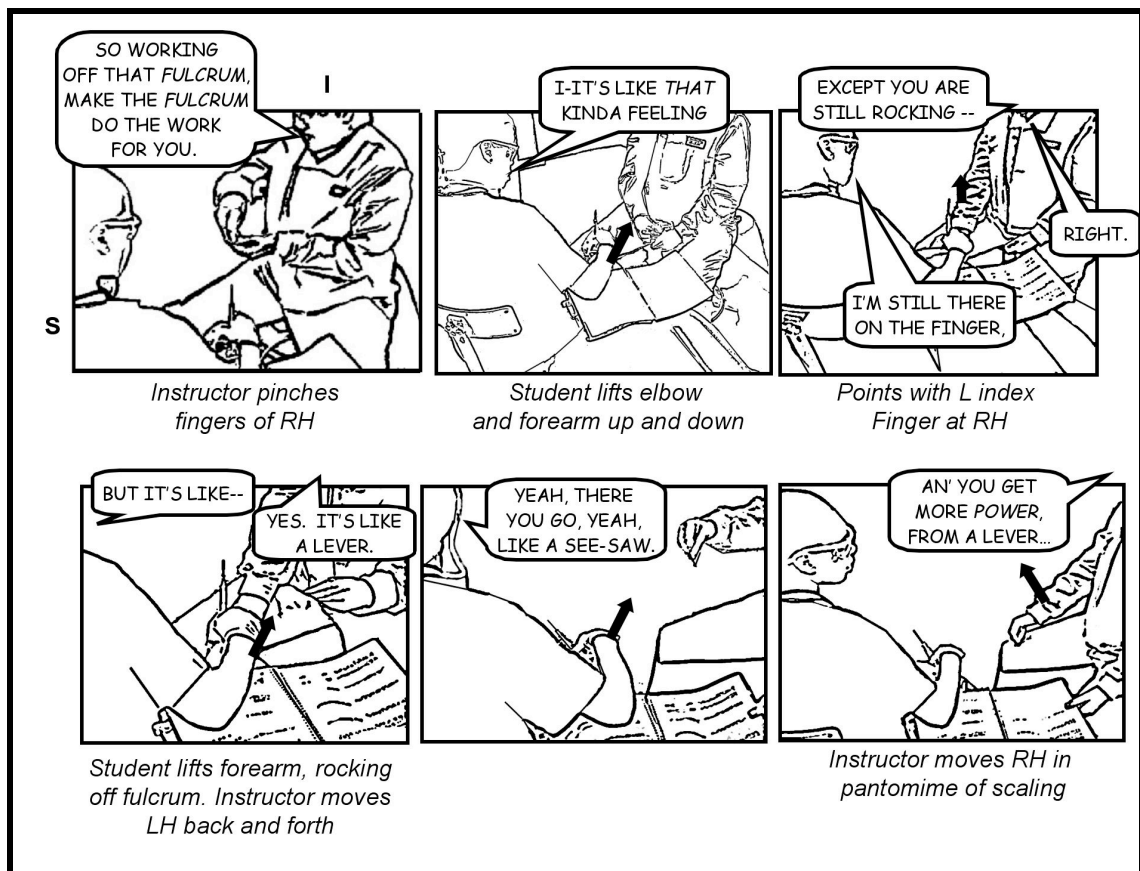
Since conceptual metaphors preserve inferential structure, such metaphors allow us to ground our understanding of scientific and technical concepts in our prior understanding of everyday physical activities. Image or embodiment schemas can play an important role in grounding metaphors. When projected via conceptual metaphor, image schemas from the source domain can provide inferential structure in the target. Linking metaphors are used to conceptualize one technical domain in terms of

another. Linking metaphors yield sophisticated, abstract ideas, and require explicit instruction and training (Lakoff and Nunez 2000).

There is a notion that advanced heavily theoretical concepts do not rely upon perceptual notions, only highly abstract, pure ideas. Some evidence suggests that scientific conceptualization incorporates "increasingly deep, abstract properties as opposed to perceptual properties, with increasing expertise" (Chi *et al.* 1981). In my own research work in the past, I performed ethnographic analyses on scientists engaged with technical material in an attempt to better understand of how scientists conceive of abstract notions of chemical concepts, like molecules (Becvar *et al.* 2005). Regardless of what sort of representation exists in scientists' brains, it is clear that when experts communicate with each other, they rely heavily on a variety of perceptually-based representational strategies. For example, some of these include metaphorical language, perceptually-based linguistic schemas (e.g. image schemas), explicit analogies, gestures, and not to mention graphs, charts, diagrams, maps, etc. The proposition that abstract knowledge can be constituted from perceptual bases is a powerful way of accounting for these strategies.

More recent contemporary work in cognitive science continues to support the proposition that perceptual and conceptual systems are interconnected in important ways (see Gibbs 2006 for an account). Many now believe that both concrete and abstract concepts exist as embodied, dynamic, and situated, in a matrix that integrates thinking, being, doing, and interacting within the world (Varela and Thompson 2001). Concepts are viewed as flexible, multimodal, and productive, and give rise to explicit inferences when applied to objects and experiences in the world. Rather than seeing knowledge and cognition as separate from the body, a more useful characterization is *cross-modal transfer* – a cognitive process in which patterns of order from one experiential domain (for instance, recurring dynamic patterns of motor or perceptual experience) act as organizational templates for another domain (Lakoff and Johnson 1987). The human capacity to use experience from one domain to make sense of another is an extremely robust cognitive resource. As Lakoff and Johnson (1987) assert, "Much of conceptual inference is, in fact, sensorimotor reference." (p. 20). Various educational studies show that students' embodied reasoning processes, obtained from a lifetime of experience in a body moving through the world, play an important role in how they learn scientific and mathematical concepts (diSessa 1993; Roth 2001).

### 3.5.6. Embodied Conceptual Metaphor: Examples



**Figure 18.** Example SEESAW

In Example SEESAW, shown in Figure 18, Stephanie offers a provisional summary of her understanding of scaling on a more general level. This segment follows the instruction she has received from Ingrid shown in the previous examples.

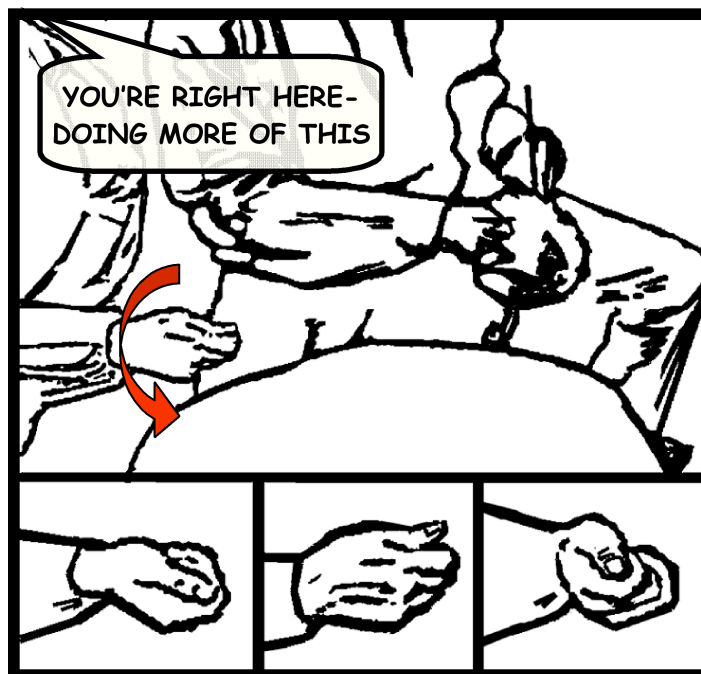
Stephanie first expresses her understanding of scaling in an embodied display, as she says, “I-it’s like that (0.5) kinda feeling,” during which time she rocks her instrument, hand and arm exaggeratedly over the mouth model. Stephanie’s gestural display comes before a verbal description of the motion ever does. This is similar to results noted by Roth and Lawless (2002) and Goldin-Meadow *et al.* (1993) who have studied at students’ use of gesture in during science and math learning, respectively. They both report that often students often show evidence of conceptual learning in gesture before acquiring the ability to verbalize concepts using formal terminology. Roth and Lawless speculate that gestures take on an

important scaffolding function. In this case, Stephanie follows her gestural description -- cued by Ingrid ("Yes, it's like a lever") -- with a verbal analogy from her own lived experience -- that the movement is "like a see-saw." Interestingly, 'see-saw' is a description grounded more in everyday experiences than the more abstract mechanical term, 'lever.'

Stephanie's gesture and verbal analogy is socially relevant - a public display, done before an instructor (and other students). In making this display public, she demonstrates her understanding, and tacitly requests confirmation from her instructor, who is in a position to do so. It is important to see the analogy, and exploration of its entailments, as cognition jointly achieved via the embodied interaction between Ingrid and Stephanie. Also, it is interesting just how embodied this level of calibration is -- by viewing the sequence in video, one can see how the co-participant's bodies move and rhythmically synchronize together.

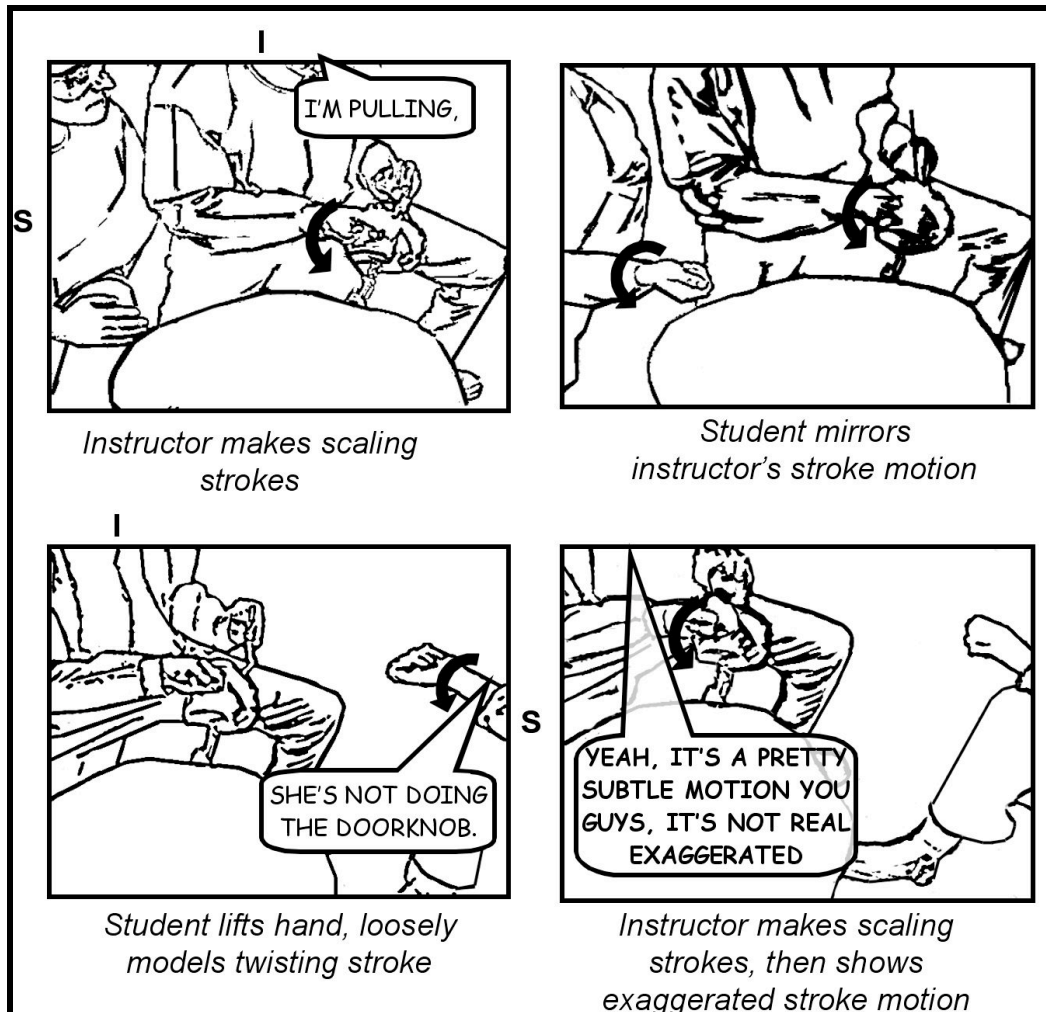
This example shows the embodied nature of acquiring the concepts behind the biomechanical principles involved in instrumentation. The motions Stephanie makes with her body seem to play an important role in her conceptualization. The provided imagery serves as an analogy for physical approximation of movement. Making the inference of "body-tool ensemble is a lever," the instructor and student jointly explore the entailments of such an inference. One of them is that you get more power with a longer lever (whole arm versus hand only). Does Stephanie need to know conceptually how a lever works in order to make an expert scaling stroke? In order to know, "A longer lever can produce more mechanical force near its fulcrum than a shorter one," requires Stephanie to have formal training in mechanical physics. However, by using embodied, experiential knowledge of the world, and cross-modal transfer, she (and Ingrid) infer that using the whole arm like a see-saw makes the stroke more powerful than if one just uses fingers to scale. Here, by drawing from her lived experience of the world, the student developed a powerful conceptual tool. Moreover, this conceptual knowledge can even be used to reason in unfamiliar situations -- knowing that she needs to use her whole arm and hand as a unit during scaling versus her fingers may help her make decisions about positioning herself for scaling with instruments and in areas she is not familiar.

In becoming skilled in a profession, students co-opt the postures and gestures of a teacher, making them their own, enacting them in their anatomy. In this sequence, notice how Stephanie's gestures and bodily movement, such as the rocking of the torso and arm, rhythmically echo Ingrid's, and even synchronize at some points, as they move in an exaggerated pantomime of scaling. This collaborative attuning of bodies during instruction may play a significant role in expertise development.



**Figure 19.** Example DOORKNOB1

Example DOORKNOB, shown in Figure 19 and Figure 20, shows another reference to embodied conceptualization process. In this example, an instructor is demonstrating instrumentation technique to a small group of students. The instructor sits at a mouth model while students look on. In Figure 19, a student to the left hand of the screen, inserts her right hand into the frame of the camera, saying, “You’re right here-- doing more of this,” while simultaneously twisting her wrist. Also, note how the student interjects her gesture into the field of view of the instructor.



**Figure 20.** Example DOORKNOB2

In Figure 20, the instructor replies, “I’m pulling,” while simultaneously engaging in scaling, and the student continues to model the movement of her hand with the instructors’ movement (even note how they synchronize, a process described in Example SEESAW above). Another student, on the right side of the frame interjects, “She’s not doing the doorknob,” making reference to a member’s term for a scaling movement where the operator slightly pronates and supinates the wrist (similar to how one opens a doorknob). Indeed, this is the motion that the student on the left is modeling – however, in order to negate it, the student on the right must recognize that “the doorknob” motion is what the first is referring to in gesture. The instructor agrees with the student on the right, saying, “No,” then proceeds to describe her scaling movement as “a pretty subtle motion.”

The student on the left's gesture, the student on the right's recognition of the gesture, and the instructor's demonstration all rely on a cross-domain mapping between the real-world experience of opening doors by twisting doorknobs, and the act of scaling. By grounding the motion required during certain aspects of scaling, the action required (or not required, as in this example), is scaffolded by drawing on a conceptual understanding of motions required during opening doors with doorknobs. Note how only certain features of the motion are mapped: the pronation/supination of the wrist and forearm, primarily, whereas other features are not, such as the grip structure of the hand and fingers.

Indeed the phrase, "the doorknob," describing this motion with instruments, has been reified as a coded members' term, used during the training of novice practitioners<sup>12</sup>. While I have no evidence as to whether or not this is a term appropriated uniquely by this group of practitioners, or in a broader community of dental hygiene educators, the point is to show how students' conceptualization of certain aspects of scaling is organized in by linking it to an everyday embodied experience. That this metaphor is to some degree institutionalized by the community shows the power of this metaphor for conveying a salient aspect of scaling in certain areas of the mouth.

Sometimes, new members of a profession must be taught through direct instruction: a process more complex than mere demonstration and imitation (though these are themselves powerful sources of learning). Williams (2005) refers to these instructional practices as *guided conceptualization*: During the practice of guided conceptualization, the available semiotic resources – speech, the body, and the material environment – are drawn upon to engage the learner in the experience of constructing relevant meanings during the course of an activity. The conceptualization processes emerge from the relationships between speech, gesture, and environmental structure. In the SEESAW example, we saw a student actively construct her own conceptual metaphor to help her understand the functional properties of scaling activity, a metaphor that shared important functional properties, but differed slightly, from the instructor's. In the DOORKNOB example we see something slightly different, a reminder that the ability to conceive relevant actions is not housed in an individual mind, but emerges within a community of competent practitioners (Hutchins 1995). Moreover, as it becomes packaged within a linguistic item, such conceptual activity can

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<sup>12</sup> In Chapter 3, the section on "Following" shows another instance of using this term during instruction.



be easily perpetuated. Indeed, this kind of activity is a fundamental practice of culture. The construction of community knowledge is a shared process of forming symbols that ‘embody experiences that have emerged in situated action’ (LeBaron and Streeck 2000).

### **3.6. Conclusion – Action Scaffolding Discursive Strategies**

One of the primary goals of practical instruction is to develop skillful performance. As we have seen, expert skill includes an integrated set of perceptual and motor abilities. During practical training, instructors deploy a set of discursive practices that nurture skilled performance in trainees. These practices scaffold particular patterns of movement, patterns that students can assimilate and subsequently use to guide or govern tool-based actions. This article has investigated three practices used to entrain students with professional perception and expert action.

One way scaffolding is achieved is by guiding students to notice a set of perceptual cues indicative of correct (or incorrect) action. For instance, when Ingrid moved Stephanie’s instrument and hand so that the handle was more upright (Figure 8: Example GUIDE1), Ingrid positioned the instrument so that the student’s stroke was more effective. Simultaneously, Ingrid told her that, “it looks like your angulation’s a little closed somewhat.” By coupling guidance with the use of coded terminology (Goodwin 1994), Ingrid references a structural configuration, being used in a particular way. This emphasizes a set of perceptual cues with a specific action, and can be used to shape Stephanie’s developing skill set. As an embodied practitioner, Stephanie scales competently not only with her hands, but with her eyes and ears. Developing perceptual skills and learning to recognize cues can help guide a student to self-correct - as was the case in Example SELFCORRECT (Figure 10), when Stephanie shifted her instrument handle just like Ingrid had done moments earlier.

Another action scaffolding practice is via demonstrations, which are instantiations of institutionally relevant phenomena, presented in a confluence of speech, physical action, and material space. Demonstrations rely on the imitation system, the ability to recognize others’ actions and transform the observed patterns into motor activity. Though imitation processes are involved in when learning from the demonstrations of experts, spoken language, tool use, and complex social factors play an integral role in

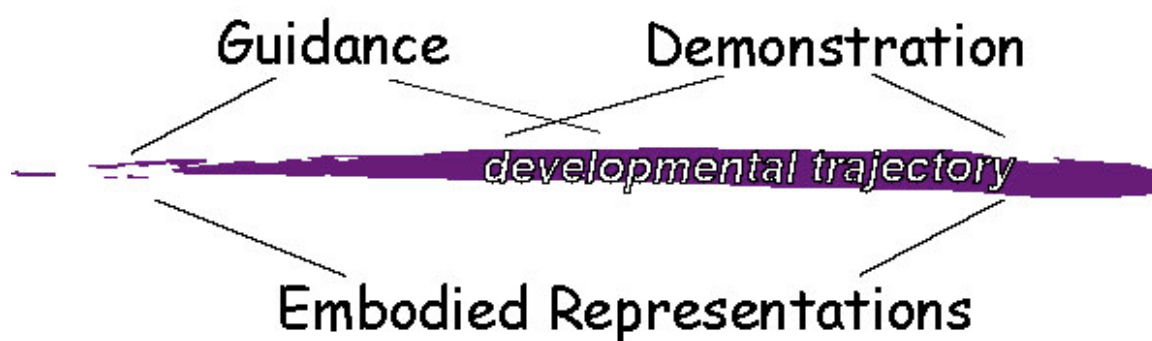
the training of novices in naturalistic contexts. In Example DEMO1 (Figure 14), Stephanie relies upon her background knowledge of the domain, such as the term “fulcrum,” in order to make sense of the demonstration Ingrid offers. Demonstrations reveal how actions and perceptions are interrelated, and scaffold a novice’s developing socially legitimate action.

Thirdly, scaffolding can be achieved through relying on patterns of movement understanding developed in other domains, such as when Stephanie called upon her knowledge how a see-saw moves in order to conceptualize periodontal scaling (Example SEESAW). Drawing upon a lifetime of experience moving and interacting with the world, students’ conceptual knowledge of spatial and motor patterns can structure how developing novices begin to formulate actions in a professional domain.

Skilled human action arises from how an individual selects a subset of behaviors from the unlimited alternatives within the self-organized constraint space that is defined by the person-to-environment interactions. Perhaps an expert’s self-organized constraint space is more structured than a novice’s. Certainly, an expert scales teeth exhibiting less wobble (i.e. ‘degrees of freedom’ in movement) than novices do. Perhaps learning might be facilitated by engaging in structured activities, revealing reliable correlations between motor activities and perceptual input derived from interactions with a specific environment. Indeed, instructors make use of a set of discursive practices that categorize and constrain a novice’s potential movements. Such practices serve to scaffold the learning process. Note that speech plays an important role in assigning coding terms to motor patterns, and by highlighting perceptual phenomena such as spatial relationships, manners of moving, auditory or tactile emissions that result during patterns of movement with tools in the world.

In this chapter I have drawn upon several representative segments of video data in discussing a set of discursive practices that are used in the training of novices. How representative are these segments? At what point during the learning process are we likely to see the various practices employed? It would appear that as a novice grows more and more familiar with instrumentation practices, the ‘degrees of freedom’ of movement decrease. If we were to think about the acquisition of the instrumentation skills as moving along a kind of developmental trajectory (see Figure 21), then based on the instructional episodes that I observed and recorded, a general trend arises. I observed that early in the learning process (both early

in the semester, and early meaning recently after a new kind of instrument is introduced) guidance activities, especially molding, are especially prevalent. This would make sense – an instructor’s hand can constrain degrees of freedom quite effectively until a student begins to develop the motor/perceptual skills necessary to position and activate an instrument. Gradually, as a student begins to develop an ability to perceive relevant features of instrumentation and the codified terminology, instructors can rely on demonstrations more frequently. (A demonstration isn’t useful unless a student is able to see and understand what features of the demonstration to attend to). Embodied conceptual metaphors, drawing upon real-world physical understandings, would seem to be useful at multiple points along the developmental trajectory. However, perhaps it might be necessary for students to grasp a basic level understanding of important features and dynamics of scaling in order to be capable of applying metaphorical understanding.



**Figure 21.** Tentative developmental trajectory for deployment of discursive practices during instrumentation skill acquisition.

One of the most widely cited theories of motor skill development, proposed by Fitts (1964), posits that motor skill acquisition proceeds through three successive stages: cognitive, associative, and autonomous. Does this approach fit well with the data I collected? I believe that the majority of the phenomena I observed would fit into the ‘cognitive’ stage, characterized by “*cognitively effortful*” learning. Certainly processing multimodal discursive strategies like guidance and demonstration would be considered cognitively effortful. According to Fitts, during the associative phase the concern is on perfecting movement patterns. It would appear that action-scaffolding strategies, like embodied conceptual metaphors and demonstrations, might be useful at this stage as well. However, I’m not convinced that

drawing a sharp boundary between cognitive and associative phases is possible, or that it does much good for helping us to understand the process of expertise development.

By working in concert with experienced practitioners on relevant tasks, the body of a novice is transformed into a ‘tool of the trade.’ This is the essence of the practical training. Competence as a professional is gained through embodied practice, by working with the relevant materials and enacting skills judged in circumstances evaluated by expert instructors. Practical education manipulates bodies, as novices are taught, “Sit this way, move this way; hold your arms, chest, and shoulders precisely like this.” Though some degree of variance is allowable, the range of acceptable bodily action is rigorously constrained. This is in part related to the design of the instruments themselves, which must be held and activated in a certain manner in order to function effectively. In the case of dental hygiene, another set of imposed constraints is placed by institutionalized principles of ergonomics – certain bodily configurations lead to repetitive stress injury, which students are explicitly instructed to avoid. Careful examination of the imagery and metaphors used during training reveals that very often the boundary between body and tool is blurred. For instance, in the Example SEESAW, Stephanie refers to her arm, hand, and tool as a single unit (and moreover, she refers to it in third person): “It’s like a seesaw.” This blurring of boundaries is similar to what Powell notes in her ethnography of apprenticeship training in Taiko drumming (Powell 2004).

## **Chapter 4. Implementation of a Vlogging System for Clinical Instruction**

### **4.1. Introduction**

Recent advances in digital video technology now make it possible to integrate capture and playback applications into high-activity, hands-on training contexts. With the wide integration of multimedia technology into several educational and professional training domains [3-5], it is important to examine how technology affects the social and cognitive aspects of these contexts. While many dramatic educational technology applications are currently being deployed, there is very little research on how technology affects the cognitive and social dynamics of educational environments. I am interested in designing and implementing educational technology that resonates with the cognitive and social structure of an authentic training environment. As Clark (1994) warns, "There is danger in beginning with an enthusiasm for some medium, and then searching for a sufficient and visible context in which to establish evidence for that solution." Rather, he argues, we must understand when, and in which situations media affects learning practices. Further, we should seek to understand how particular attributes of media and representations support learning practices.

### **4.2. Human-Centered Design**

Our current understandings of cognition impact the way we design technology for supporting cognitive processes. New models of human cognition have now begun to challenge traditional approaches towards system and usability design (Hollan *et al.* 2000). We now know more about how humans opportunistically off-load cognitive effort into the environment and use space to accomplish cognitive tasks (Rumelhart 1987; Kirsh 1995), and how cognition extends beyond the individual and is embedded within cultural systems (Hutchins 1995).

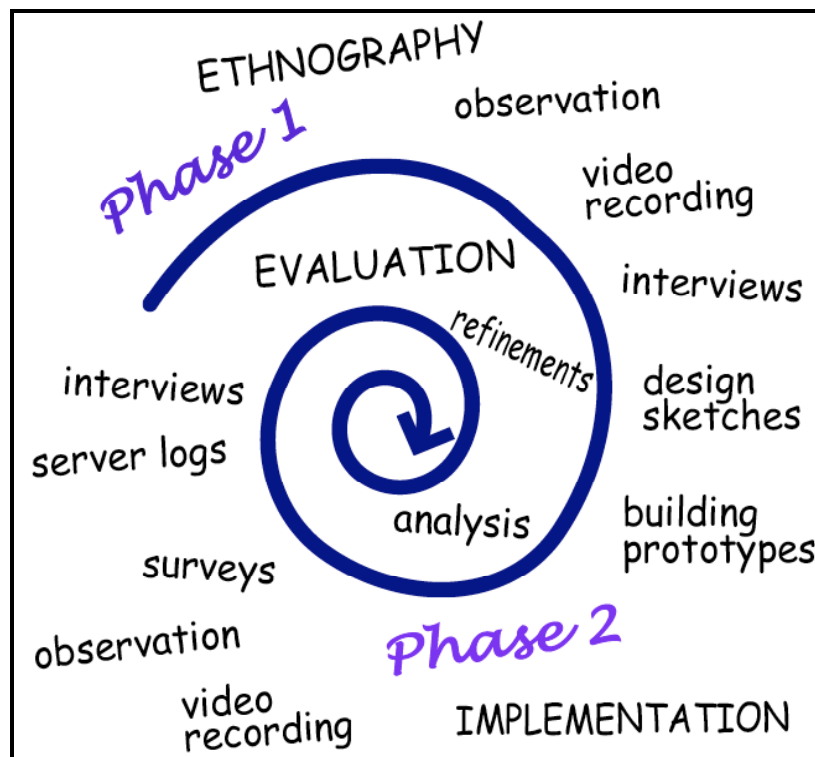


Figure 22. Ethnography-for-Design Cycle

Figure 22 is a schematic of the research approach that was taken, inspired by *human-centered design* (Norman 1993; Buxton 2006), cognitive ethnography for human-computer interaction design (Hollan *et al.* 2000), and participatory design (Ehn 1988; Kensing 1998)<sup>13</sup>. The aim of this research approach is to keep the user community central to the design. We can think about the problem of technology design as a multi-dimensional design space with many different axes specifying design constraints. In this space exist multiple potential design solutions; some more optimal than others. A preliminary goal of research is to generate a set of design constraints for the system<sup>14</sup> using both existing

<sup>13</sup> A related design framework is Activity Centered Design (Gifford & Enyedy 1999), which builds upon the insights of distributed cognition (Hutchins 1995; Pea 1993) and Activity Theory (Leont'ev 1979). In this view, learning is understood as a complex process in which an individual learner's cognition is defined by its relation to the material setting and the forms of social participation encouraged by these settings. Activity Centered Design emphasizes the design of computer-mediated learning environments to support and structure the interactions and interdependencies of an activity system, including the relationships between students, their instructors, the tasks they undertake, and the inscriptions they use.

<sup>14</sup> By “system” I mean an entire cognitive system – which includes both people and technology, and the interactions between them (Hutchins 1995). So this does not just mean technology, but how technology and people interact.

knowledge of human cognition and findings generated through research done in ethnographic study of the particular domain of interest. Using these guidelines as a guide, technology is designed and prototyped in the setting, and the resulting changes in activity are evaluated. Inward movement along the spiral happens as the design is refined and tested, generating new design guidelines and adjusting those that have been established.

As a basis for design guidelines, we can look to existing knowledge of cognition, trying to harvest what is known about cognition. So, some research that might be important to this particular study includes research on expertise: motor learning, learning-in-practice, and video-based instruction. However, because expertise is highly context-dependent, perhaps general knowledge of cognition will not apply to a specific domain in the way we anticipate it will. This is where ethnography is useful, because it can provide a detailed analysis of a particular domain, and can be used to refine design features.

Ethnography is a methodology characterized as the study of people in their natural settings, providing a descriptive account of social life and culture in a defined social system, based on qualitative methods (such as detailed observations, unstructured interviews, analysis of documents, digital video recording and analysis, and others). In a design context the goal of ethnography is to develop a thorough understanding of current work practice as a basis for the design of technological support. Blomberg *et al.* (1993) describe ethnography-for-design with four important principles: it takes place in natural settings; particular behaviors must be understood in the respective context; it develops descriptive understanding in contrast to prescriptions; it is grounded in members' meanings and perspectives. Using ethnography in the design of computer-based systems has become increasingly prominent especially within the research communities of Computer Supported Cooperative Work (CSCW) (Kensing and Blomberg 1998), but also within Contextual Design (Beyer and Holtzblatt 1998), and Human-Computer Interaction (HCI) (Hollan *et al.* 2000).

Both methodologically and philosophically, social studies of technology design and use depart from the classical experimental, hypothesis-driven paradigm. A large number of the studies of work practices and technology rely on ethnography as the primary research methodology for creating a "thick description" of the settings (with due regard to anthropologist Bronislaw Malinowski). Thereby, the goal is

to create a detailed understanding of local culture, unpacking existing social norms, work processes, acculturation processes, and the situatedness of actions. It is also the philosophical nature of these sorts of investigations that causes them to depart from experimental or positivist scientific tradition.

Fundamentally, ethnographic investigations rely upon inductive, rather than deductive, approaches. There is no “hypothesis to be tested,” but rather, lines of exploration emerge in the process of the investigation. For instance, a typical study might emphasize the observation of people in their working context, an elicitation of tacit knowledge and an inductive approach to observation and description.

Unfortunately, the dominant view of ethnography in HCI seems to be that it is a corpus of field techniques for collecting and organizing data to aid in technology design (Dourish 2006). The term “ethnography,” indeed, is often used to describe investigations that are, to some extent, *in situ*, qualitative, or open-ended. This perspective of ethnography as a purely methodological toolkit is somewhat dangerous, because it promotes the idea that the reason to adopt ethnographic methods is not that they will generate quite different kinds of understandings from experimental investigations, but rather than laboratory-based methods are unsuited to the target domain. However, in reducing ethnography to a set of methods for extracting data from settings, the theoretical and analytic components of ethnographic analysis are obscured. Ethnography is concerned with the member’s perspective and the member’s experience, but it does not simply report what members say they experience. Ethnographic data are not unproblematically recorded from a setting, but rather, are generated through an encounter between the setting and the ethnographer. Ethnography is always perspectival, and this perspectival quality is inherent to what ethnography is.

Moreover, field sites, as cultural hubs, are always in a state of dynamic flux. No matter what designers predict will be effective technology in ‘brainstorming sessions,’ we can almost never anticipate what will happen when new technology is implemented into a domain. Here the ultimate goal is to develop technology-based artifacts that resonate with, and at the same time transform, the activities and organization of work within which they are embedded. Flexibly prototyping technology and evaluating its effects on the activity and organization of the domain requires careful attention to the details of human interaction. Ethnographic methods can be valuable at this stage of research as well. Through a process of



iterative design, implementation, and evaluation, we can arrive at designs that may be fluidly integrated into current or developing practices.

#### 4.2.1. Digital Cognitive Ethnography

Our theoretical stance towards understanding cognition impacts the way we go about designing research methods. The methodology employed in our investigations should be compatible with our theoretical viewpoints. In the proposed research, cognition is taken to be inseparable from its context and embedded within other cultural systems (Cole 1996; Hutchins 1995). Honoring such a principle requires a research method that does not separate the cognitive phenomena from the setting where it occurs.

We can apply the methods of ethnography, grounded in a theoretical framework provided by distributed cognition, and expand our focus to include the material and social means of the construction of action and meaning. Furthermore, using ethnography can provide us with better functional specifications for the human cognitive system, and thus better guide how we go about system design (Hollan *et al.* 2000). *Cognitive ethnography* focuses on understanding cognitive processes as they are enacted in naturally situated activity.

Cognitive ethnography draws on methods for observing, documenting, and analyzing such phenomena: particularly: information flow, cognitive properties of systems, social organizations, and cultural processes. Because cognitive ethnography is an observational discipline, we cannot always establish causation -- the inferences we would like to draw are at times not rigorously proven by the available data. In such cases, the findings of cognitive ethnography may suggest ecologically valid experiments to enrich our analyses, which can be undertaken in more controlled research environments.

The focus of cognitive ethnography is on the characterization of activity systems as *information ecologies*. When we view cognition as a process extending beyond the skin and the skull of an individual (Norman 1993; Hutchins 1995; Clark 1997), then relationships between humans, each other, and their natural environment become paramount for understanding cognition. This level of description is especially useful for looking at the relationship between people and technology because it emphasizes technology as an active, and not merely incidental, participant in the cognitive system. Cognition and

action are interwoven in the details of the interactions between people and technology. Cognitive ethnography documents the context of such interactions, finding critical moments of activity in which a fine-grained examination of real-world behavior can reveal cognitive processes at work, processes that may prove relevant in suggesting technology supportive of cognition.

A cognitive ethnographer documents ongoing activity and interactions in the field site of interest. Real-world human interactions can be documented by making field notes, recording observations, collecting documents and artifacts, and recording video and audio. A major factor in ethnographically-inspired approaches is that human activity is socially organized, and actual behavior may differ from how it is described by those who do it (Cicourel 2004). This implies that detailed studies should include observations as well as interviews, and critical comparisons between them.

### **4.3. Research Methods**

#### **4.3.1. Field Site**

I discussed the field site in which I performed this research in depth in Chapter 2. To summarize, this study was done with a local dental hygiene training program, located in South San Diego. The program provides basic education and clinical experience to prepare graduates for licensure as dental hygienists. New students in the program are required to take an introductory course in basic instrumentation skills. This course was the central focus of my research. The introductory course was held in a newly constructed (completed Spring 2005) hands-on clinical laboratory. In the training clinic, each student is assigned to a practice workstation, equipped with dental unit and associated technology. As beginners, these students do not work on live patients, but instead practice on mouth models with realistic teeth and gums.

#### **4.3.2. Approach**

I conceived of this research study as a two-layered, iterative process. The first priority was to gain an ethnographic understanding of the field site, looking deeply at teaching and learning practices, media and representations used in teaching, social and institutional structures, and practical concerns

(financial and education level of participants). The second priority was an implementation of a design prototype, designed based on findings from the first stage of research. During the implementation phase, I collected more ethnographic data, looking closely at how the new technology was incorporated into teaching and learning practices in the field site.

#### **4.3.3. Preliminary Ethnographic Research**

During the first phase of research, I engaged in extensive fieldwork, spending a year in the field site with the first-year class of students and instructors. I collected ethnographic data in order to understand the types of activities that participants engage in, the circumstances they typically encounter, and the sorts of tools and technologies they rely upon to accomplish their work. While in the field, I made extensive observations, and in many cases held lengthy discussions/interviews with participants (both students and instructors).

Data in Phase I included digital video recordings of moments of instruction in the training clinic. I subjected them to repeated inspection using slow motion and frame-by-frame viewing. I focused on the discursive practices instructors and students engage in during practical instruction, e.g. what they say, how they say it, what they mean, and how this leads to skill development in students. Furthermore, all students were interviewed at least twice. The content of these interviews focused on how students studied course material and practiced instrumentation in clinic and at home. All five instructors in the course, and the program director were interviewed as well. The content of these interviews included what technology and representations faculty use and would use (as a new teaching clinic was being built at the time). These sessions also included brainstorming about the kinds of technology that could be integrated into the practices in place, in a participatory design style (Kensing and Blomberg 1998).

#### **4.4. Design and Implementation of a Vlog System to Support Clinical Learning and Instruction**

After analysis of ethnographic data, I used findings to motivate the design of instructional technology for the clinical training laboratory. Several results from the ethnographic portion of the study

motivated the choice of prototype implemented. In 2005, the program finished construction of a new clinical teaching laboratory (see Chapter 2) that had eighteen individual practice workstations equipped with embedded computer monitors, which were designed to show patients their medical records while they sat in the clinic. Typically, these computers will be used by hygienists to pull up patient records as part of a dental appointment; for instance, to show a patient's digital x-rays, information about necessary care, etc. However, I hoped to opportunistically utilize the technology infrastructure in place by harnessing the workstation computers for instructional purposes as new hygienists become trained themselves.

Below I summarize some of the design motivations for the system that was implemented:

#### **4.4.1. Design Should Integrate with Naturalistic Activities**

During the ethnographic phase of the research, we observed how instructors use action-scaffolding discursive practices (e.g. gestural demonstrations and hands-on guidance) in conveying instrumentation practices to novices. Our goal in technology design was to augment the kinds of interactions that can take place in the training clinic, not to replace the instructional practices integral to the training process. As Spector (2001) reminds us, "Some legitimate learning goals are effectively met with traditional and well-established methods; so we need not abandon what we know works well when embracing new technologies." For instance, hands-on guidance is an effective, and inexpensive, strategy for conveying instrumentation principles. A technological replacement of this activity, while possible to dream up, is not financially practical enough to be considered superior, or even necessary. Rather, the technology we chose to implement was designed to integrate with the social groupings and clinical training activities already established by faculty -- solo practice, partner practice, and faculty-guided group discussions (though inevitably, the technology changed the nature of some of these activities, which I explore in Chapter 6).

#### **4.4.2. Design Should Support Dynamic Representations of Motor Performances**

Originally, the idea was to implement a digital video system. Video seemed like a robust representation for showing instructional material, as much of what is learned in clinical training is motor-

based, and not shown well in static images. Properly conceived, video technology can be a powerful learning tool. Video media can be used in exercises that encourage learners to reflect on their practices, which has been a practice recommended for developing expertise in a number of domains (Schön 1987; Grossman 1990; Edmund & Hansen 1989). Locating concrete examples in terms of a body of professional knowledge is a key ability in integrating the general content of education into consistently effective professional practices (Pea 1994; 2004). A performance assessment system incorporating video can provide an evaluation of the learner's ability to both engage in effective performance and to reflect on that performance in professional terms.

Video has some unique characteristics that make it more rich and powerful for representing information compared with other media (Elmagarmid *et al.* 1997). Because it represents multimodal, dynamic information, it appears to be a particularly good representation of motor performances, preserving spatial and temporal information of movements. Video is concrete, providing a detailed record of the context and situational factors that may be backgrounded in other media (Kellog *et al.* 1997). It has a richness that cannot be as conveniently portrayed in text descriptions. Furthermore, video has a narrative structure that distributes information through time. Digital video has the additional benefit in that it can be accessed non-linearly as well as linearly.

On the other hand, video has some drawbacks. A complete scene cannot be captured in video. A video recording device produces a record that is partial (because it is limited by the operator's perspective: what the operator has chosen to capture and what to ignore). Often amateur video recordings are challenged in the audio dimension (Lampert and Hawkins 1998). When reviewing video recordings, we may be interested in different aspects of the events than what we recorded on film; for instance, events that occurred out of the field of view are unable to be recovered. Moreover, viewers are limited by zoom ratio of the camera – small details may be rendered too grainy or pixilated to be accessible to the viewer. This might be especially relevant when examining videos of small or subtle phenomena. Understanding the effects of perspectival biases in using video media for educational applications is important, and should play an important role in how we use video for educational purposes (Sfard and McClain 2002).

Nevertheless, video technology has been shown to be a powerful medium for teaching motor-based tasks in a variety of settings, including medical training (Levitan *et al.* 2001), surgical training (Beckman *et al.* 2003; Hall 2002; Kardash 1997; Wilson 1998), dentistry (Gray *et al.* 2003; Robinson and Lee 2001; Ruotoistenmaki *et al.* 2003) and dental surgery training (Correa *et al.* 2003), and athletics (Guadagnoli *et al.* 2002).

Learning motor abilities from video relies on the human capacity to imitate. Imitation is the ability to replicate an action performed by others and by so doing, learn and acquire new skills by the observation<sup>15</sup>. These skills can include entirely new motor patterns or exist as combinations of the imitator's behavioral repertoire. Motor skill imitation relies on the ability to recognize others' actions and transform the observed visual patterns into motor commands. Therefore, imitation involves the integration of multiple cognitive systems, namely perception, action, and learning. Imitation is a fast and automatic process (see Prinz 2002, for a review). People perform a finger movement more quickly in response to seeing a video of that same finger movement (i.e. to imitate) than they are to perform the finger movement in response to an arbitrary cue (Brass *et al.* 2003). Further evidence comes from transcranial magnetic stimulation of motor cortex together with recording motor evoked potentials from relevant muscles. Increases in muscle potentiation in the subject's hand are observed with the subject watches a hand performing gestures, grasping, or manipulating an object (Clark, *et al.* 2004).

We envisioned running a digital video system on clinic computers that would allow students to record themselves and view a split screen comparison of their practice with instructors'. Learning environments incorporating new digital video technology can scaffold a developing professional perception by providing opportunities to reflect on practice in comparison with expert demonstrations. For instance, professional training programs like teacher education are using online digital video programs with great success, such as Pea and Mills digital video software program, DIVER. Initially, we brainstormed about the possibility of using the DIVER system (Pea *et al.* 2005). The DIVER Project—Digital Interactive Video Exploration and Reflection—at Stanford University is a research effort that is implementing many of the ideas for successful learning technology using digital video that have

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<sup>15</sup> Many behaviorists would also include that true imitation occurs when the imitator replicates action with the same resultant consequence as the "imitatee."

been discussed in this section. DIVER supports interactive video repurposing, prompted by a user's desire to review content, and communicate and share their interpretations with others. DIVER provides what is referred to as 'point of view' authoring (Pea *et al.* 2002) of video records and multimedia archives in a way that facilitates sharing, collaboration, and knowledge building. DIVER also supports what is known as "guided noticing" -- using video editing techniques such as panning, zooming or annotation to direct attention in a video clip. Portions of the visual field can be emphasized through editing techniques, such as pan and zoom, or annotation. A user can share her perspective on a scene by reframing the clip within the program, creating what is known as a DIVE.

In early 2005, I met with faculty in the dental hygiene program (program director, three instructors), to discuss the possibility of integrating DIVER into introductory clinical instruction. I demonstrated the DIVER system using pilot clips I had videotaped with an instructor. Initially the faculty I talked to seemed to be enthusiastic about DIVER; especially the program director. I also made three visits to Stanford in order to discuss collaborating with their lab on the project, and how we might adapt DIVER to suit the needs of this project. However, when the time came to begin prototyping technology in the clinic in the spring and summer 2005, the head instructor told me that using DIVER was not a possibility. Once she saw what learning the software would entail, she became concerned about the extra class time it would take to train a student population having varying levels of computer literacy on how to use the DIVER software. She also felt it was too much of an additional burden to create training and video annotation exercises into the curriculum. Moreover, the school became very concerned about the additional work that would be created for the school's network administrator in order to install and manage the DIVER software. (At first blush, these challenges may seem not to have the same theoretical importance as some of the other constraints for advancing our understanding of the learning processes involved in clinical education. But according to often social and institutional factors often take precedence over usability concerns, and can therefore have enormous practical implications for design. I will discuss these social issues further in Chapter 6).

Therefore, we worked to create a technological solution that would support the cataloguing and viewing of video records without the need for specialized or unfamiliar software.

#### 4.4.3. Design Should Support Attention-Directing Annotations

Research has shown that video is most effective as a teaching tool when it is accompanied by additional, attention-directing augmented information (Schmidt 1998). For instance, an instructor accompanies a video replay, and highlights the important details from the irrelevant elements. Or, after watching a video, students create written annotations reflecting on their practices and experiences in relation to the video. Writing about what students perceive in the video records may facilitate the development of professional perception (Pea 2004; Halter 2006). Tools for reflection enable making comparisons and evaluations, and allow learners to explore alternatives (Boyd and Fales 1983). For a system to be capable of supporting reflective practices, it should have a compositional medium that affords adding new representations, modifying and manipulating old ones, and performing comparisons.

Working with the program director, I came up with a design compromise that met as many of the design guidelines as possible, while meeting the practical constraints we were under. As DIVER was not a possibility, we instead implemented a video blog [‘vlog’] system, which was prototyped in the incoming class of students in Fall 2005. A vlog format was chosen because of its flexibility, universal access, capacity to support a variety of media and annotations, and its ability to be readily modified (Wikipedia 2007). A screen shot of the vlog is shown in Figure 23 and Figure 24. The vlog and accompanying digital video<sup>16</sup> required basic Internet skills, and could be viewed and controlled from practice workstations in the training clinic (see Figure 25 and Figure 26).

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<sup>16</sup> Blogger software was used to create the class and student vlogs, which were supported from our home server. Videos were created in Quicktime format.





Figure 23. Screen shot of the main page of the vlog.

MONDAY, SEPTEMBER 12, 2005

## Demonstration of the Periodontal Probe

This clip shows Director Poulos explaining the basics of periodontal probing.

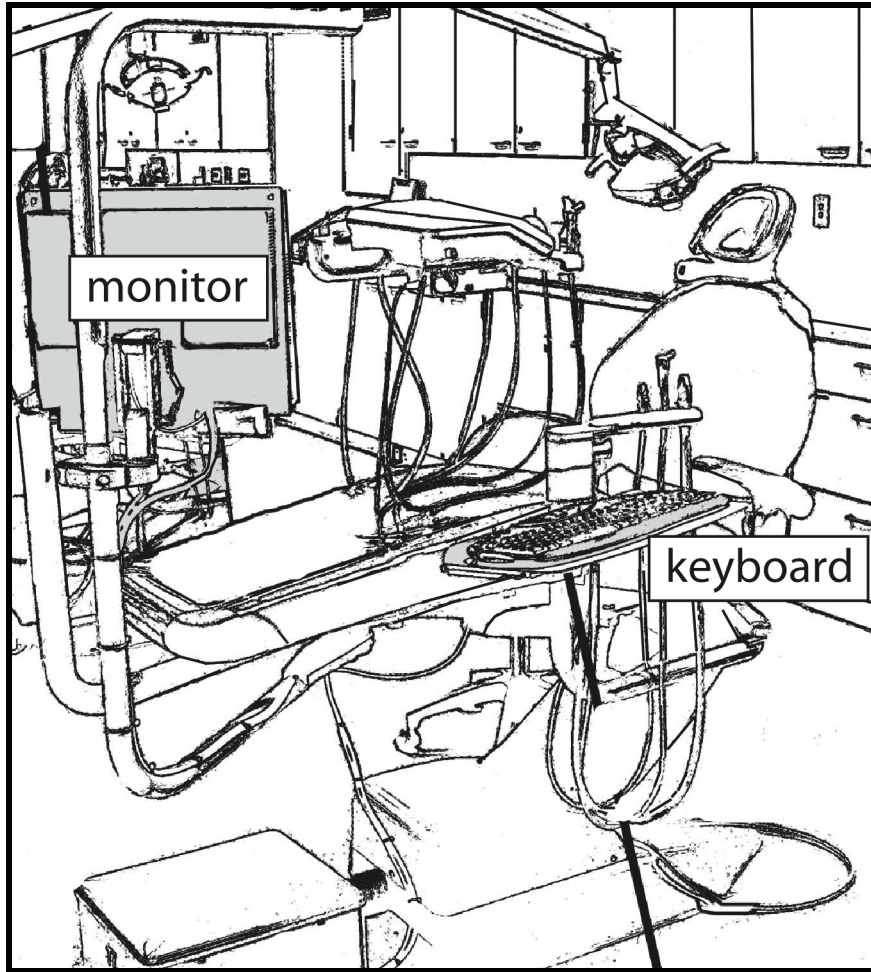
To view this video file in a separate window, click:

[HERE](#)

Or click the play button in this frame to open directly here:



**Figure 24.** Screen shot of a vlog entry.



**Figure 25.** Line drawing of a student workstation in the clinical training laboratory, based on a digital photograph. The embedded computer system (flat panel monitor on a swivel and keyboard+mouse on a rotating tray) is shown in grey.



**Figure 26.** Student engaged in hands-on practice in the clinic, while simultaneously watching a digital video on the vlog and conversing with her study partner about video material. Note how she has angled the computer screen to face her while seated, and has placed the mouse (covered with a sterile plastic film) within arm's reach.

Though blogs have existed for some time, little research has been done exploring blogs as learning spaces for students in higher education. Exceptions include exploration of methods for using blogs for educational purposes in university courses (such as Harvard Law School, and the Brisbane Graduate School of Business at Queensland University of Technology – see Armstrong and Berry 2003). A strong point of blogs is their versatility, and only recently have educators begun to exploit blogging technology in educational circles. Furthermore, the nature of blogging engines allows for the creation of a legitimate warehousing of captured knowledge, and archiving for later retrieval (Bausch, Haughey & Hourihan 2002). Some of the first applications of blogs and electronic discussion boards in educational settings have been for predominantly text-based material, i.e. discussions, summaries, and debates about course material. An important distinction between blogs and similar asynchronous discussion forums, such as newsgroups and discussion boards, is that the blogging interface easily supports the inclusion of

hypertext links, images, audio and video material. More recently, blogs have been created that can support a variety of multimedia materials, such as video, audio, and images. In fields where much of the material involves a significant visual and/or motor-based component, multimedia blogs provide a valuable resource.

#### **4.4.4. Design Should Support Viewing of Activity from Relevant Perspectives**

In studies where video was used for training in manual skills, it was found that perspective is important: motor facilitation while observing hand actions was found to be selective for those instances when the perspective of a video matched the perspective of the performer, as indicated by both performance outcomes and measures of cortico-spinal activity (Maeda *et al.* 2002).

The collaborative vlog contained a variety of records. Each week, I recorded the program director as she demonstrated technique for the instruments being taught. I made an effort to film from an angle close over her right shoulder in order to make the perspective of the video as close to “first person” as possible. Additionally, I created videos of faculty demonstrations done during class time, again from a site behind the clinician’s right shoulder.

Hence, on a weekly basis, several short (2-5 min.) video segments were made and posted to the vlog. The vlog was periodically updated as new information was discussed in class, and the newest posts were put at the topmost section (just below the first entry, with directions on how to use the system). Students and faculty were given access to view video records and add, edit, or view accompanying blog commentaries and posts. The vlog was accessible both in clinic and remotely. Figure 27 shows a summary of the records contained on the vlog.

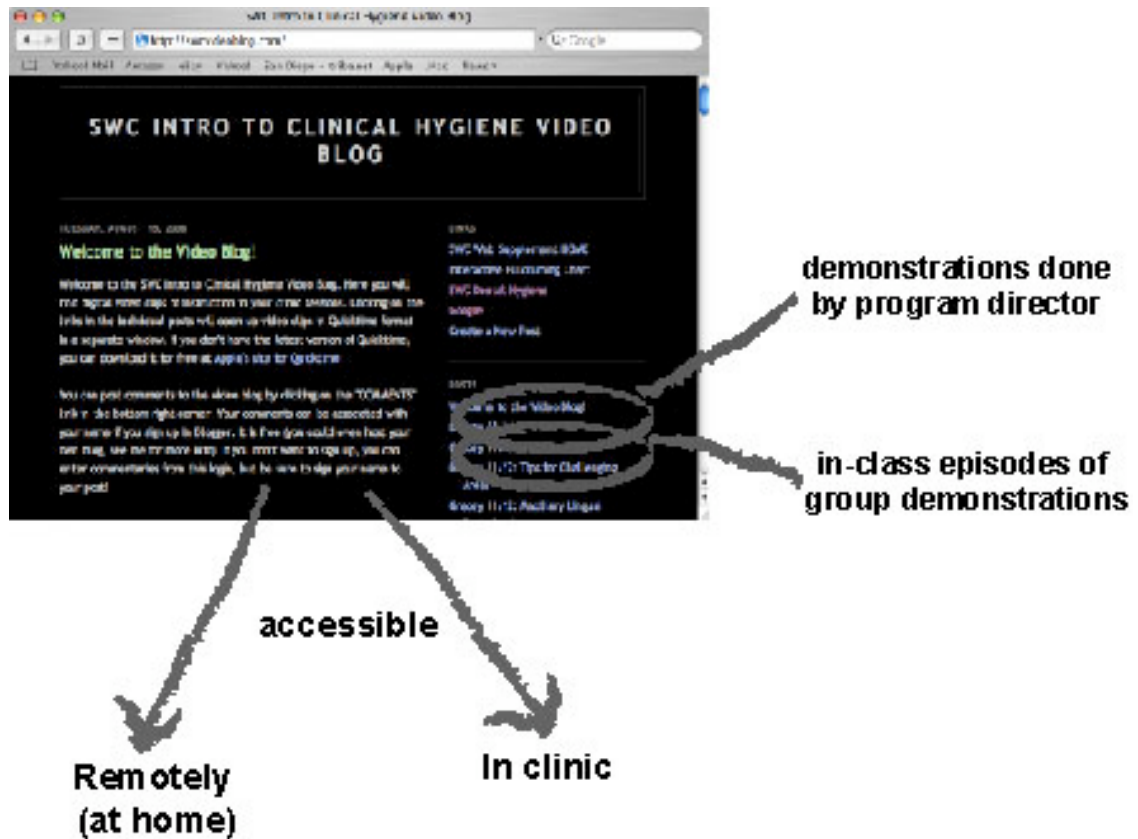


Figure 27. Records contained on the vlog, and locations from which the vlog could be accessed.

#### 4.5. Summary of Research

In this section, I discuss broad usage patterns and perceptions about the new vlogging system that was used in Fall Semester 2005. This project was carried out using ethnographic methods, such as observation, video recording of technology use, a post-semester web-based survey, server log data, and student and faculty interviews.

##### 4.5.1. Observations of Technology Use

I attended both meetings of both sections of the introduction to clinical hygiene course. I chose to work more closely with one student group (LR's group), consisting of five students and one instructor, so as to do more in-depth observations. I chose this group in large part because of the group instructor's

expressed interest in the project, and her perceived comfort with my presence and videotaping of sessions. Closer observation of this group allowed me to establish a rapport with participants, as they became comfortable with my presence. It also allowed me to make repeated observations and see patterns of interactions develop over the course of the semester. I realize that the decision to look more in-depth at one group, as opposed to broadly at all six, means that I may have sacrificed access to more generalized observations in order to collect more detailed data. However, I did make the effort to compare preliminary analytical findings observed in one group with the rest of the class (for instance, technology usage and interaction patterns) in observations, interviews, and survey responses. I also conducted several interviews with faculty who worked closely with student groups, which gave me another perspective on usage trends and events.

While in clinic, I made extensive field notes and observations, focusing on how students and instructors made use of the video blogging system. I also recorded sixteen hours of digital video in the clinical laboratory, focusing on instances when students and faculty used the vlogging system in the lab. These video records were examined, transcribed, coded and analyzed. I discuss this process further in Chapter 5, where I present some representative segments of video.

#### **4.5.2. Post-Semester Survey**

Web-based surveys were administered to students and faculty (two different versions). Copies of the survey are located in the APPENDIX, as is a copy of the email I sent out requesting participation. Questions to students were aimed at how technology was used in clinic and at home, as well as things students liked or disliked about the technology. Questions to faculty had to do with how faculty promoted technology in clinic or at home, and what they liked or disliked about the system. The surveys were created using Freeonlinesurveys.com, a company that creates assistive software for survey creation and data compilation. An email was sent to students and faculty asking them to confidentially fill out the surveys online. Through Freeonlinesurveys.com, results were sent to a database and downloaded into Excel. Sixteen of thirty-two students and three of five instructors voluntarily submitted surveys. The survey data was managed and analyzed in an Excel spreadsheet. The data is shown in the results section.

### **4.5.3. Server Log Data**

Server log data from our lab server was captured from August 2005 through January 2007. Using standard UNIX commands I modified the log data to show only those requests for video files. I decided to ignore visits to the vlog home page, because I thought that the requests for video files would better represent occasions when students were actively using the vlog (and by default, show visits to the vlog home page). I also extracted requests that came from my home computer or my computer in lab so that these were not included in the data. Furthermore, upon visual examination of the raw server log data (especially in the early stages of the implementation), I noted that oftentimes duplicate requests within a few to several seconds appeared in the log file. Referring back to my field notes, I correlated this result with the observation that early on students had clicked multiple times on the video link before it had time to fully download (this often took about 20-30 seconds). Because I didn't want this behavior to artificially inflate the number of requests, I ran a customized UNIX macro that would extract duplicate requests that occurred within a 10 second window. Frankly, there may have been cases where a viable record was excluded, but I chose to err on the side of caution.

Using Analog 6.0, and Analog Helper, a set of freeware software for analyzing server log files, I ran several analyses of the data, which are shown and discussed in the results section.

### **4.5.4. Student and Faculty Interviews**

Thirty-three students and five clinical instructors voluntarily participated in this study (two students enrolled in the program and one faculty member chose not to participate). Each student was formally interviewed once during the semester, though several informal contextual interviews were also conducted as students worked. According to Beyer and Holtzblatt (1998), holding interviews in the users' environment 'grounds' the interviews in surroundings and artifacts, making the discussions more concrete and uncovering factors such as routines, interactions with technology, and collaborations. The bulk of the interviews with faculty were done in the clinical laboratory, but some longer interviews were conducted privately in faculty offices, and off-site.



The five faculty members were interviewed several times, and the details of this data are shown in Table 2. The results of these interviews are discussed more deeply in Chapter 6. Having access to information about the way instructors perceived that students were using the technology was helpful for guiding an evolving design. Instructors' reports gave a perspective on problematic aspects from both a curricular standpoint (how the technology fits with the course design and material) and a pedagogical standpoint (how the technology presents information to students and structures their activity).

**Table 2.** Summary of interviews done with faculty.

<b>Instructor's Initials</b>	<b>Pre-Semester Interview</b>	<b>During Semester</b>	<b>Post-Semester Interview</b>
TP	8	12	2
KR	3	5	1
LR	2	8	1
DJ	1	2	1
PD	4	--	6

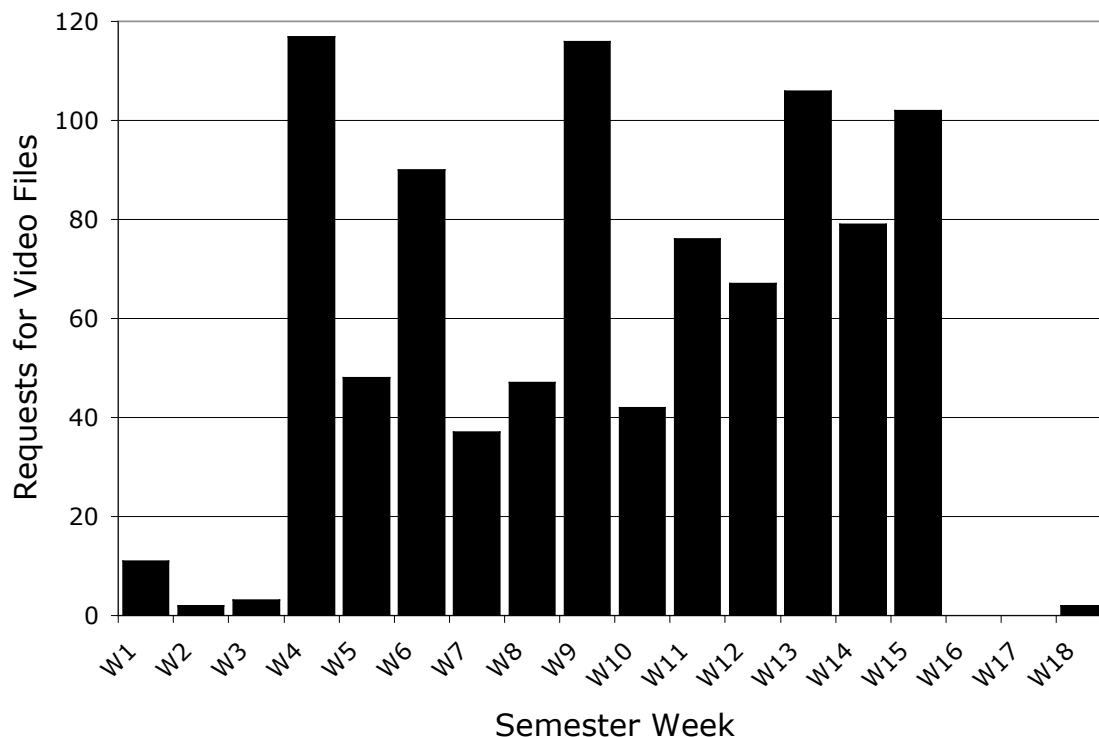
## 4.6. Results

### 4.6.1. Class Vlog Use

Figure 28 shows server log data recorded during the Fall Semester 2005, divided by week of the semester. The chart indicates the number of requests for video files from the main page of the vlog. In total, between the dates of August 15 and December 22, 2005, there were 1,167 requests for video files (calculated after cleaning up the data by removing duplicates and requests sent from my computer workstation). I correlated the server logs with the course syllabus (Table 3) to look for emergent patterns of use.

**Table 3.** Course Syllabus for Introduction to Clinical Practice in Dental Hygiene.

<b>Week</b>	<b>Topics Covered</b>
1	Introduction/Positioning
2	Instrument Parts, Grasp
3	Activation, Pivot, Handle Roll
4	Periodontal Probe/Explorer
5	Periodontal Probe/Explorer
6	Principles of Scaling/Sickle Scalars
7	Sickle Scalars/Medical History
8	Sickle Scalars
9	Universal Curette
10	Universal Curette
11	Gracey Curettes
12	Gracey Curettes
13	Polishing/Compressed Air
14	Hoes, Chisels, Files
15	Review
16	Prep for Partner Care
17	Partner Care
18	Partner Care



**Figure 28.** Server log data showing access frequency of class vlog (both in-class and home, combined).

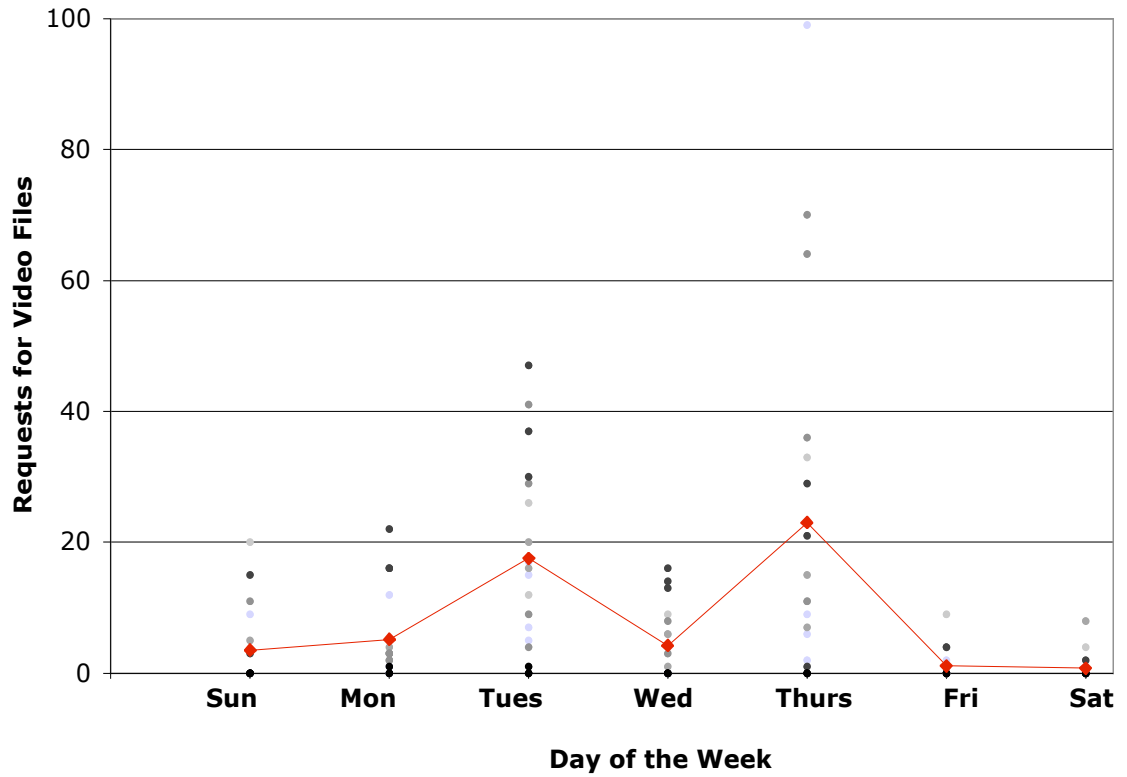
For instance, I demonstrated how to use the vlog technology in Week 1. Consequently, we see some low level activity of video file access. In Week 2 and 3, students worked on clinic safety and positioning, material for which no videos were created or posted on the vlog; likewise, very few accesses were made in Weeks 2 and 3. The first week that had video material posted on the vlog was Week 4, which was incidentally the week showing the most online activity. We see fluctuations in activity over the next several weeks. Interestingly, the peaks in video accesses occurred when new material was introduced (most notably, Week 4, 6, 9, 11, and 14). Final oral exams on instruments were given in Week 16, which may explain the high level of activity in Weeks 13-15. After Week 16, students practiced on live patients (their student partner), and apparently did not access the vlog much during this activity, either at home or in clinic. These trends make it seem that the majority of students found videos most relevant when they

were learning a new instrument/concept, preferring other strategies when they were reviewing material or studying.

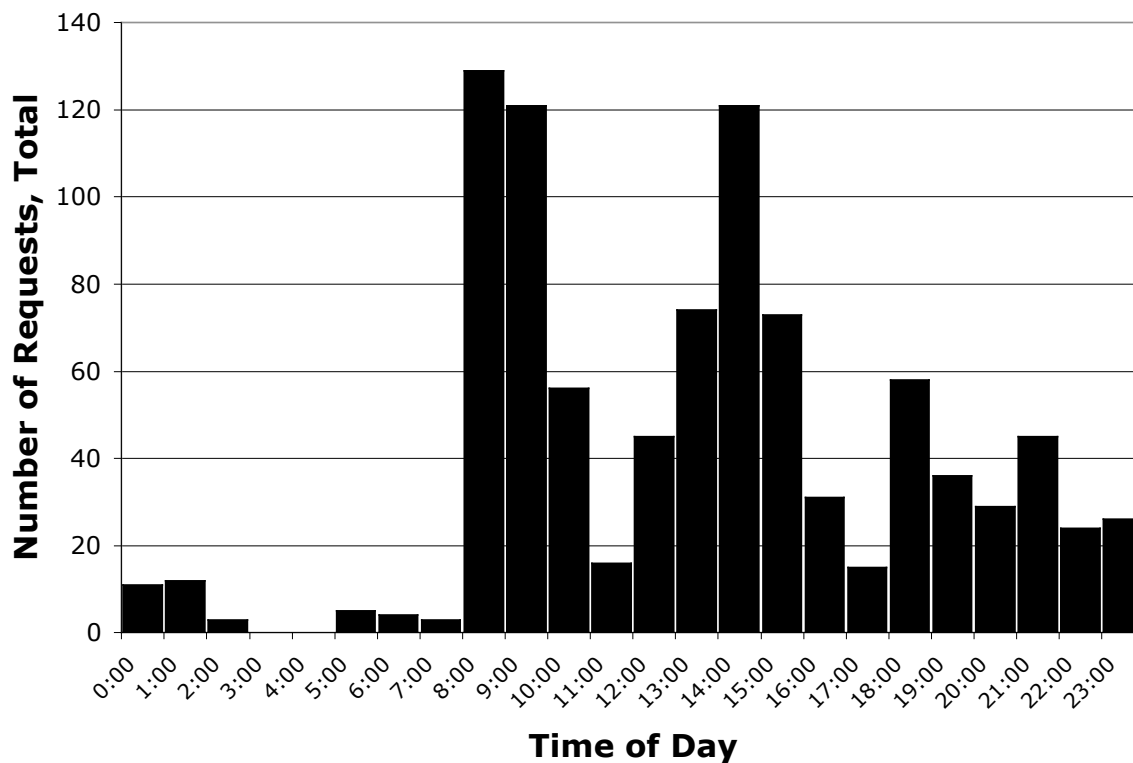
Following the end of the semester, some low level of activity was observed (not shown in Figure), amounting to 59 requests total from mid-December through January. In interviews, some students mentioned that they planned to watch videos at home over the semester break to review technique prior to the start of the spring semester. Presumably this activity is due to students practicing on their own at home.

Figure 28 shows the number of requests per day of the week for the entire semester. Each data point represents the number of requests for video files on that day. The shade of the point indicates the week of the semester; the later into the semester, the darker the shade. The average number of requests by day is shown in red.

Figure 28 shows that the vlog was accessed most frequently during clinic times (Tuesdays and Thursdays), followed by evenings that preceded clinical meeting times. Several students noted in the web-based survey that they often used the vlog at home to prepare for practical exams. It is likely that home-based vlog usage was mostly due to students' preparing for practical examinations held during clinic meetings. The large spread of data, especially seen on Tuesday/Thursday, indicates that vlog use varied greatly week by week. The day showing the most requests for videos was during Week 4 (99 video file requests on Thursday), the first day that new information appeared on the vlog. While this high number may be representative of a 'novelty effect,' the fact that the vlog continued to be used considerably throughout the semester indicates that it became integrated into practice.



**Figure 29.** Server log data showing the number of requests per day of the week for video files from the class vlog. Each data point represents the number of requests for that day. As the week of the semester increases, the color of the data points for that week gradually increases from pale gray to black. The average number of requests for that day of the week are shown as diamonds, with a line trace between points to denote trends.



**Figure 30.** Server log data showing the total number of requests for video files from the class vlog per hour of the day.

Figure 30 shows the total number of requests for video files per hour of the day. The figure indicates that the vlog was most frequently used during clinical meeting times (8-11AM; 1-4PM). We also see a substantial amount of use at evening times, which are representative of home use.

#### 4.6.2. Web-Based Survey

I administered a web-based survey to students at the end of the semester. Roughly half (17/31) of the students voluntarily completed the survey online. Table 4 shows a summary of some of the results from the multiple choice segment of the survey, showing when and in what context students often made use of the vlog, and what features students wished for in future versions of the vlog system.

**Table 4.** Student survey questions, responses, and percentage of respondents (NOTE: not all data from the survey is shown in the table).

Survey Question	Responses		
On average, how frequently did you use the vlog in class?	72% once a week	28% once every two weeks	
On average, how frequently did you use the vlog at home?	57% once a week	43% once every two weeks	
Did you prefer to use the vlog in clinic or at home?	28% clinic	28% home	44% no preference
Did you use the vlog with a partner or working alone?	100% both		
What activities were you doing while watching videos?	72% practiced with mouth model	28% just watched	14% took notes
What improvements should be made to the vlog?	72% wished for bigger video frame	57% wished for more lessons	

Students pointed to extensive use both inside and outside of formal clinical teaching. The majority of respondents (72%) said they used the vlog in class once a week, and 57% used it at home once a week.

The survey also had several short answer segments. Included below are several responses to short answer segments. I have identified several themes that the responses to fall into.

#### 4.6.3. Access to Instruction

In clinical instruction, the student/instructor ratio is roughly 6:1, and instructors spend on average 20 minutes per student in a three-hour session (according to time log calculations done during research in 2004). Students commented that though one-on-one directed faculty instruction is not always possible,

they felt the vlog enabled them to access information in a self-paced manner that before they only had when working with instructors. Below are shown several responses to the following question:

**In your opinion, what are currently the biggest benefits of the video blog?**

- *I feel the video blog helped keep me from developing bad habits, as well as answering questions I had that may have otherwise had to wait until the next clinic class time.*
- *Most often at home the video blog was very useful as the instructors were not available to ask questions, or demonstrate.*
- *They are a visual reminder of what we were taught in clinic. You can turn them on anytime of the day at home. It's like having your own demo anytime you want. You can rewind, and watch it over and over; a specific part.*
- *The vlog was so helpful because I learn visually, and I couldn't remember the demonstration at times, that the professors would give in clinic. It was a "follow-up" for me, from what I learned in clinic.*
- *It was very difficult to know if you were doing something correctly when working by yourself with no feedback. The vlog gave me a way of knowing if I was doing something well or no, because I could compare myself to what I saw on screen.*
- *I liked how the vlogs showed the instrument in action. The book is two-dimensional, and sometimes does not even cover the same instruments as what's in our kit. In clinic, we only get to watch the instructor 2-3 times, and after that we are on our own. I can't imagine doing this without the videos.*

Many students mention that having the vlog empowered them to access relevant course material and demonstrations that otherwise would require an instructor. By comparing themselves to expert demonstrations onscreen, students indicated they were able to self-assess technique and make adjustments to their own technique.



#### 4.6.4. Usage Patterns

I also asked students to report on specific cases where they made use of the vlog:

**Question:** If you can, please describe a specific situation where you used the video blog to learn about a particular instrument or technique. Include details like where you were, who else was there, ideas that the videos helped you understand, and how many times you watched the video in a row. (If you can't think of one, go ahead and skip).

- *WITH THE GRACEY 1-2, I WANTED TO KNOW WHERE I SHOULD FULCRUM/SCALE WHEN DOING THE ANTERIOR TEETH TOWARDS ME. WATCHED ~5X BY MYSELF IN CLINIC. I WENT BACK MULTIPLE TIMES UNTIL I GOT IT.*
- *For example, the probing. I learned using different side of the instrument to adapt different tooth's surfaces.*
- *I was having difficulty with the Gracey 1/2, so I watched the director with her angling of the handle, working end and strokes. I watched the video sometimes 5x in a row.*

Other responses were more general, describing typical use patterns:

- *I practiced on the mouth model while watching the vlog, and paused it for hand, or fulcrum position.*
- *I would usually just watch and take notes. I would watch it the whole way through unless I missed something or was unclear about something then I would rewind and watch that part again.*
- *I used it while practicing on my mouth model and usually had it up while practicing for a proficiency.*
- *I watched them multiple times before a proficiency test. I watched them alone, with my mouth model, at home. The videos helped me remember how to use the instruments in general, and specifically, positioning, fulcruming, angle of the instrument for adaptation, etc. I would watch the video blogs sometimes 3 times in a row, to try to get some of the finer points down.*

Several students mention watching the videos multiple times, or at home. Many students indicated that they simultaneously practiced on their mouth model while instrumenting, both in the short answer segment of the survey and the multiple-choice section (72%).

#### **4.6.5. Critical Feedback**

Some students also reported that they were dissatisfied with the quality and size of the video records. They had a desire for bigger viewing windows, or zoom capability (72%). In interviews, students expressed a desire to zoom in and see “larger than life” close ups of instruments and oral anatomy. Because the clinic computers had a relatively slow Internet connection, we had set the video frame size to create files that were small enough to download quickly to minimize wait time. In the future, it is possible that advances in digital video technology and new compression algorithms will allow us to produce high-resolution video segments of small file sizes. In the meantime, we came up with a ‘band-aid’ solution that worked fairly well. One afternoon, I noticed that one of the more techno-savvy students had opened up a magnification program and was looking at a still image from the video in the magnified region of his screen. Intrigued, I had him explain to me what he had done, and with some small adjustments to match the screen refresh rate to the video frame rate, we set up a strategy that students could use to get a closer view of video material. However, there were some losses to video quality at the expanded size.

I also had a short answer segment for comments on other aspects of the vlog that students were dissatisfied with.

#### **Question: In your opinion, what are currently the biggest shortcomings of the video blog?**

- *My wish list for the vlog would be that it contain more demonstrations for the proficiencies. Most of the time the areas contained in the blog were of other areas of the mouth. The proficiencies were of the most difficult areas, at times, and hand position and fulcrum were*

*hard to achieve without a demonstration. It would have been nice to practice at home prior to coming to clinic so we could be more productive in clinic prior to proficiencies.*

- *I think you did a great job on this, but some of the videos are hard to see and maybe have demonstrator take off gloves so we can more accurately see finger positioning. Gloves sometimes blended in and made it difficult to tell exactly what her hands were doing and where positioned.*

#### **4.6.6. Use of Commenting Features**

One of the original visions we had was that students could interactively use the vlog to post questions and comments about specific material. When I created the vlog I enabled features that would support commenting and discussion on post topics with associated video. For instance, if a student had a question about a particular post, they could attach a question and open a dialog with instructors or other students. On the front page of the vlog, I described how a student could log into the system in order to leave a comment or post a question. I also mentioned this when I introduced students to the technology and demonstrated how to use it at the beginning of the semester.

Aside from one case, students did not use this commenting feature much at all. The case in question was when material shown in one of the videos did not match up with the head instructor and book. In the video, "Introduction to Scaling: Basic Principles," the operator demonstrated scaling sitting in a position that differed from what is shown in the text. In Table 5 below I have shown the comments posted to the vlog, associated with this post:

**Table 5.** Summary of comments posted to the class vlog from 10/12/2005-10/13/2005.

<b>MP said...</b>	I am confused - she is sitting at 11:00 and not at 8:00 to 9 oclock like it says in the book. Thanks for your help, MP 10/12/2005 8:15PM
<b>GB said...</b>	Yeah this is confusing us too - what are we suppose to do? -GB 10/12/2005 8:30PM
<b>LL said...</b>	If you sit at 11, then you can do surfaces towards and away without having to move the chair. LL 10/12/2005 8:34PM
<b>SWC said...</b>	ya but whats on the proficiency? 10/12/2005 8:41PM
<b>GB said...</b>	Hey you guys, I just check the fulcrumign chart - it says that 11 is the Alternate Configuration for surfaces towards, anterior maxillary. :) GB 10/12/2005 8:41PM
<b>JS said...</b>	So what does that mean, can we sit there during the proficiency? Can someone ask Prof KR during the help session Thurs please? I can't go because I need to pick up my daughter from day-care. Thanx! JS 10/12/2005 9:01PM
<b>LL said...</b>	Sure JS I will ask her. I will be there. LL 10/12/2005 9:11PM
<b>LL said...</b>	Hey everyone, I guess we can sit either place, whichever is easiest for us. They said we can do that on the proficiency tomorrow too. LL 10/13/2005 5:50PM
<b>AB<sup>17</sup> said...</b>	Hi everyone, I also changed the text on the video blog to reflect what the faculty have said about fulcruming in anterior regions (i.e. the two options). -- AB 10/13/2005 7:31PM

Beasley and Smyth (2004) report a similar result in a study they did on the usage of an online learning environment for engineering students. They found that although an asynchronous discussion forum was provided for students to ask subject-specific questions, and the purpose of the discussion boards was communicated to the students, it was never used. In surveys, students reported that they were aware of the system and they did know how to use it, but they preferred getting feedback face-to-face. Perhaps, in our case as well, lack of use has to do with the difficulties of translating image and dynamic information into writing? Another key reason mentioned by Beasley and Smyth is that it was because the academic staff did not actively integrate the discussion forum into the curriculum. As many students tend to satisfy only the basic requirements for interacting with new technology (Light *et al.* 1997), it is unlikely that students will participate in asynchronous discussion simply because a facility for this has been provided (Tomlie and Boyle 2000).

Furthermore, seeing the website as something they can co-create, rather than simply consume, might involve a significant conceptual shift. Jonassen *et al.* (1999) point out that it is often necessary to re-

<sup>17</sup> NOTE: I am AB, I posted the response indicating how I had altered the associated text with the video, after discussing this issue with the head instructor.

educate learners about how to participate in dynamic learning environments, as old educational models of passive learning are still prevalent. Furthermore, it is now well documented in HCI literature that cultural factors are a powerful variable affecting users' expectations and behavior (Evers and Day 1997). Given this student population is drawn from underserved communities, with low computer literacy skills, they might experience strong cultural barriers that prevent them from transforming and revising the very website that they regularly consult for instruction. Indeed, blogging may not be a familiar activity to this student population: according to data collected from the *2005 Pew Internet Project Tracking Survey*, only seven percent of adult Internet users say they have contributed content to a blog, and twenty-seven percent say they read them – and those who were blog readers were more likely to be living in highly wired and high-income homes than in other populations (Lenhart and Madden 2005).

#### **4.7. Discussion**

We implemented collaboratively built video blog in an introductory clinical dental hygiene course in the fall of 2005. A vlog format was chosen as a compromise between desirable representational attributes and practical constraints.

Recall that we were able to identify 1,167 individual video access sessions in the server log data. In total, there were 74 video demonstrations captured. If we assume that there were 32 students enrolled, then the numbers show that 1 in 2 students visited every demonstration at least once. Of course, based on observations, interviews, and survey data, we know that some students did not access videos at all, and others probably accessed them more than their peers, but on the whole, these numbers indicate that the captured video demonstrations were frequently accessed by the students. Therefore, through survey analysis and system use, I conclude that not only do students say the vlog is useful, but that they actually did use it.

Though it was *most* popular on the first day relevant information first appeared, the vlog was used regularly throughout the semester. Server logs show that the majority of requests for video files appeared on the weekdays when the clinical course was held, Tuesdays and Thursdays, though it was also popular on days immediately preceding clinical meeting times. Server logs also show vlog use to be

most frequent during the times of day when class met, followed by early evening hours. This indicates that students did access the vlog at home. In sum, though students most commonly used the vlog in the clinical lab during class time, home use was also popular.

A web survey was administered at the end of the semester. Students indicated that they often watched videos while simultaneously practicing on their mouth models, so presumably they found the capability to make visual comparisons between themselves and experts onscreen useful. Furthermore, many survey responses pointed to a practice of reviewing a video several times in a row, so it appears that the vlog's capacity to be self-paced was an important feature.

I also noted that with the exception of one case, the commenting feature of the vlog was not used as I had envisioned. As Nardi *et al.* (2003) have noted that with collaborative electronic technology in education, such as blogs and discussion forums, just because commenting functions are available doesn't necessarily mean that they will be used with regularity. The availability of design features alone is not sufficient for the development of an online community presence. Because the technology is very malleable, usage patterns evolve naturally, and conform to social practices. Just because certain features are "designed in" does not in any way guarantee that they will be utilized. This is why implementing prototypes in real-world situations is so important.

Indeed, Spector (2001) notes that "wholesale replacements of one form of instructional media with another rarely have proven effective; rather, hybrid or mixed-delivery media can offer a path for graceful adaptation and development while maintaining the best features of standard methods." I believe an important aspect of the vlog's successful integration was that it did not replace or diminish any prototypical activity in the clinic (i.e. instructors and students could still do everything they had always done). Instead, it served as a new representation around which new or modified practices could develop.

In our case, I noticed that by and large, students preferred to use the vlog as an online delivery system, rather than as a location for storing discussions, comments, or questions. (Note that this does not imply that discussion, questioning, or commenting did not go on as students watched videos. As we will see in Chapter 5, these practices comprised a significant portion of how students interacted with video material – it's just that students preferred to do these activities in person as opposed to online.) Moreover,

just because students made active use of the vlog didn't mean that they no longer used other supplementary material, such as textbooks, notes, and handouts. For instance, the student shown in Figure 4 has placed a handout that describes positioning for all the teeth on her workstation chair beneath the video screen. Her text and other notes are also present (under the handout). Placing textual material on the workstation chair was a customary strategy. Evidently, students found the availability of both text and video material during practice to be important, and this 'hybrid' solution to be preferable over one medium or the other.

At several times during the course of my research, I have had researchers and colleagues suggest that I should consider integrating not simply a video system, which is two-dimensional, but instead, building a system that could provide haptic feedback to inform students about subtle aspects of their hand position and instrumentation strategy. Ideas range from a data glove to an instrument with built in position sensors and accelerometers that can sense when a student is making correct movements. I usually say that design is always a process of balancing tradeoffs. Clark (1994) aptly reminds us that often there are multiple media or sets of media attributes that can yield similar learning gains, and he recommends that we make the least expensive choice for achieving a particular learning goal. In everyday teaching contexts, economic, institutional, and social constraints play a major role as to whether technology will or will not be integrated (dePaula 2004). So, a designer is often forced to make decisions based on practical reasons. It was simply not possible for me to spearhead a project integrating haptic feedback technology: financially, intellectually, and time-wise. I've also shown in Chapter 3 that the instructional practices of molding and guidance practices are very effective at conveying kinetic information to novices. And, I decided that there was a great deal I could learn from integrating a video playback system, although it was not as glamorous as a high-tech haptic feedback data glove. In everyday teaching contexts, economic, institutional, and social constraints play a major role as to whether technology will or will not be eventually integrated (dePaula 2004).

Another issue to address is that by being an active participant in the clinic, explaining to students how to use the technology, or even just my presence alone, may have affected whether or not the technology got used. As one of my dissertation committee members put it, "You (Amaya) are part of the

‘technology’ that you brought to the program.” This is true – I did teach students how to turn on and set up their computers at their workstations. I taught them how to open their web programs, and how to access the video blog. I taught them how to open the video windows. I explained how to open a magnification program that enabled them to view the videos at a larger size. My simply being present during clinic made it such that I was often called upon to refresh someone’s memory of how to use their computer system, explain why a video wasn’t opening, or make a correction to a broken link. And also, when I was videotaping students using the vlogging system as part of my data collection process, I may have influenced their practice. I was part of the video blog technology. One caveat, though: in Chapter 6, I present some follow-up data that I was able to collect in the Fall Semester of 2006. I was pleasantly surprised to discover that the program was actively using the vlog system I had set up in 2005. Note that I had all but closed up the ‘data collection’ portion of my research, and did not attend a single clinical meeting, nor continue an active relationship with faculty members. Was I then merely a ‘vlog ambassador,’ and now, having established the system in the school, my presence no longer necessary? Would faculty ever have incorporated the vlog into their teaching practices if I’d never attended clinical meetings with regularity during the prototyping phase? In Chapter 6, I present data from 2006 -- faculty and student interviews and web server log files -- that I collected at the end of the semester, where I explore how the video blogging system continued to be used.

In conclusion, I was able to leverage a background knowledge obtained through ethnographic research in this domain as a means to maximize the chances of successful implementation. Design research can suffer from being too cursory in fieldwork components and/or lacking ecological relevance [7]. This work drew strength from having an extensive, in depth fieldwork and prototyping component, and a continuing, mutually invested design relationship with the field site members. For instance, unexpected administrative changes in the faculty precluded our implementing the DIVER system into the introductory clinical education program as we had originally planned. Short-term field-testing or a more tenuous or transitory relationship with field members may have derailed the project entirely. Instead, we were able to jointly establish a technology design that was more tailored to the needs of the program by using a video blogging system.



## **Chapter 5. Social and Instructional Impacts of the Video Blogging System**

### **5.1. Introduction**

In recent years, researchers have become increasingly aware of how the technological environment features in human cognition, action, and social interaction. A number of naturalistic studies have looked into the role of tools and technologies in complex work environments, such as airline flight decks, laboratories, and air traffic control centers (Hutchins 1997; Goodwin 1995; Becvar *et al.* 2005; Zuckerman *et al.* 2006). This research demonstrates the importance of addressing how the technological aspects of the environment participate in cognition, action, and social interaction. Nevertheless, a good deal remains to be done in order to have a complete account of the ways in which objects feature in specific courses of action and interaction. We have relatively little understanding of how objects enter into and are interconnected with social organization and how they feature in practical activities, such as collaborative learning. Instead of treating the material environment as though it has a stable influence on the field of activity, and assuming that its significance remains constant throughout an emerging course of events, we should examine the ways that objects and artifacts come to gain significance at specific moments within courses of action.

Studies of settings such as offices and control rooms have shown that individuals use objects and artifacts -- such as screens, documents, diagrams, and models -- not only to accomplish their various activities but to coordinate those activities, in real time, with the conduct of others. Examples include how strips of paper form foundational resources with which to coordinate and reveal a working division of labor within air traffic control rooms (Mackay 2006), how an individual's glance toward a particular screen can inform a colleague of what they are doing and its relevance to the emerging activity (Goodwin 1995; Heath & Hindmarsh 2000); and how artifacts, such as compasses, can be seen to embody or preserve cognitive processes (Hutchins 1995).

We can, and should, be critical of technology at a number of levels of human activity. However, often evaluation studies of technology focus at the scale of interface design features, interaction engineering, and usability concerns. On the other hand, naturalistic studies of human interaction have

shown that the ecology of the material environment provides resources for the production of action, and in the ways in which participants themselves recognize and make sense of each others' conduct. The sense and significance of the material environment is constituted, in and through, the participants' action and interaction (see also Goodwin 1995, Heath and Hindmarsh 2000, LeBaron and Streeck 2000). Therefore, we should also study how technology plays a role in complete, complex, and interactive environments, which includes more than one person. Indeed, important work from cognitive science, human-computer interaction, and CSCW community indicates that limiting usability studies to one individual interacting with technology is far too restrictive a focus (see Hutchins 1995, Heath and Hindmarsh 2000; Goodwin 1995, 2000; Nardi and O'Day 1999). If we want to design technologies that support real people's needs, then we must be conscientious of broader settings and patterns of activity. Nardi and O'Day (1999) remind us that,

The part we often focus our attention on is the technology: computers, networking, applications, handheld information gadgets, instruments, monitors, widgets ad infinitum. We look at the shape, color, texture, and functions of the technologies, and we think creatively about how to make them more usable, appealing, and effective. But it is in the spaces between these things - where people move from place to place, talk, carry pieces of paper, type, play messages, pick up the telephone, send faxes, have meetings, and go to lunch - that critical and often invisible things happen. As we look at information ecologies, we need to be mindful of those spaces. (p. 66).

### 5.1.1. Technology for Learning

Ethnographies of learning technology in higher education are beginning to show how a polarized focus on 'the technology' can blind us to what students' real activity consists of, and can mislead us about how to design supportive tasks and environments (Crook & Light 1999). Now, a growing number of researchers recognize the importance of addressing the social, collaborative and community aspects of learning. We have some understanding of how to best design group learning tasks and facilitate group processes (e.g., Riel & Levin 1990; Finn *et al.* 1997), but there is further work to be done.

One important debate has arisen based on the question of whether media itself *affects* learning. Richard Clark and Robert Kozma, two pioneers of the educational technology movement in its early years, fervently debated this question. Richard Clark posits that media are mere vehicles to deliver instruction. It is *not* the media used; rather, it is what a teacher *does* that influences learning. Under this perspective, it

should not matter what form information takes, only how an instructor uses that information. Kozma disagrees, saying that "medium and method have an inseparable relationship and they are both therefore key components for the design on instruction" (Kozma 1994).

Research in cognitive science supports the view that how a problem is represented can have dramatic impact on how easy or difficult it is to solve (Zhang and Norman 1987). Different media have different affordances, making it more or less difficult to engage in certain kinds of learning tasks (Norman 1993; Kirsh 1995). For instance, consider how learning to play the guitar might be considerably easier from an educational video than by reading a book. On the other hand, if one had both a real guitar and a partner present while reading that book, the task would be quite different. Computers and digital technology provide new ways of representing the world. So if the media through which we learn have implications for *how* we learn, then technology-based representations have the potential to provide us with new ways of thinking and learning.

Therefore, I adopt Kozma's opinion that instruction should be considered as an *integration* of media and methods. This view necessitates a careful consideration of the media together as part of a broader ecology of instructional methods. Simultaneous examination of media and methods allow us to avoid confounding results as many first generation studies did (i.e. the positive learning effects attributed to technology were a result of instructional strategies, and/or other social factors, not simply the technology utilized). Media and instructional methods therefore should be examined in close association (Samaras *et al.* 2006).

Secondly, different media afford different kinds of interaction with material, and each other. When designing educational technology studies, the fundamental question should be not whether media affects learning, but rather how to take advantage of the various media to make instruction and learning more effective. We must endeavor to understand when, and in what situations, media facilitates learning, how to design effective media, or how (through which instructional methods) to use attributes of media to support the learning goals that have been set to various tasks. At the same time we should focus on what content to use with particular learning tasks, instructional methods, and media, and even consider in which cases it is best to avoid the use of media altogether. Clark aptly reminds researchers that often there are

multiple media or sets of media attributes that can yield similar learning gains. In everyday teaching contexts, economic, institutional, and social constraints play a major role as to whether technology will or will not be integrated into a setting (dePaula 2004).

In a similar vein, Hollan and Stornetta (1992) point out how different media have different capabilities for enabling interaction. Instead of trying to replicate the features of one existing media (say, face-to-face interaction) with another (like telecommunication), we will fall hopelessly short. They introduce the needs-media-mechanism framework, which suggests new approaches for introducing new technology, recognizing that new technology often enables new ways of interacting with information and each other.

### **5.1.2. Knowing-in-Action; Reflection-in-Action**

Donald Schön, in his work on expert practice and expert learning, identifies two types of reflection: *reflection-in-action* (evaluating an experience of practice in the moment of action) and *reflection-on-action* (retrospective analysis of an action after the fact) (Schön 1987). Often, reflection is considered to be an active, conscious process, but practitioners are able to think about what they are doing, even while they are doing it. Schön claims that it is the process of reflection-in-action which makes it possible for expert practitioners to deal so well with situations which are novel, uncertain, or unique.

Based on his studies of expertise, Schön presents a case for the value of developing expert skills in action: that is, learning how to perform as an expert develops through real-world engagement and action in context, not by merely talking about it or developing ‘abstract’ skills (a strategy many traditional formal educational settings often take) (Schön 1987). Furthermore, Schön proposes that reflecting on one’s own practice while learning a skill might be greatly beneficial during the process of developing expertise. Schön notes the importance of reflection for developing expertise: “By observing and reflecting on action, it is possible to reveal the tacit ‘knowing’ implicit in ‘doing’” (Schön 1987, p. 34).

Which of these two types of reflection are important to support during the learning process? Engaging in reflection-in-action might be considered as a developed skill of experts, and achieving that skill might be a crucial step in progressing towards expertise. Experts may be able to simultaneously engage in an action and maintain an awareness of the efficacy of that action – i.e. engage in reflection-in-

action. Because of the high cognitive demand of engaging in new motor and perceptive skills during learning, perhaps learners have more challenging time of reflecting on practice in the moment of action. Learning to reflect involves developing a level of awareness of effective practice – a professional vision to guide action in a domain, and also self-assessment skills to determine the efficacy of that action. More research into reflection and learning is needed to understand how learners develop reflective skills, and the relationship between these skills and the development of expertise.

### **5.1.3. Digital Video Technology for Supporting Reflection and Professional Perception**

Digital video accessed with computational media reviewing tools, in proper contexts, can support reflection. Using such reviewing tools, digital video can be stopped, started, instantly rewound, slowed down, and accessed non-linearly. The viewer is given control over the timing and access to the media, important attributes for supporting reflection. Digital video has the additional benefit in that it is interactive: it can be accessed non-linearly as well as linearly. Therefore it is particularly well-suited for reflective learning applications, where the student is allowed freedom of action and encouraged to take initiative (Nielsen 1995; Pea 2004).

New digital video technology now provides us with opportunities to see one's own practice and reflect on it (Suchman and Trigg 1991), and therefore the potential to help one develop a professional vision. Multimedia environments can be built having facilities for digital video viewing, segmenting, and editing, together with spaces for annotating supplementary information. Such environments can be used to scaffold a developing professional vision, by providing opportunities to reflect on one's own practice. When combined with facilities to annotate and comment on video segments, a powerful learning application can result that encourages reflection. According to research by Boyle (1997), learner-centered applications have educational benefits over tutor systems, which are experiential and not learner-directed.

Van Es and Sherin (2002) point out three key aspects of a developing professional vision that are promoted by using digital video in applications that promote reflection:

- *Shifts in perspective.* Learners begin to shift their perspective from first person to third person; for instance, teachers in development workshops begin to look at their own practice from the perspective of the student, or the classroom as a whole, instead of their experience.
- *Range of events noticed.* Viewing their practice changes in the range of events noticed, and novice teachers can begin to see and reflect on events that were at first perceived of as peripheral. Moreover, viewing video at different time scales can reveal events that are not noticeable at a normal pace.
- *Citing real evidence, not intuition.* Human memory is selective and fallible (Baddeley 2001). Video supports seeing new things that were not noticed in the moment the video was recorded. After using digital video technology, developing teachers began to cite real events as they reflected on their own practices, instead of speaking in generalities.

Mezirow (1991) and Brookfield (1991) also present studies that show that engaging in critical reflective practice can aid in the development of professional vision. In addition, several psychological experiments have shown that various environmental factors composing a study context influence the learning in a motor task. When a person attempts to remember the information later, the same contextual information, if present, can serve as memory cues (Wright and Shea 1994). Videotape can provide a visual and auditory representation of the context of a particular activity, which is important for supporting effective reflective practices.

#### **5.1.4. Characteristics of Successful Learning Media**

Computer-based technology – when used effectively – can provide ways of teaching that are much better suited to how people learn (Schacter 1999). In a recent review article, Pea *et al.* (2002) conclude that although further research is necessary to identify how educational technology can be designed and implemented to best support learning, the past two decades of educational research points to four characteristics of successful learning environments: (1) active engagement and reflection, (2) participation in groups, (3) frequent interaction and feedback from instructors, and (4) explicit connections to real-world contexts (Bransford *et al.* 1999). These characteristics can be supported with new

computational technology. The following discussion describes hallmark examples of computer-based technologies that have been shown to support these four fundamental characteristics.

- *Learning through active engagement and reflection.* Educational research has shown that students learn best by actively “constructing” knowledge from a combination of experience, interpretation, and structured interactions with peers and teachers (Bransford *et al.* 1999; Greeno *et al.* 1996). When students are placed in the relatively passive role of receiving information from lectures and texts, they often fail to develop adequate understanding in order to apply what they have learned to situations outside their classrooms (Bransford *et al.* 1999). That is, despite the assumption that students will transfer more abstract knowledge to specific domains (e.g. using long division to help compare prices in a grocery store), such a transfer of knowledge often fails to occur.
- *Learning through participation in groups.* An important branch of educational research focuses on the social basis for learning, largely influenced by the research of Vygotsky (1978) and Lave and Wenger (1991). A large body of educational literature indicates that students learn better in collaborative environments (Springer *et al.* 1999). Performing a task in coordination with others not only provides opportunities to imitate what others are doing, but also to discuss the task and make thinking explicit (Rogoff 1990). Much of learning involves acquiring the meaning and correct use of ideas, symbols, and representations. In group activity, students are compelled to make and negotiate meanings in interaction. In addition, it has been found that social needs and pressures often drive a student’s motivation for learning (Lave and Wenger 1991). Because a student’s social identity is enhanced by participating in a community or by becoming a member of a group, involving students in a social intellectual activity can be a powerful motivator and can lead to better learning than individualized work.

Using technology to support such collaborative activities can improve the extent to which classrooms are socially active and productive, and can encourage educational

interactions that expand students' understanding of the subject (Pea and Gomez 1992). Moreover, digital video can be used in multimedia online learning environments that can enable groups to interact collaboratively. In online environments, groups can define problems, represent ideas in different media forms, and augment the resources with personal commentary and alternative viewpoints (Pea 1994).

For instance, one impressive, long-term effort that exemplifies many of the promising features of collaborative technology is the Computer-Supported Intentional Learning Environment (CSILE) (Scardamalia and Berierter 1994, 1996). CSILE was constructed to support structured collaborative knowledge building by having students share their ideas and criticisms using a shared database. One major advantage of the CSILE system is that it permits students or experts to participate, regardless of whether they are collocated in space and time. In addition, similar projects, such as the "Multimedia Forum Kiosk" and "SpeakEasy" projects (Hoadley *et al.* 1995), have been shown to facilitate more inclusive and gender-equitable participation than ordinarily occurs in face-to-face classroom discussions. Reports from educational researchers suggest that students who participate in computer-supported learning networks show increased motivation and a deeper understanding of concepts (Weir 1992).

- *Learning through frequent interaction and feedback.* In typical classrooms, students typically have very little time to interact with materials, each other, or the teacher (Pimm 1987). Moreover, in the traditional pedagogical model, students must often wait days or weeks after engaging in classroom material to receive feedback on their learning (e.g. in the form of examinations or written reviews). In stark contrast, educational research suggests that learning proceeds most rapidly rather when learners have frequent opportunities to apply the ideas they are learning, and when feedback on the success or failure of an idea comes almost immediately (Anderson 1996).

Computer tools can be used to analyze each student's performance and provide more timely and targeted feedback than the student would typically receive (Andersen *et al.* 1995).



Indeed, research indicates that computer applications such as those described above can be very effective tools to support learning (Sivin-Kachala and Bialo 1999).

- *Learning through connections to real-world contexts.* One of the troubling issues of learning research has been the failure of students to apply what they learn from one domain (school) to another (real-world contexts) (Lave & Wenger 1991). A detailed literature on this topic suggests that in order to transfer knowledge from the classroom to the real world, learners must master underlying concepts, not just memorize facts and solution techniques in simplified or artificial contexts (Bransford *et al.* 1999). Despite this, typical assignments often do not give students a conceptual understanding, or give them the opportunity to learn when to apply particular ideas, since what is learned is often in restricted, artificial contexts. Computer technology can provide students with an excellent opportunity for applying concepts in more realistic contexts.

#### **5.1.5. Cognitive Science and Technology Design**

Many researchers have studied how learners perceive, remember, and learn information presented through multimedia technology. For example, Dwyer (1978; 1987) sought to understand how a learner integrates multimedia information presented verbally and visually through dynamic pictures that are accompanied by narration, and Lowe (2003) compared the influence of dynamic against static media on achieving particular learning goals (Lowe 2003). Well-known cognitive learning researchers have been concerned with the attributes of the human learning system that affect the comprehension and retention of information presented through multimedia, and have examined various ways in which those attributes could be exploited by designers of multimedia systems to lead to improved learning outcomes.

Relaxing the boundaries of "knowledge" by recognizing that cognitive structures can exist both inside and outside the skull, (structures such as relationships between humans and the world rich with artifacts, tools, and other humans), changes the framing of how we understand learning and cognition (Hutchins 1995). It is important to acknowledge the contribution of social and environmental features in a cognitive system. The distributed cognition framework explicitly encompasses not only cognitive

phenomena that might take place in the head (mental representations, human information processing) but also representations and phenomena that take place in the world, between and among people in a social system (Salomon 1993; Hutchins 1995). Designing for distributed cognitive systems requires a different framing of research, evaluation, and design methodologies than designing for single users (Hollan *et al.* 2000). Briefly, the central challenge is that design decisions in a distributed cognitive system have to respect not only individual design constraints, but also systemic realities.

Hoadley and Kilner (2005) identify three transformations that technology can provide to learning environments designed within a distributed cognition framework:

- a representational transformation, where information technology provides access to novel representations of information in support of learning;
- a process transformation, where technology supports or facilitates learner tasks or activities. Computer technology can affect the learning process itself. This advantage reflects the ability of interactive technologies to scaffold tasks, procedures, or processes that learners encounter during learning. Changes the learning process and the manipulations involved in the instructional process. It's not the media itself, but the instructional process that the media supports; and
- a social context transformation, where technology shifts the social context in which the learning takes place, changing either relationships between people or relationships to self.

The paradigm of distributed cognition is a useful framework for guiding the design of learning technology because it focuses on how tools and computer-based representations can change a distributed system of individuals who are engaged in some sort of learning, concordant with our conception of knowledge building communities above. The framework focuses on how computers can transform the overall distributed cognitive system of users. Representations, process support, and shifts in the learner's social context can help support the functioning of knowledge building communities of practice. Using a distributed cognition framework may also help provide insights into evaluation and assessment of not only individual learning, but also the overall functioning of communities of practice.

### 5.1.6. Technology, Representations, and Learning Activities

Many learning activities involve an interaction between a learner and a representation of domain specific knowledge. Examples of knowledge representations include lectures, textbooks, and lecture notes. The kinds of representations we use change the nature of the learning activity. It would be naive to assume that because the material that students are covering is constant (for instance, introductory periodontal instrumentation), the only thing different is the way the material is represented. Likewise it is naive to assume that representations involving newer or more sophisticated technology must automatically be superior/better/more effective, as was an oversight that many early educational technology designers made (Kozma 1994).

In a similar vein, Seymour Papert (1987) long has warned against the temptation to ask, "Does Technology X work?" or "What is the effect of the computer program on a student's learning?" These questions reveal a tendency to think of "computers" and "technology" as agents that act directly on learning and thinking. More importantly, they disclose a tendency to reduce the most important components of education -- people and culture -- to an auxiliary role. The context for human learning is always a culture, never a discrete 'technology.' This is not to say that often in the presence of technology, culture changes, and with it the way people think and learn. But if you want to understand the change, you have to attend to the culture, not just the technology.

Papert was instrumental in developing a programming environment called LOGO that was implemented and studied in many different elementary classrooms in the late 1970s and early 1980s (and still today). In early studies, LOGO seemed to have a positive effect on learning, but this was not always consistent. Sometimes LOGO's outcomes seemed negative, in that students who used LOGO did more poorly than student groups who used other more traditional educational methods. With the publication of these results, the project received harsh criticism (Pea and Kurland 1983). However, according to Papert:

I have noted how LOGO environments differ in many relevant ways, ways that are not mentioned in the reports of many studies. In my own experience, I have become impressed with the fact that diagrams on the walls can influence what projects the students want to do and how they think about LOGO. (p. 27)

Papert reminds us that technology itself does not affect learning. Certain kinds of learning activities develop with certain kinds of technological representations. (I refrain here from using the term 'affordance' to describe how technology might facilitate certain ways of interacting. Though the term is intuitively tempting, it has historically oversimplified the complexity of features leading to the sorts of interactions and activities that go on with a particular piece of technology. Saying that a handle affords grasping does not acknowledge the complex ergonomic, physical, and cultural features that play a role in a perceived 'affordance.' (Gibson 1978)). By changing the nature of representations we will change how learners interact with knowledge and each other. Or, as Dourish (2006) says, "People develop practices around technologies, and technologies are adapted and incorporated into practices." Therefore, it is imperative that we understand how representational technology affect learning practices, and how integrating new technology alters the complex social dynamics of educational environments.

## **5.2. Summary of Research**

The data in this chapter comes primarily from video recordings taken during the fall of 2005 in the clinical training portion of the introductory course on dental hygiene instrumentation. In this chapter, I examine how altering the "technology landscape" of a professional training environment enabled new social interactions and introduced new learning activities. I also looked more deeply into how the presence of digital video recording and playback affected solo, partner, and group interactions amongst students and faculty. This analysis was aided using ethnographic methods, such as observation, field note-taking, video recording of technology use, a post-semester web-based survey, and student and faculty interviews.

### **5.2.1. Video Recording of Technology Use**

I recorded sixteen hours of video in the clinical laboratory, focusing on instances when students and faculty used the vlogging system. When deciding where to place the video camera so that the most relevant activities could be captured, I relied upon a background understanding of the domain obtained in fieldwork prior to recording. My placement of the recording equipment was directed by specific concerns;

most notably, I typically positioned the camera in order to capture as much of the face and bodies of participants, and technology in use (e.g. computer screen) as possible. However, as often the focus of action was on very miniscule details, I sometimes used the zoom feature on the camera in order to capture small-scale movements of hands, fingers, and instruments. I relied upon both my intuitive understanding of human interaction, and my understanding of the domain gleaned through fieldwork. Sometimes, zooming the lens caused me to miss other details of interaction that occurred off screen, such as facial expressions, eye movements, or other (relevant) activity in the scene. I attempted to be sensitive to my part within, and influence on the scene, both during field observation and video recording (see Goodwin 1986), recording these observations in accompanying field notes.

These video records were examined, and representational portions were segmented out for transcription and analysis. My decision to select a portion of video for deeper analysis was guided by a decision to capture instances that were representative of a class of activity, for instance, students working solo, in partnership, or in a small instructor-lead group. Selected segments were transcribed and coded in a spreadsheet in Excel. Later, I created ‘comic’ transcripts of a smaller subset of representational data, which is included in this chapter, along with an analysis (see APPENDIX).

### **5.2.2. Portrayals**

Portrayals represent portions of my fieldnotes taken in a notebook while I was observing in the clinic. I often abbreviated the notes in an attempt to record as much of the activity and dialog happening in the moment as I could. As was my practice, after spending a day in the field site, I would come home and type up more complete versions of my notes into a laptop computer. This practice is described in Emerson *et al.* (1995), (the text also contains a thorough discussion of interpretive and analytic issues pertaining to the selection and writing of fieldnotes). The scenarios are segments of these original notes, selected as data that supports a particular analytic framing.

### 5.2.3. Framing the Analysis of Data

One of my goals in technology design was to augment the kinds of interactions that can take place in the training clinic, not to replace the instructional practices integral to the training process. The vlog was designed to integrate with clinical training activities already in use: solo practice, partner practice, and faculty-guided group demonstrations. Within these activities, I observed that the vlog further supported novel interactions; for instance, enabling students to view expert demonstrations while simultaneously modeling those motions with their own instruments and mouth models. However, unlike live instruction, the student is able to maintain control over the pace of information flow, and is able to freely pause, rewind, and review demonstrations.

In the ethnographic phase of research, I identified a set of discursive practices that are used to scaffold and structure the actions of novices as they learn the tools and practices of a professional domain. I described action-scaffolding practices used in interactions between instructors and students. These practices coordinate multiple representational streams: auditory, visual, kinesthetic, and artifactually-mediated streams. To summarize Chapter 3, the practices that I identified are:

- **molding:** a practice in which an instructor physically manipulates the body of a novice into institutionally established configurations and movement patterns.
- **directing:** the act of 'talking' a learner through a new procedure
- **demonstration:** constructing gesture-based models of actions.
- **embodied conceptual metaphors:** drawing metaphorical parallels between everyday sensorimotor understanding and expert actions.

Here I will present representative examples from the data for each of the following classes of activity: students working solo, students working in partnership, and instructor-led small groups. Analysis will focus on how the vlog changed the nature of these activities, and supported new practices, including those for action-scaffolding.

### 5.3. Results

#### 5.3.1. Following: Solitary Interactions with the Vlog

Students often have large blocks of unstructured practice time during the clinic session. Scenario 1 describes a typical example of what happens during solitary activity in the clinic.

##### Portrayal 5.1: 9/22/05

*Mary, a student, turns on her computer and opens Internet Explorer from a shortcut on her computer desktop. From the home page in her browser, she navigates to the main page of the vlog. Scrolling down, she finds the newest videos posted to the site. She clicks on the video link to “Introduction to the Probe.” A new window opens in her browser, and the video file begins to download. While she is waiting for the file to download, she begins to set up her station, taking out her instruments, adjusting her mouth model, and adjusting her chair. Once the video has finished downloading, she clicks on the play button with her right hand (simultaneously holding a probe) and begins watching. Though she is watching at her chair, and continues to hold the probe in her hand, she does not practice along with the video; instead, she only watches.*

*The volume is at a level that I can hear from a vantage point about 15 feet away. To me, it seems rather loud, in that I can hear it over conversations close to me, and it occurs to me to consider mentioning to the students that they might consider bringing in headphones to wear in clinic while watching the videos<sup>18</sup>. About 3 minutes later, Mary reaches up and lowers the volume on her computer screen. After the video ends, roughly a minute later, Mary stands up and addresses the group, “Anybody want to come hear the demo?” Jess, her neighbor comes over and Mary starts the video again. They both watch – Mary sitting in her chair, and Jess standing nearby. As the video plays, Mary holds the probe, and from time to time moves it up into her visual field looking at it and mimicking some of the actions onscreen.*

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<sup>18</sup> I later changed my mind about this, as I began to appreciate how fluidly students came into group interactions while videos played into the sound space of the clinic. It seemed that having peripheral awareness of when videos were playing was important. I was afraid that encouraging headphone use would interfere with this process, impeding students from interacting with classmates (as headphones often can isolate one from interacting in ambient social space).

### **'Following' Examples**

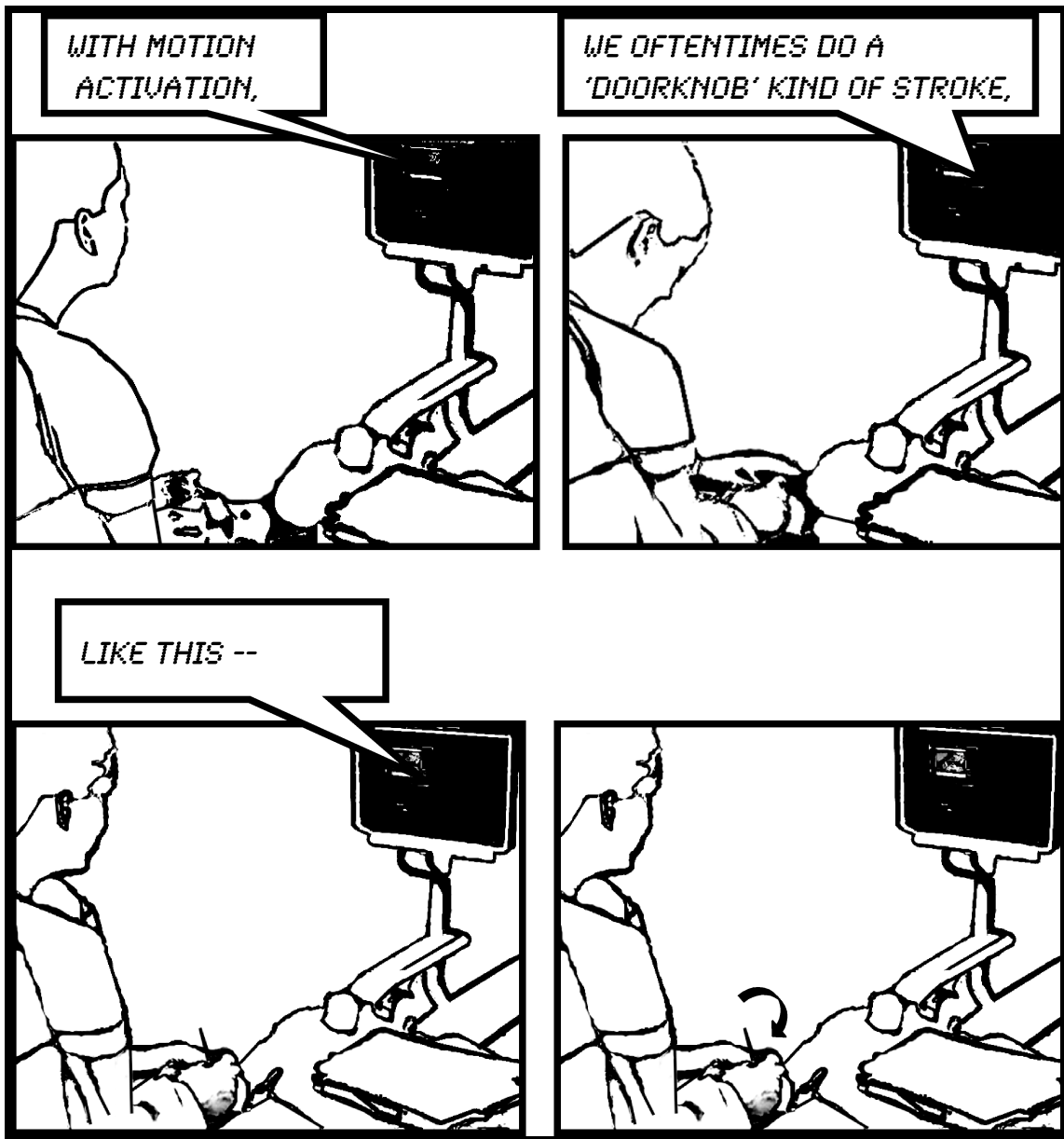
This activity of following was the first time that students had direct access to a visual comparison of their practices and an expert's. In previous instructional models, faculty demonstrated and/or modeled student's hands, but students were not empowered to make visual comparisons between themselves and instructors. We filmed the videos on the vlog from a first-person perspective, enabling this kind of comparison.

When viewing the vlog while simultaneously practicing, students engage in *following* – another discursive practice for action scaffolding (see Chapter 3). Sometimes, following couples *directing* and *demonstration* -- such as when one exercises along with an aerobics video. The practitioner receives a synchronous visuomotor demonstration and auditory direction. Following behavior was not observed prior to the implementation of the video system, largely because of the physical constraints of the clinic (faculty and students cannot practice simultaneously).

Example FOLLOW, shown in Figure 31, is a prototypical situation in which a student is making use of the video blog system in the clinic while participating in following activity. In Figure 31, the student has positioned herself at her dental chair, and is using an instrument to practice scaling on the typodont. At the same time, she has opened the video blog on the built-in computer workstation, and is playing the segment entitled, "Introduction to Scaling." As the video plays, she follows along, prompted by the ongoing dialog and imagery. The student has already watched the video segment from the vlog once through, and is watching it a second



time.



**Figure 31.** Example FOLLOW1

The segment begins with student watching the video, holding her instrument away from the mouth model. She looks down and places her instrument into the model as the video begins, “We oftentimes do a ‘doorknob’ kind of stroke.” When the video says, “like this,” the student looks up, perhaps responding to verbal deixis (‘this’) indicating that something is being shown in action/gesture; in

this case, what a “doorknob’ kind of stroke” looks like. Indeed, as she watches the demonstration of “this,” she activates her own hand and instrument, following in time with the instructor’s motion onscreen.

Also, interesting to note is the instructor’s use of the pronoun *we*, (as in “we oftentimes do”) which invites the student to participate in the legitimate practices of the larger professional community of dental hygienists.

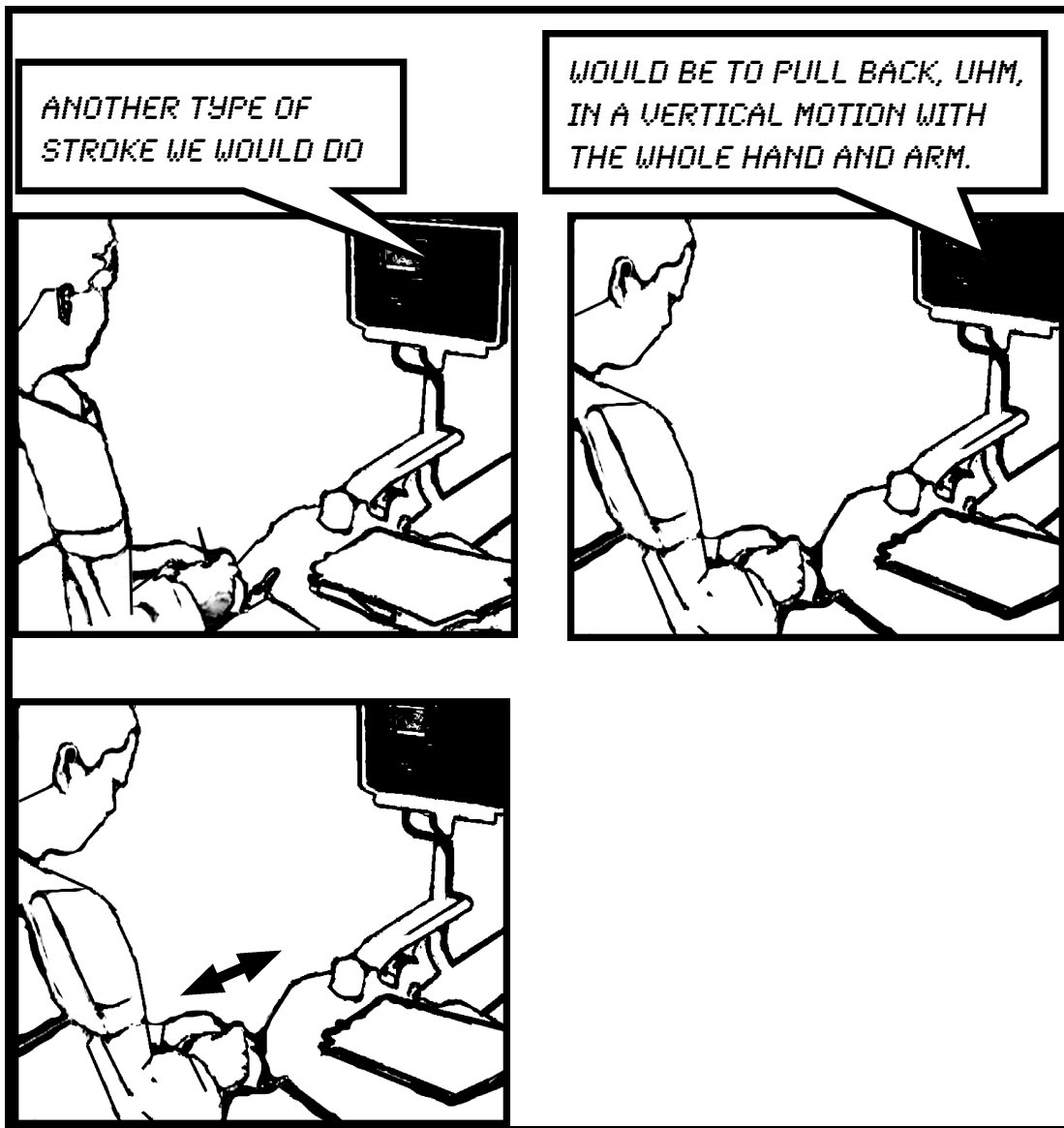
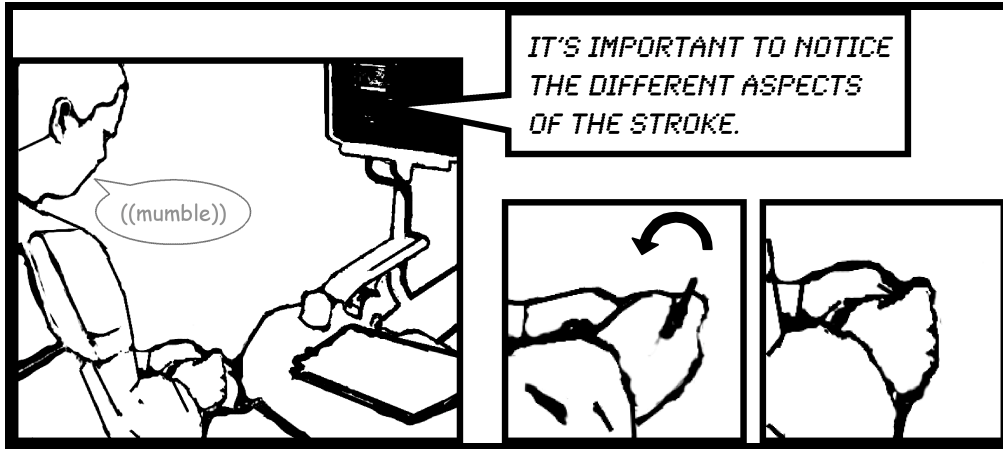


Figure 32. Example FOLLOW2

In Figure 32, the student watches the instructor demonstrate what a vertical motion is before activating her own hand. As she moves her instrument, she follows the demonstration onscreen by modeling the motions in her own body.



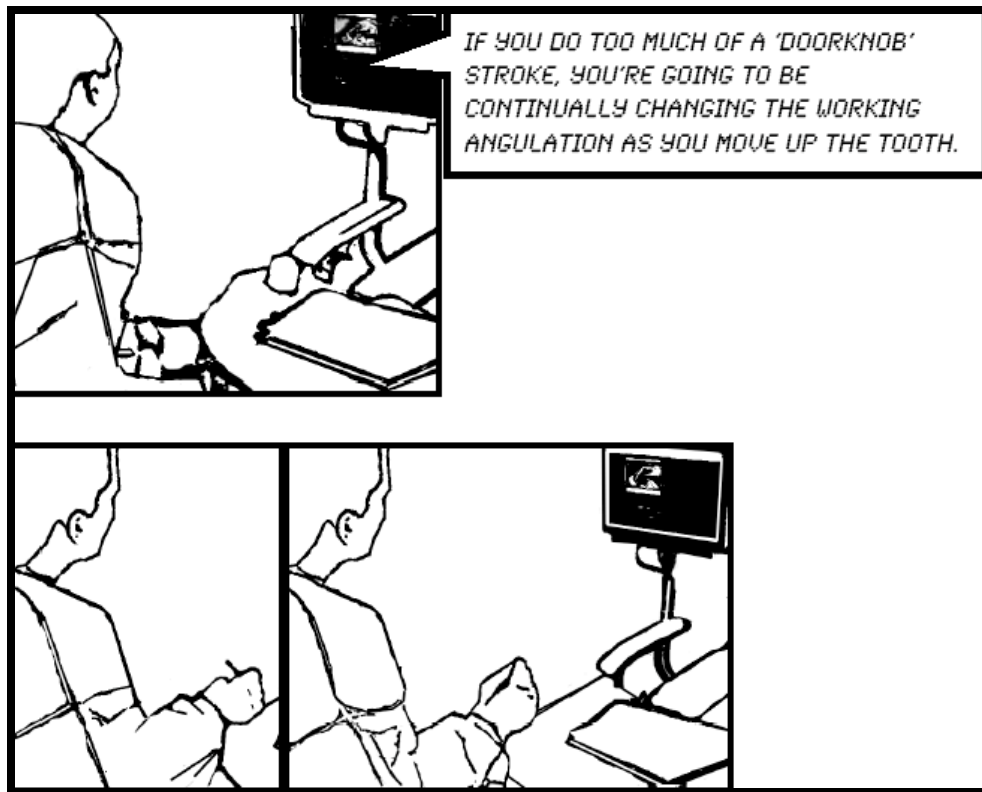
**Figure 33.** Example FOLLOW3

In Figure 33, the student appears to still working out the ‘vertical motion’ with her own body. While the video moves on in content, saying, “It’s important to notice the different aspects of the stroke,” the student continues to watch her hand as she makes vertical strokes. She even pulls the instrument away from the mouth model, and makes two strokes in the air as she mumbles something to herself. Only then does she quickly attend to the screen again.

Sometimes I observed the video ‘getting ahead’ of where the student is conceptually, as in Figure 33. A nice affordance of digital video is that it can be easily controlled – stopped, paused, rewind, and/or replayed. I often observed students stopping and replaying small segments of the video, or the whole video multiple times. As I mentioned before, Example FOLLOW shows the student’s second time watching this particular video segment.

The student reengages with the vlog in Example FOLLOW4, shown in Figure 34, as indicated by her pointedly leaning her torso forward, in the direction of the computer screen. In the video, the instructor demonstrates what happens if “you do too much of a ‘doorknob’ stroke,” by demonstrating what “not to do” (see Chapter 3 for more discussion of demonstrations). Also of note is that what the instructor is talking about, the ‘angulation’ of the blade of the instrument, is a visually small detail. Her lean forward

could be an indication that she student is trying to get closer to the screen to see the blade of the instrument.



**Figure 34.** Example FOLLOW4

As the student continues to watch the video segment, she cocks her head to the right. Though it isn't within the scope of this project to make assumptions about the student's mental state in seeing the demonstration, her cocked head as she watches the computer screen seems to publicly display thoughtfulness.

The student then makes an exaggerated vertical stroke in the air. Is this a gesture for thinking or gesture for communicating? While we can't answer this question, the point is that it efficiently does both: namely, solidifying the "correct" motor pattern for scaling by repeating what she has seen the instructor doing onscreen, and communicating that the student 'gets it' in a public space.

In summary, the vlog provided students with a new opportunity to engage in 'following' activities: instrumenting at their workstation while simultaneously watching the hands of an expert engaged in authentic practices and listening to descriptions what she is doing with professionally coded

language. For the first time, students could make visual comparisons between their own bodies and hands and the instructor's onscreen, as facilitated by the video being framed from a 'first-person' perspective. Motor learning literature reports on the value of modeling when learning motor tasks, but all the evidence is from a paradigm where the task is modeled and viewed by a subject prior to a subject's reenactment (Schmidt 1998). As far as I have found, little experimental evidence exists on the effects of concurrently 'following' the actions of a live or video model, where periodic visual comparisons can be performed, versus watching the demonstration prior to practicing. Indeed, there is much research to be done on how video supports various aspects of the learning process, including supporting context, which will be discussed in the next section.

Furthermore, in a clinic rife with distractions, the vlog may provide students with a structure to serve as a locus of activity. The clinical space is open, noisy, and chaotic – eighteen students and four instructors are performing a variety of learning tasks, and rapid time switching, disruptions, etc. might preclude opportunities for deep engagement and reflection (Norman 1993). Videos appeared to provide students with a point of focus, a meaningful representation to attend to and reflect on for long stretches of time. A new kind of interaction happens when a student follows along with the video, guided by the physical demonstration and the verbal directions.

### **5.3.2. 'Context-Supporting': Partner Interactions with Vlog**

During the course of the semester, as some of the students and instructors began to incorporate the vlog system into their habitual patterns of practice, common interaction schemes began to emerge. A common interaction scheme involved one student sitting at his or her mouth model, and a neighbor watching in an 'auxiliary' position. Perhaps this could be because the audio intruded slightly on the sound space of near neighbors, and the noise of the soundtrack invited neighbors to view each other's screens. Or possibly it came at a lower cost to view the video a neighbor had already opened, rather than accessing the system separately. Nevertheless, it opened up the possibility of a kind of interaction activity that had not been present before the video blog system was in place: namely, the joint viewing of a video segment.

One of the instructors commented that contrary to her initial thoughts about how the technology would be used, the students seemed to prefer to watch the vlog in groups of two or three.

I guess I had assumed they'd want to practice by themselves when watching [the videos], so they could practice on their mouth models, at their own chair. But they really seem to prefer watching together, that way they can talk about the material being presented, clarify things, and give each other feedback. More often than not, you see them watching together.

### **Portrayal 5.2: 10/20/05**

Portrayal 2 describes a partner interaction that I observed that took place in the presence of a video playing off the vlog.

*Two students are sitting together watching the video entitled, "Gracey 13/14: Basic Principles." One student sits at the mouth model (Ilene), and the other sits in his operator chair on the other side of the dental chair (Jason). The first time through the video, the students just watch. The second time through, Ilene begins following along with his Gracey 13/14 and his mouth model. The second time the video finishes, Jason says, "All right, so they're cupping the chin ((making his hand into a curved shape))." He walks back to his chair and sits down to practice on his mouth model. Ilene starts the video again for a third time.*

*After the video finished, Jason makes a public assessment to his partner, "All right so they're cupping the chin." Several things strike me about this statement. Firstly, who are "they" (as in "they're")? Why would Jason use a plural pronoun, when only one instructor is seen onscreen? I believe it is because Jason is referring to the entire community of professional dental hygienists, of whom the instructor onscreen is serving as a proxy, or prototype of. When he says, "they're," he literally means, this is how "they" -- the experts -- do it. Secondly, why does Jason make a statement it at all? If he had a question about where the hands are positioned, why not ask it as a question? I believe the public nature of Jason's utterance and gesture is of value, affirming his developing status as a practitioner, his ability to "get" the subtle aspects of scaling technique. It is a request for confirmation, which Ilene can provide with mere silence.*

I believe the most significant aspect of this interaction is how the vlog supports a context where students are empowered to engage with material and arrive on intersubjective understanding of material being presented on the video. Example LATERAL shows another example of the “context-supporting” role of the digital video records on the vlog, when viewed in collaborative activity.

### ‘Context-Supporting’ Examples

Example LATERAL1, shown in Figure 35, illustrates two students -- SL (Student on the Left) and SR (Student on the Right) -- viewing a video selection on scaling from the vlog.

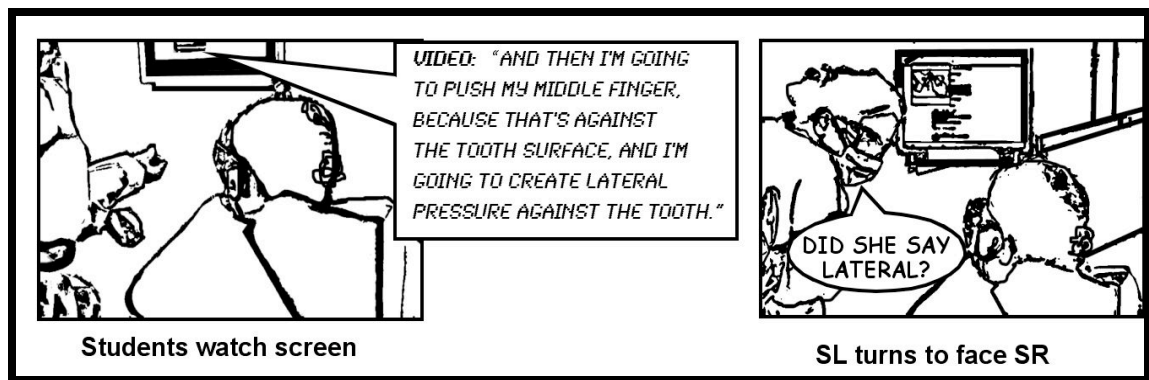
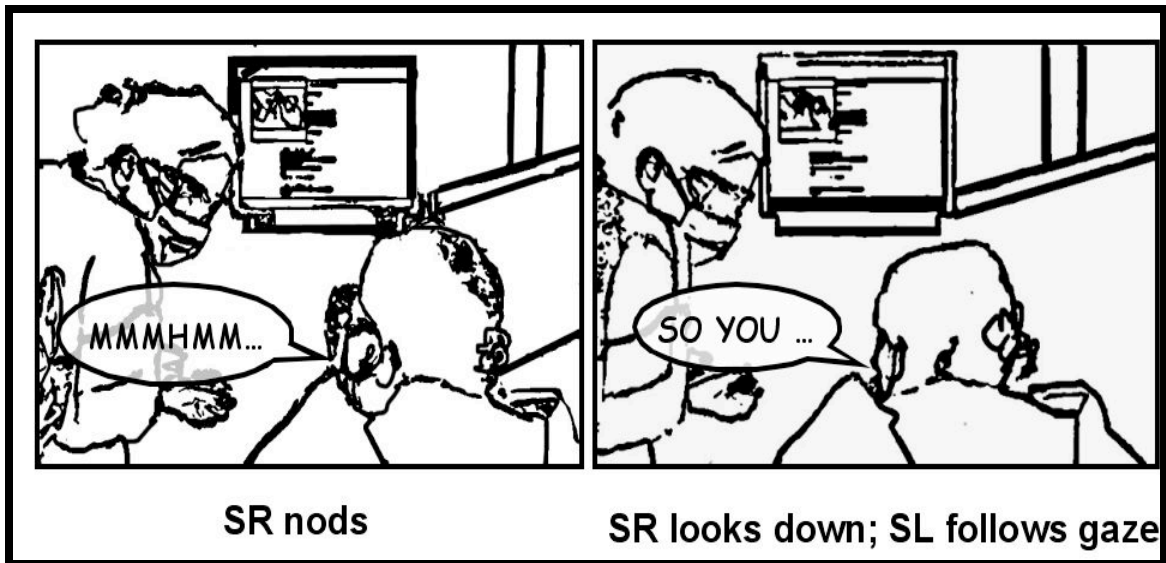


Figure 35. Example LATERAL1

In Figure 35, after the video says, “create lateral pressure against the tooth,” SL turns to SR and asks, “Did she say lateral?” That is, prompted by the video’s mention of the technical term ‘lateral,’<sup>19</sup> SL turns to her partner for clarification.

As we saw in Example FOLLOW, the viewing of the video blog is not a passive activity. Often, students are actively engaged with the material world while viewing. Furthermore, students working together can employ a variety of multimodal resources to interact with each other as a video is played, such as speech and non-speech sounds, gesture, eye gaze, and body position. The video establishes a contextual backdrop upon which a discussion can take place.

<sup>19</sup> In this case, *lateral* is referring to horizontal pressure that is applied as a scaling instrument is moved up the tooth, which is necessary for removing tartar deposits. This is similar to the horizontally directed pressure that must be applied to remove paint from a wall with a scraper.

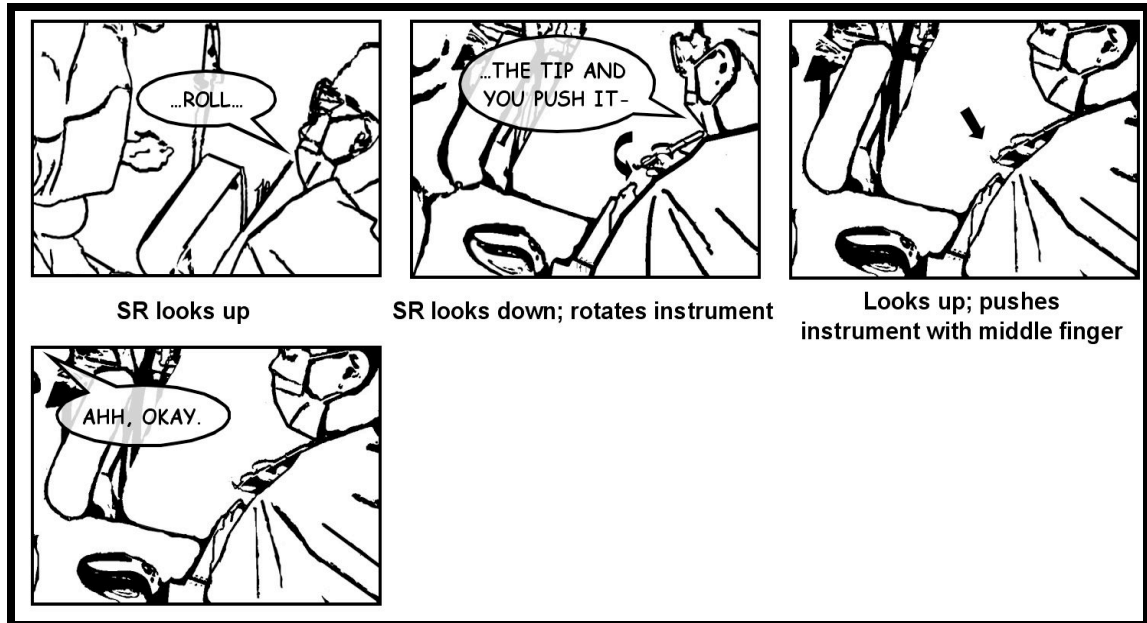


**Figure 36.** Example LATERAL2

Indeed, as seen in Figure 36, SR not only responds affirmatively to SL's question about whether the instructor on the video said 'lateral,' but she also begins to elaborate on what that term means by instantiating it in real-time activity with her instruments. In fact, SR responds as though SL had made an implicit request (i.e. What does lateral mean when we are scaling?). Beginning with, "So you," SR turns her gaze downwards, to her hands. As SR shifts her gaze, and SL follows, the locus of attention moves from the screen to SR's hands in the participation framework (Goodwin 1986) formed by the screen and the two students<sup>20</sup>.

<sup>20</sup> Not represented in the "comic transcript" is the video soundtrack, which continues to run as the students converse with each other. I chose not to represent the ongoing speech on the video in the transcript, because it does not play a role in the participation framework, and does not until the students' discussion ends and the locus of attention shifts back to the screen.





**Figure 37.** Example LATERAL3

In Figure 37, SR further elaborates on the meaning of lateral by instantiating it in instrumental action as she speaks. She simultaneously twists the instrument between her fingers as she says, “roll the tip,” and then pushes on the instrument shank after she says, “push it”. Note how SR even uses the vernacular verb “push” to describe what she does to the instrument, instead of the member term “lateral pressure,” which further builds a semiotic bridge between instrumental action → everyday speech terms → technical terms.

In the LATERAL example, we have seen how the video provides information content at a particular time that participants can reference, bring into a dialog by indexing in speech or gesture, and augment, with commentary. I believe that the video on the vlog provides students with a ‘common ground’ of reference (Clark and Marshall 1981) that they can use while developing skills. The social science concept of ‘common ground’ refers what people seek to achieve in collaborative activity in order to coordinate what it is that they are attending to and/or communicating about. In educational research, the concept of common ground is often used to look at collaborative discourse, gesture, participation frameworks and joint visual attention (e.g., Pea 1994; Goodwin 2000; Barron 2003). We may even argue

that achieving common ground – the ability perceive relevant entities in a professional domain and act in expert ways -- is the essential to the success of professional education.

Goodwin reminds us that our power to say something relevant and consequential resides not within ourselves alone, but instead is embedded within a social ecology of meaning making practices organized through ongoing processes of human interaction (Goodwin 1995). He describes how an aphasic man has the ability to use the talk of family members to formulate the details of what he wants to say even though he can say only three words: "yes," "no," and "and." His utterances and gestural displays interpolate within temporal organization of the ongoing talk of others, and derive meaningful coherence by nature of the juxtaposition. In an analogous scheme, the students here rely upon the ongoing narrative in the video in order to ground utterances and gestural displays within a fertile loam.

The students' actions and speech are aimed at aligning intersubjective understanding of video content. By exploiting the unfolding narrative sequence in the ongoing video, students are able to anchor interactions within a rich conceptual context. In a sense, the video ‘scaffolds’ collaborative discussion between novices. As the head instructor eloquently put it, in an interview done in 2006, “The vlog would give them words to express what they're challenged with.”

Presumably, though, students may not be attending to the video during the times that their attention is directed to each other and a conversation unfolds. However, a benefit of having digital video in a Quicktime movie player is that it can be easily rewound and replayed. Even if a segment of video is missed while students are focusing on dialog with each other, the missed segment can be revisited.

### **5.3.3. Instructor Highlighting: Group Activity with the Vlog**

In Example LATERAL, we saw the video blog play an important role in a system formed by two students working together. The vlog guided their activity in certain ways, for instance, providing a focal point to focus shared attention, and a context of relevant discourse upon which students could layer their talk and action. In Example GROUP, we see a similar phenomena occurring; this time with a small group of five students and an instructor.

### Instructor Highlighting Examples

In Example GROUP, the instructor has gathered a group of five students around one student's workstation. Prior to when the data recording begins, the instructor has been demonstrating to the group how to use the Gracey 13/14, a scaling instrument. The instructor still sits at the student's chair, and holds the instrument in her right hand. Following her 'live' demonstration, she chooses a video from the vlog that discusses the Gracey 13/14, and plays it while the group looks on.

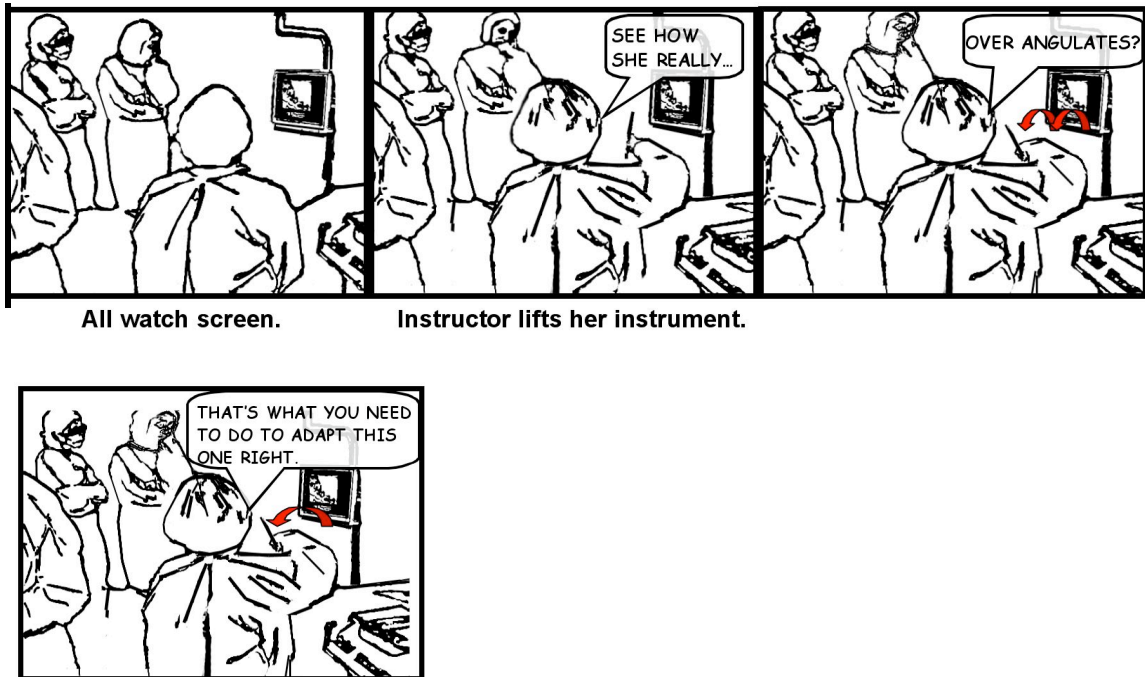


Figure 38. Example GROUP1

In Figure 38, we see a video segment playing as the student group looks on. The group watches for a few minutes, then the instructor lifts her instrument up at her eye level and says, “See how she really over angulates?” As she says, “over angulates,” the instructor bobs the instrument handle in the air while rotating it counter-clockwise. (The verb *angulate* refers to the angle that the instrument blade makes with the surface of the tooth, which can be controlled by adjusting the handle of the instrument; *over* refers to an exaggerated angle.) Prompted by the video display, the instructor *highlights* a feature of instrumental action onscreen to the group (Goodwin 1994). She accomplishes this by positioning her body in a representational framework where her hand and instrument aligns with the instrument and model onscreen

(from her perspective). Her utterance, “See how,” effectively moves the locus of attention of the group from the screen to her hands (note the shift in gaze of the student across from the instructor), but the alignment of the gesture with the structure onscreen makes it clear to what she is referring. Held up in the air, and exaggerated in motion, the instructor’s gesture with the instrument guides the developing professional vision of her students, instructing them about what is meaningful about what they see onscreen.

Here, in the context of professional training, the attention of the student group is directed by the instructor. Schegloff (1969) argues that intersubjectivity is locally managed. Moreover, he also argues that it is “interactional and sequential.” Though Schegloff (1969) refers to purely spoken interaction, what we are talking about here is the full repertoire of embodied conduct in the presence of a material world (Heath and Hindmarsh 2000; Goodwin 2000). Therefore, we should consider not only isolated conversational turns, but also the accompanying displays of bodily conduct co-produced with talk, and further, how these bodily displays align with the material world. When we consider this, we can appreciate the sophistication required to orient to the sequential nature of human activity.

What we see in GROUP is another example of the “context-supporting” property of the vlog. The instructor is able to “say more than she is saying” by her points and references to the ongoing video. However, in this case the students have the additional benefit of having an expert commentator who provides a meta-level analysis of the expert’s practice onscreen.



**Figure 39.** Example GROUP2

Following the instructor’s commentary, in Figure 39, the third student to the left (S3) asks, “So you’re almost like,” while configuring her hands into a gesture, then appears to revise her statement, “The

shank's almost parallel with the occlusal surface?" Following silence, she continues, "'Cause the terminal shank kinda lays down?"<sup>21</sup> while making a flattening gesture with her right hand. The instructor comments, "No, I don't quite see what you mean," then turns her attention to the video. We see that in Example GROUP3, shown in after watching the video for several more seconds, the student revises her statement again.



**Figure 40.** Example GROUP3

In Figure 40, the student says, with her eyes on the video, "I guess she's kinda working around it still." Relying on ethnographic experience in the domain, I assume what the student means is that the practitioner onscreen is continuing to move the instrument around the tooth (i.e. "it"), moving beyond the occlusal plane. It is interesting to note how this time that she speaks, the student covers her mouth with her hand, which may indicate self-consciousness. In response to this comment, the instructor looks

<sup>21</sup> Frankly, I am still a bit uncertain about this statement – one reason is because the student's initial statement and gesture + revision are contradictory (something parallel to the occlusal surface of the teeth would not lay down, it would be vertical). It is quite possible her statement is incorrect – it could be she misused parallel or occlusal, technical terms that she may not fully have competence using. Nevertheless, my confusion helps me relate to the instructor's negative response to the student.

quickly to the student and nods. Then the instructor adds, “So she’s fulcruming closer”. She then raises her arm and points with her instrument to index the screen as she invites the group to “See how she changes her fulcrum as she comes around?” Here, again, she opportunistically uses the representational structure provided by the video demonstration as she highlights another feature of scaling.

**Portrayal 5.3: 10/18/05**

*Class has recently begun. I am observing/note-taking as an instructor reviews how the Gracey 11/12, an instrument which has been introduced in the previous class, should be used. The instructor is sitting at a student’s chair, and her entire group is watching the video blog segment, “Gracey 11/12: Basic Principles.” About two-thirds of the way through the video, the instructor says to a student, “Can you rewind it a bit; I want to show you something that’s hard to do.” The student begins advancing the video, using the rewind button. Looking on, the instructor says, “Stop it when she’s right at this distal,” as she points to a tooth onscreen. Soon, the student stops the recording when the video demonstrator’s instrument reaches the point the instructor had indicated.*

*The instructor says, “So what happens right here is that students this morning were like, ‘How can I keep this parallel (she holds instrument directly up to the tooth on the screen) in this facial plane here?’” She waves her left hand, flat and rigid, against the screen, drawing it up and down. She continues, “If you watch the video (she points), see how Theresa is fulcruming in front of her instrument?” She holds her hand up in a similar handshape near the screen. Then she shifts her chair, moving to the other end of the chair. She sits at the student’s mouth model and begins demonstrating what she was talking about by showing students how to use the Gracey 11/12 by fulcruming in front of the instrument, as opposed to behind it.*

In both of these cases (Portrayal 5.3 and Example GROUP), the screens serve as a dynamically changing representation to which joint attention is focused. The video supports a context upon which an instructor’s gestures and speech can layer upon in order to augment the content and present new strategies for seeing practice expertly. As phrased by Goodwin (2007), the instructor constructs “a multimodal sign

complex (language + gesture+ things), in which structurally different kinds of signs in different media mutually elaborate each other to create a whole that is both different from, and greater than, any of its constituent parts” (p. 13). Note how the instructor aligns her hand + instrument against the screen in non-arbitrary ways – she in fact preserves the orientation of the instructor’s hand onscreen, and uses the oral anatomy onscreen to demonstrate positioning with her own hand and instrument.

What the instructors are doing in real-time here is a similar practice to that which the DIVER system created by Roy Pea’s research group at Stanford University attempts to encapsulate through facilities for digital video annotation (see Pea *et al.* 2004). This software system allows experts to augment videos by creating annotations that show “what they are seeing” or “what is salient” about a particular scene. Moreover, they are not only teaching students how to see, but also, where to go to find answers should they need them reviewed (an activity supported by the archival status and wide accessibility of the vlog). Interestingly, in both of these examples, the instructors are repurposing the videos as representations to show a subtlety of scaling that is not being explicitly discussed on the video; for instance, where the instructor onscreen is fulcruming with a particular instrument. The video provides a contextual backdrop that the instructors can augment with gestures and talk.

Moreover, motor learning research shows that video replays are more successful in the teaching of motor skills when accompanied by cues or directions from experts, such as experiments where subjects are explicitly taught to focus on certain aspects of the display during video replay (Kernodle and Carlton 1992; Newell 1991).

#### **5.4. Discussion**

Seymour Papert, in a retrospective article about his experiences in the 1980s with the LOGO system, wrote:

The context for human development is always a culture, never an isolated technology. In the presence of computers, cultures might change and with them people's ways of learning and thinking. But if you want to understand (or influence) the change, you have to center your attention on the culture -- not on the computer. (p. 22)

This research resonates well with his argument: it was not a "controlled" experiment on whether or not of video blogging technology “worked better” than traditional teaching methods. Rather, it was an

attempt to create a working educational environment in which computers and video blogging are important elements – and to study how the educational culture was affected by the presence of new technology and representations.

The technology-supported interaction schemes reported herein are emergent phenomena, arising (in part) as a result of the particular set of design affordances and constraints. Students were not explicitly taught to use the technology in a particular way, or encouraged to use it through formal task assignments, (e.g. they are assigned to watch videos on the vlog for a set amount of time, or make a written report on material); rather, students were simply informed about the existence of the vlog and taught how to use it. That students and faculty used the vlog at all, with regularity, indicates that this technology served a set of perceived needs, and that the field members created a set of practices for interacting with the technology and integrating it into their instructional tasks.

Educational researchers have reported discrepancies between gestural and verbal modalities during developmental transition periods, with gestures foreshadowing conceptually more advanced understandings (Goldin-Meadow *et al.* 1993). Seen in another way, it appears that action-based representations often precede verbal descriptions of technical phenomena. Roth and Lawless (2002) use examples from a physics classroom to illustrate how the perceptual ground and gestures have an important scaffolding function in students' development of scientific language, because they take on a representative function. They argue that representations free up the verbal modality to focus on constructing new conceptual statements. Furthermore, they propose that when students use gestures, the activation levels in neuronal regions involved in meaning-making increase, and thereby facilitate the production of verbal descriptions. Because the same neuronal assemblies are activated for perceptual and corresponding motor activities (Decety & Grezes 1999), both perceptual cues and accompanying gesture may scaffold the emergence of a corresponding language that encodes meaning in the verbal modality. Thus, the perceptual ground and gestures have an important scaffolding function in students' development of scientific or technical language, because they take on a representative function.

In Chapter 1, I argued a similar point - that the use of embodied perceptual schema and action-based representations scaffold a student's emerging technical expertise. Here, I would like to comment on



how students can opportunistically use the structure presented on videos to scaffold their technical development. In Example LATERAL, we may assume that a student was prompted by the dialog on the video to ask a peer about the meaning of 'lateral.' In this activity, the students are in the process of constructing and negotiating a common repertoire of practices characteristic of the profession in which they hope to gain access. Many of their interactions are focused around achieving a sense and significance of what they are seeing and hearing in the videos. The sequential ordering of the video provides a framework upon which they can hang utterances or displays aimed at aligning their perception and action within a professional world.

Users of a new technology can opportunistically exploit the affordances of a representational medium to enable emergent new practices. In this case, participants utilize the ongoing narrative and action in the video medium to provide a discursive framework upon which to layer action and talk. Both students and instructors take advantage of the unfolding video stream to provide content upon which to act and comment.

## **5.5. Conclusions**

### **5.5.1. Transformations in Social Interactions**

In this chapter, I have investigated how a digital video blogging system, made accessible through flat panel displays embedded in practice workstations, affected the learning practices and complex social dynamics of professional training in dental hygiene. Brown's (2000) metaphor of a *learning ecology* is useful for describing complex, real-world learning domains. This concept is useful because it emphasizes how such environments are constantly evolving, and largely self-organizing. We might expect that through appropriating new technology, new practices might emerge. By analyzing digital video data taken while practitioners began to regularly work with the vlog in clinical practice, I identified three new classes of activity that practitioners developed to integrate the vlog into their daily activities:

- *Following* – during solitary work, students often practice instrumentation while simultaneously watching videos. The video content on the vlog was filmed from a “first-person” perspective, allowing students to make visual comparisons between themselves and the expert onscreen.

- *Context-Supporting* – Students frequently watched videos while working in dyads, where one student controlled the video and worked at their practice station, while another student looked on in an auxiliary position. As students watched the video, they often conversed with each other about topics currently being modeled or discussed simultaneously on the video. During partner collaboration, the video supported a context of relevant speech and demonstrations that the students could view together and comment upon. As stated in an interview with the head instructor in 2006, the vlog would “give them words to express what they're challenged with.”
- *Instructor Highlighting* – during group work when an instructor was present, instructors often highlighted, or indicated relevant features of a video with speech and gesture, during group viewing. This may support the development of the students’ professional vision— seeing the world as an expert does.

During the course of this study, I have had a privileged look at how practices evolve in the presence of a new representational medium. Observing how use practices emerge (or fail to do so) may give us further insight into how technologies form an integral part of the way people coordinate activity in learning environments. That being said, I speculate with caution, because moving into predictive analysis based on such observations is a risky game. Given that disclaimer, we can argue that certain trends do exist.

One important new trend is how the publicly visible computer screens (flat panel monitors placed at eye level on a swivel arm can be rotated in all directions) became focal points for group activity, such as in the *context-supporting* and *instructor highlighting* cases. In a similar vein, Sellen and Harper (2001) have noted that a critical "affordance" of paper is its ability to flexibly support workplace discussions -- the physical properties of paper support exchange in face-to-face encounters, enabling verbal annotation of texts such that two participants can verbally 'walk through' the document. In our case, the computer screens become ‘hubs’ for the organization of collaborative learning (to use a term coined by Heath and Hindmarsh (2000)). The screens, playing videos, become sites that organize collaboration within the clinic, where students and instructors refer to and discuss objects and features of objects in the course of training activities, solving difficulties, organizing perception, and planning courses of action.

## **Chapter 6. Transparency and Technology Appropriation: Social and Institutional Factors Affecting the Appropriation of a Video Blogging System**

### **6.1. Introduction:**

The primary endeavor of human cultural practice is constructing meaning. It is through culture that we make sense of the world around us and share our experiences with others. Culture influences how we interpret our perceptions – that is, how we understand what we perceive. Meaning is assembled in the mental experience of a cognitive being with a body interacting in a world that includes other cognitive beings. Our interactions with this world (and with others) play critical roles in the meanings we construct.

Culture is highly adaptive and dynamic. For instance, culture can change in a community as new technologies are appropriated into practice. These transitions can be subtle and seamless, or rocky and controversial. For instance, consider how many social practices have changed dramatically as cell phones have become ubiquitous. Now, when coordinating a rendezvous, it is common to “call someone’s cell phone when you arrive,” rather than decide upon an exact meeting time and place beforehand.

During times of transition, breakdowns in social conventions and violating taboos can become more prevalent. People may find themselves in novel social situations for which they have no prescribed social script to follow. For example, what should one do when his cell phone rings at the same time a friend greets them in person? Because cultural norms are often tacit, they can be elusive to study and understand. However, when transitions, violations and breakdowns occur, tacit conventions may become more explicit, providing researchers with unique opportunities for access.

Indeed, new technologies can be met with resistance when they violate cultural practices. For instance, though context-aware computing applications bear great promise in many domains, striking concerns about privacy, accuracy, and behavior modeling are arising as these systems are implemented in real-world domains (Rogers 2006). Rogers notes that many context-aware systems attempt to guide a person through certain activities using a rational and predictable model of human behavior. However, people often behave in “unpredictable and subtle ways in their day-to-day contexts” (p. 408). Clashing with existing cultural norms may doom an otherwise well-designed technology to failure.

Moreover, technologies that reveal information previously obscured or hidden can destabilize community practices. In some cases, this destabilization (or the potential of instability) can cause a technology to fail to gain acceptance. For example, in the 1990s, surveillance cameras were installed in many U.S. cities at stoplights that were frequently violated (Wikipedia 2007). Indeed, camera enforcement has been controversial since the first speed camera system issued tickets by mail. Often, red light camera ticketing programs last no more than a few months before public pressure force the systems to be dropped (Dunn 2006). For instance, many U.S. cities have rejected right light cameras using municipal voting power (Peoria, Arizona – 1991; Batavia, Illinois – 1992; Anchorage, Alaska - 1997 referendum; state of Hawaii – 2002; Steubenville, Ohio – 2006). In many cases, controversy surrounding the deployment of red-light cameras came because police and government were accused of "Big Brother tactics" in over-monitoring of public roads, and of "revenue raising" in applying cameras in ways to increase government revenue rather than improve road safety.

Given that existing cultural practices have important bearing on how technology gets appropriated, having an understanding of them during the process of technology design can help predict or explain ways that technology might conflict, or resonate with, current practices. Understanding the social and historical context has direct implications for the design of collaborative educational technologies. Traditionally, HCI design methodologies attempt to establish the projected usefulness of a technology at design time. However, recent work asserts that the perception of usefulness is not embedded in design, but is dynamically and constantly crafted by the different social groups and contexts that the technology is implemented within (Gardner and Wagner 1996; dePaula 2004; Dourish 2006). Multiple interdependent social groups negotiate, legitimize, and sometimes define usefulness through various perspectives and perceptions.

Different groups regard problems and potential solutions associated with a technology in different ways. The power relations among groups of people in a user community can heavily influence why particular technological interventions might succeed or fail. Moreover, a deeper understanding of these 'political factors' influencing a technology's acceptance and appropriation can be achieved only through an analysis of the processes that created such circumstances, rather than just an emphasis on their

outcomes.

In this chapter I investigate some of the factors involved in the appropriation of new video blogging technology implemented in 2005 and 2006 in a local community college's dental hygiene clinical instruction laboratory. This analysis will contribute to the discussion about how social processes affect the acceptance and appropriation of new forms of technology.

### 6.1.1. Cultural Models

Cognitive anthropology has a long history of exploring the regularities of how cultural knowledge structures our world. According to Roy D'Andrade, "cognitive anthropology investigates cultural knowledge, knowledge which is embedded in words, in stories, in artifacts, and which is learned from and shared with other humans" (1995; p. xiv).

One way to think of cultural knowledge is as a distributed system of models. In a *schema*, the complexities of a procedure, an understanding, or a behavior become simplified, caricatured, or otherwise filtered until only the most salient aspects remain. David Rumelhart refers to schemas as the "building blocks of cognition," defining a schema as a conceptual abstraction that mediates between sensory stimuli and behavioral responses (1980). Cognitive psychologist George Mandler notes that, "Schemas are built up in the course of interaction with the environment. Schemas are abstract representations of environmental regularities" (1984, p. 55-56).

D'Andrade notes that schemas are sufficiently open and flexible to allow lots of possible organizations of experience (1995). For instance, when one thinks of grocery shopping, the schematic representation of shopping might include a number of 'slots' waiting to be filled: the consumer, the market, the kinds of products they would expect to find, the varieties of products they would expect to choose from, the methods for making buying decisions, the currency used in a purchase, the rituals for making a purchase, and more. In spite of these slots being open, though, the *gestalt* of these different elements combining into the complex we refer to as "grocery shopping" becomes clear.

Naomi Quinn and Dorothy Holland expand such notions into a *cultural model*: "Cultural models are presupposed, taken-for-granted models of the world that are widely shared (although not necessarily to

the exclusion of other, alternative models) by the members of a society and that play an enormous role in their understanding of the world and their behavior in it" (1987). Hutchins (1980) played an important role in moving cognitive anthropology away from models of cultural knowledge toward schema theoretic cultural models. Strauss and Quinn (1994) develop this point:

Since subgroups such as households, genders, regions, ethnic minorities, and historical cohorts crosscut one another, an individual may share schemas with as many different groups of other individuals as he or she shares a history of membership at the same time sharing all of his or her schemas with no one else in any of these groups. This way of thinking about culture as differentially distributed cultural understandings, or schemas, seems to us to account for that cultural sharing which does occur without reifying culture as a bounded entity. (p. 293)

A good ethnographic example of a cultural model from American culture appears in Quinn and Holland's study of marriage (1987). Using extensive interview material from husbands and wives in eleven marriages, they performed discourse analysis. By studying the metaphors and key words, a series of propositions that characterize the notion of marriage were discovered. Among the proposition-schemas that supported the cultural model of marriage were: 1) marriage is enduring; 2) marriage is mutually beneficial; 3) marriage is unknown at the outset; 4) marriage is difficult; 5) marriage is effortful; and 6) marriage is risky. What Quinn and Holland's depiction of the model of marriage elucidates is that, in contrast to a simpler psychological analysis, her model not only posits desire, but also illustrates, through these proposition-schemas, how desire gets organized cognitively and affectively. Even more interesting, these proposition schemas show how desire may be generated by collective beliefs, values, and goals. A desire for marriage does not spring from a unitary individual source, but originates in culturally mediated understandings of numerous schemas.

How do individual models of the world, built from our bodily experience of the world, interrelate with these shared cultural models? Shore (1996) proposes that complexity increases as the individual moves between personal mental models and culturally shared ones: "Their creation is more complex than that of personal models, since they have been externalized as shared institutions as well as internalized by individuals" (p. 47). As Shore moves to larger scales of analysis, the models he describes become more deep-rooted and pervasive. The models exist as patterned public forms such as greetings, discourse genres, workplace conventions, public spaces, conventional body postures, and even deliberately orchestrated

aromas. Such instituted models provide foundations for social existence. Instituted models are at the essence of a culture, the particular ways that it organizes and expresses its distinct way of life in word and behavior.

Recently, new ideas have emerged in cognitive science that may contribute to our understanding of cultural models. Such work includes theories of embodiment (Lakoff and Johnson 1999; Clark 1997; Lakoff and Núñez 2000), situativity (Suchman 1987; Lave 1988; Goodwin 1994), activity (Lave 1988; Nardi 1996; Cole 1996), and distributed cognition (Hutchins 1995; Hollan, *et al.* 2000). These approaches contribute many new ideas, one of the most important being that the structures and processes internal to the human brain are probably not direct representations of the patterns that people experience. Rather, the observed patterns of behavior emerge from interactions that internal processes have with structures and processes that are present in the environment. This means that what we consider culture may not be entirely "inside" individual members of a group in question. As Hutchins (2002) states, "culture is a shorthand label for an emergent pattern."

Therefore, the concept of cultural models provides researchers with a useful tool for describing regularities in social behavior. Presumably existing cultural models influence how new artifacts and technologies are appropriated into practice. Moreover, cultural models may evolve during the process of appropriation. Therefore discovering cultural models that have a social reality in the community we are studying becomes paramount. How do we go about this?

Culture is always present in the processes that construct activity, but our real challenge lies in making culture visible. In constructing meaning, people can draw upon resources from a wide range of sources, and we researchers need to know which resources are recruited and why, and how applying those resources constrains the system. As Hutchins (1995) has demonstrated, this method is applicable for researching highly rationalized settings. Notably, an important part of this approach is lies in sampling behavior in the context of interest. In Hutchins' (2002) words, "seeing professional culture requires exposure to the organization."

As researchers studying culture, we should keep in mind that culture is something that the observer imagines is in or behind the organization of activity. Geertz (1973) would say that culture is

brought into existence only by the activity of anthropologists who write about it. Emerson *et al.* (1995) agree, stating, “Member’s meanings are not pristine objects that are simply discovered. Rather, these meanings are interpretive constructions assembled and conveyed by the ethnographer.” They warn that an ethnographer’s job is not to present “static taxonomies of terms,” but instead, “explain how members use terms in specific interactional situations and how involved parties differentially understand and evaluate them” (p. 108).

Studying culture as an emergent pattern requires a shift in the theoretical application of ethnographic methods (Hutchins 2002). The new theoretical focus is oriented toward identifying patterns of interaction and emergent properties of activity systems and the resources people draw upon to construct meaningful courses of action. For instance, when one begins to unravel the underlying cultural models behind an informant’s comments, the question we ask is, *what schematic understandings must a person hold in order for what they say to make sense?*

### **6.1.2. Human-Computer Interaction: A Brief History**

In the past two decades, the field HCI has developed a rich set of methods, techniques, and theories to address a wide range of issues related to designing computer technologies that dovetail with human needs. The early focus of usability research was on low-level perceptual and ergonomic issues, but progressed to a focus on the larger set of tasks that involve a single user interacting with a computational desktop environment. Throughout this development, the unit of analysis remained on the individual user, with relevant theories drawn from cognitive psychology, computer science, and human factors. In principle, the model that early HCI operated under studied cognitive factors (e.g., perception, memory, learning, and problem-solving) as they played out in users’ interactions with computer interfaces. The goal of this research was to evaluate the effectiveness of a design given a set of well-defined tasks—that is, the ease-of-use of an interface design based on objective metrics and descriptions of tasks and context.

In the 1990s, a number of groundbreaking works directed attention to the need for a broader understanding of the use of computer technologies in real-world situations. Examples are works on technology adoption (Grudin 1994), situated action (Suchman 1987), distributed cognition (Hutchins



1995; Halverson 2002), and activity theory (Nardi 1997). Grudin (1990) argued that HCI had gone through a number of stages, and at the time, had begun to shift from single users and computers to a focus on broader work settings. This move to a focus on work settings emerged as an approach to better design technologies that are indeed more useful for particular use settings, with design constraints generated through achieving an in-depth understanding of work settings and practices. This shift led to design methodologies such as User-Centered System Design (Norman 1993), Contextual Design (Beyer and Holtzblatt 1998), and more recently Ethnography-for-Design (Hollan *et al.* 2000).

Another approach has been the Scandinavian methodology of Participatory Design (PD), which attempts to bring members of the user community in to participate in the design processes (Ehn 1988). PD has for years adopted a systemic approach to the design of both technology and work practices. By bringing users to the design process, it not only creates the opportunity for their concerns, values, and needs to be incorporated into the design, but also allows users to take the ownership of the possible design solutions. The major limitation of PD lays in the fact that end-users are not necessarily design experts, and therefore perhaps are not able to effectively articulate and participate in the design activities.

Now, with the development and widespread dissemination of computer networking technologies, and the presence of computer technologies in a large range of social settings, a move toward a new perspective on design has arisen. This new perspective is characterized by designs of sociotechnical systems that support distributed and networked activities in social workplace contexts. It is important to incorporate approaches that attempt to understand the social and political issues of real-world uses of technology into the existing framework. Instead of looking at an interface as simply a dialogue between a single human and machine (even though usability studies based on such a premise are important), it is important to look at the role of technology in an extended way, including the social, cognitive, technical, and institutional conditions for human communication, coordination, and collaboration (Bødker 1997).

This shifting perspective foregrounds a growing awareness in how human activities are mediated by technology. It also emphasizes that certain types of media are better suited to certain kinds of interactions. As computer networks, and computation in general, become more pervasive and integral to everyday life, an even broader view of 'technology' needs to be taken into account. Applying theories

grounded in social and organizational themes is imperative for understanding how technology shapes communities, and how best to design systems to support complex social ecologies. Toward this end, some design approaches now attempt to draw upon interpretive models that recognize that social reality is socially constructed and subject to various interpretations by different social groups (Ehn 1988; Winograd and Flores 1986). Social facts are not pre-ordained or absolute; rather they are emergent properties of technological interactions, continually negotiated, reinterpreted, and revised (Dourish 2004).

### 6.1.3. The Social Life of Technology

Technology is part of a complex ecology of people and things. The adoption of technologies, especially collaborative work systems, involves both technical and social issues. Ackerman (2000) uses the term “socialtechnical gap” to describe a spanning distance between how far we can “reach” with technology in the design process and the systemic realities of technologies used in practice. In emphasizing a gap, Ackerman characterizes design as a bridge. However, Ackerman criticizes the notion that people *adopt*, and then must *adapt* technologies because those technologies are poorly designed, and that if the technology had been better designed, there would be no need for adaptation during the appropriation process.

In contrast, social science perspectives suggest a different view of the creative processes by which communities bring technology into practice. Specifically, that these processes are natural consequences of everyday action, and not problems to be solved. As Dourish (2006) says, “Technology...is a site for social and cultural production; it provides occasions for enacting cultural and social meaning” (p .561).

Many factors can determine whether or not a technology will be well integrated into a setting. However, a common misconception is that particular attributes of the technology itself (namely, interface design, access, usability, ergonomics) are the major determining factors as to whether or not a technology will be accepted. Equally, or perhaps even more likely, acceptance and appropriation is related to the social and political conditions of the social settings into which the technology is to be integrated (dePaula 2004).

A typical design approach is to collect 'the design requirements' solely at the early stages of the life cycle of a technology. The idea is that by collecting design requirements, based on contextual data, designers can more adequately support the needs of target users' everyday work practices (Beyer and Holtzblatt 1998). However, this process is dependent on adequately revealing users' needs and contexts at design time, and predicting the potential impact and possible outcomes of the design. Therefore, designers must determine the usefulness of a particular technology before that technology is implemented.

In contrast, dePaula (2005) suggests another alternative. He proposes that a technology's *perceived usefulness* to the social group is of major importance. 'Usefulness' is a meaning-making process negotiated and shaped throughout a technology's design, introduction, and use. Social groups collectively construct and shape perceptions of usefulness. Group perceptions of usefulness are negotiated in the interplay between perceptions of usefulness and the meanings given to the technology. Furthermore, as an interpretive process, the perception of usefulness is also contingent on the social groups' hidden agendas, "strong feelings" or attitudes towards the technology. Both the technology and the settings of use go through a process of mutual adjustment, which is a process of *appropriation*.

#### **6.1.4. Technology Appropriation**

Technology is not adopted at one discrete moment in time, and then fluidly integrated into practice; rather, the users of a technology engage in a process of adjustment and adaptation. Appropriation refers to the transformative and interpretive process that takes place when an artifact is introduced and brought into use (or not) within a particular context. One of the simplest acts of appropriation is the discovery and exploitation of *affordances* (Gibson 1978), which, simply put, are patterns of alignment that grow from the relationships among bodies, minds, context, and technology. A social group may begin to construct a system of interaction with a new technology in a context. Important ethnographic studies of technology, such as Suchman (1987) have shown that everyday routines, artifacts, and interactions are quite pliable as technology is brought into a system.

When studying appropriation processes, we privilege the transformation of practices in the setting as a technology becomes part of it. Most importantly, appropriation as a theoretical concept assumes that

users create meaningful uses of a technology. In other words, whether or not a technology is appropriated, and how it will be appropriated, is not objectively determined by the attributes of a technology, rather, it is a cultural construction. As technology is designed and used, it is constantly being re-evaluated, re-interpreted, and restructured by the various social groups involved (including users, designers, and policymakers). Also we must keep in mind that these structures are not static; they are constantly shaped and replicated through action and interaction in the setting.

While it is somewhat tempting to view an affordance as a property embedded into a particular tool (e.g. “that handle affords pulling”), it is critical to acknowledge that “reading” affordances is always embedded within a rich cultural matrix. That is, though the design of a handle can fit nicely within a set of constraints established by the physical architecture of the human hand and body, understanding the meaning of “handle” and what to do with it is inherently a cultural process.

Appropriation involves a change in participation in a sociohistorical activity (Rogoff 1995) as one gains the ability to use the artifact to mediate interaction with the social environment. In particular, in computer-mediated social environments, appropriation is the process by which users create meaningful uses of the technology. Participants creatively explore new ways of using the sociotechnical features implemented on the system, *persistent structures*, so as to enable social meaning to be conveyed through the technology. For instance, users of newsgroups have created emoticons to convey social cues. These dynamic appropriations and modifications foster the emergence of new social structures. Moreover, as a representational device, technology can also reveal social structures either being created, or already in place.

Therefore, it is important to understand the social structures in place that affect and are affected by the appropriation of a technology. Studying the process of technology appropriation with ethnographic methods allows us to document and analyze this process in detail. In particular, given the breakneck speed with which the modern era creates social practices around new technology, understanding this process is an area of great importance.

### 6.1.5. Technology and Institutional Change

As most large organizations, institutions of higher education are constrained by habit, tradition, and culture. These structures represent significant obstacles to organizational change, and they therefore must be recognized and addressed in order to realize genuine pedagogical and institutional transformation. Among the theoretical models that can be used to understand the opposition and resistance to new technologies by educational organizations, the 'institutionalist perspective' provides a number of major insights (Twigg 1994).

The institutionalist model has developed in opposition to organizational theories that assume that organizations adapt to changing environmental pressures in entirely rational and functional ways. In contrast, the model provides a framework for understanding institutions that are highly resistant to these pressures, such as is the case with many institutions of higher education. Indeed, in institutions of higher education, standard operating procedures for teaching and learning remain intact for long periods of time, and often appear impervious to external pressures; moreover, organizational members often fiercely defend such procedures. For example, the classroom institution has historically centralized power and influence in the hands of the instructor. Some examples of centralized power include: faculty are seen as the source of knowledge; faculty unidirectionally communicate information and influence the students; faculty determine what will be taught, who will speak and when; faculty determine the correct or incorrect answer; and faculty determine when it is time for students to "stop learning" and leave the classroom. In contrast, many new learning technologies, especially Web disseminated technologies, shift a considerable amount of power, authority, and control from the faculty to the students. In many cases, the transition from traditional classroom learning to asynchronous online learning networks has been rocky and lags behind what an entirely rational model of institutional change would predict. In order to understand some of the issues at play, we need to look more deeply at the systems of meaning that make up institutions of higher education.

Meyer and Rowan (1977) suggests that highly valued organizational practices take on the status of "rationalized myths." They are "rationalized" in the sense that a particular organizational practice is regarded as the single best and necessary means for assuring a desired outcome. However, such

institutionalized organizational practices are also “myths” because arguments for their effectiveness rest less on empirical verification or assessment than on deep-seated consensual beliefs and long-standing tradition (Maurer 1996). For instance, in the example from above, the teacher-centered classroom tradition has become the widely accepted standard for evaluating the appropriateness and legitimacy of educational practices. Meyers and Rowan comment, “Such elements of formal structures are manifestations of powerful institutional rules which function as highly rationalized myths that are binding on particular organizations” [Meyer and Rowan 1977, p. 15].

The institutionalist perspective provides a framework for explaining why organizations will assign value and resist change to established routines. On the other hand, not all organizational practices and routines are highly valued, nor do they necessarily elicit a strong emotional reaction when threatened, nor are organizational members always unwilling to adopt alternative methods. Is there a basis for explaining the variation in the intensity of opposition and resistance? Another sociological concept can shed some light on this question.

In an interview on organizational change, Margaret Wheatley, a writer and commentator on organizations and leadership, defined *organizational resistance* as “people's assertion of their identity as they presently construct it” (Maurer 1996, p. 50). Identity seems to be at the heart of what galvanizes opposition to organizational change. Indeed, the greater the degree to which a particular organizational practice defines and reinforces one's core professional identity, the greater will be the opposition and resistance to alternatives. When identity is defined and reinforced through particular forms of social action -- then proposals that advocate alternative actions will be met with significant resistance (Jaffe 1998). More specifically, the faculty identity as a professor, as an expert, as a source of knowledge and information, is heavily shaped and reinforced through the role of classroom instructor and the face-to-face interactions that make up the classroom teaching arrangements.

However, organizations do change and long-standing practices are often discarded and replaced by new administrative procedures and organizational processes. Oliver (1992) presents a model of deinstitutionalization that identifies some of the central factors and conditions promoting the deinstitutionalization process. Deinstitutionalization is defined as:

The process by which the legitimacy of an established or institutionalized organizational practice erodes or discontinues. Specifically, deinstitutionalization refers to the delegitimation of an established organizational practice or procedure as a result of organizational challenges to or failure of the organization to reproduce previously legitimated or taken-for-granted organizational actions (p. 564).

Oliver outlines various intraorganizational and external pressures that might facilitate the deinstitutionalization of institutionalized practices. As already noted, there are significant external pressures to apply new instructional technologies and implement alternative delivery modes. It is possible that, over time, these pressures might erode some of the attachment to institutionalized patterns of educational delivery.

Furthermore, Oliver cites another key factor that might facilitate deinstitutionalization: the growing pressure for learning institutions to clarify learning goals and demonstrate that goals have been attained to external regulating bodies. As this applies to higher education, and as the struggle over outcomes assessment has clearly demonstrated, there are great difficulties establishing a consensus over educational goals, and the means for measuring them.

In this chapter I detail the appropriation process of new video blogging technology implemented in 2005 and 2006 clinical instruction laboratory of a local dental hygiene training program. I will address questions about the appropriation process, such as: how do participants construct meanings about the new forms of technology, what are the meanings, and what are they based upon? How is this influenced by the way that technology is introduced into a setting? What kinds of activities get constructed around new technology, and how does this process evolve? Are previously unnoticed features of the educational infrastructure revealed by new technology? Who has the power to decide what content gets embedded in new technology? How does this influence participants perception of technology? How does this perception shift over time, and why?

## 6.2 Methods: Ethnographic Approach

Many of the methods used, such as portrayals, observations, and participant observation have been discussed elsewhere. Below I detail some minor deviations and additions that were made to the methods described earlier in order to collect the data used in the analysis.

### 6.2.1 Faculty Interviews

Four clinical instructors voluntarily participated in this portion of the study, along with the Program Director, and the Dean of the Higher Education Center. I did a series of interviews with these six faculty members. Interviews were recorded and held in relatively quiet spaces such as faculty offices, the instructional clinic, the faculty lunchroom, my vehicle, and local coffee shops.

The faculty members were interviewed multiple times, as shown in Table 6. Some of the material from faculty interviews, in particular related to the evolution of the system design, has been discussed in Chapter 4. Instructors' reports gave a perspective on the vlog system, and pointed to problematic aspects from both a curricular standpoint (how the video blog technology integrates with the course design and material) and a pedagogical standpoint (how the technology presents information to students and structures their activity). I also attempted to understand some of the factors involved in the faculty members' appropriation of video blog technology into their teaching practices. Some of the specific issues I looked into were: How did they structure their teaching practices so as to explicitly include (or not include) the vlog? What were the underlying conceptual models that structured their perception of this technology? What were their perceived role(s) as instructors, and how did the new technology affect this (or not)?

**Table 6.** Summary of interviews done with faculty.

<b>Instructor</b>	<b>During 2005</b>	<b>During 2006</b>	<b>During 2007</b>
<b>TP</b>	12	2	1
<b>KR</b>	5	1	2
<b>LR</b>	8	1	1
<b>DJ</b>	2	1	--
<b>PD</b>	--	6	2
<b>CP</b>	1	--	--



### 6.2.2 Server Log Data

Server log data from our lab server was captured from August 2005 through January 2007. The server log data is discussed in detail in Chapter 4. In this chapter, I show server log data in order to detail how system use changed between Year 1 (2005) and Year 2 (2006).

### 6.2.3 Design of the Vlog

I detail the design of instructional technology for the clinical training laboratory and the decisions that went into our initial design in Chapter 4. Of relevance to this discussion, however, is a more thorough description of the content presented on the vlog. Two kinds of records<sup>22</sup> made up the vlog's video component:

- *Demonstrations filmed outside of class.* The director of the program, who had been teaching periodontal skills to dental hygiene students for over 23 years, met with me on Monday mornings. As I filmed her, she performed 'ad-lib' video demonstrations of the current week's content; for instance, if the students were learning how to use the explorer that week, she would talk about the explorer. We created segments of about 2-5 minutes in length on various issues (for instance, how to identify the proper end of the instrument, how to position the hand in various areas of the mouth, how to create optimal pressure, etc.). Drawing upon her teaching experience, she created the content of the video segments. Here, I deferred to her judgment, letting her decide on the content. For instance, she might remark to me, "Students often have trouble in the maxillary posterior area with this instrument, so let's create a segment on that." Monday afternoon, I would digitize the videos on my home or school computer and upload them to the vlog. My goal was to allow students could to access current material by the time that the laboratory course met (Tuesday/Thursday), and they would be interested in the content presented on the video segments.

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<sup>22</sup>See Figure 27 in Chapter 4 for a graphical representation of blog content and access.

- *In class demonstrations.* During the clinical sessions, I filmed group instructors as they demonstrated technique in class. I chose times when instructors were working with small groups. I digitized the videos on my home or school computer and uploaded them to the vlog. Here, I made decisions about segmenting the videos, trying to keep them to one identifiable topic, which I used to name the segment (for instance, “Prof. Z demonstrates the anterior sickle scaler”). I made every attempt to upload video files on the same afternoon that I filmed them, so that students were able to access current material for home study.

The majority of the design of the strategy of how records were created and updated records on the vlog was generated over the summer of 2005, prior to implementation in the course. Again, I had worked predominantly with the director of the program to create the technology design and implementation strategy, though I also met with the other course instructors in order to discuss the research project, goals, and approach. I met with instructors individually in ‘pre-interviews’ where I described the technology and project goals, and gave them space to air their concerns. I also held two training sessions with all course instructors in the clinic before the semester began in order to instruct them on how to use the computers, set up the monitors, and call up the vlog.

### **6.3. Results. Technology Appropriation and Challenges**

Decisions about the usefulness of a technology are socially constructed throughout the entire design and use cycles of a technology by the various actors who participate in the community of practice. Moreover, technology is not adopted at one point, followed by use; instead, the technology and the context of its use go through a process of mutual adjustment -- appropriation. Appropriation is an interpretive process that emerges from the interactions among actors, technology, and social settings. Studying the cultural processes behind appropriation can help us understand how to design technology that is more likely to be appropriated and used by the community.

The challenges to appropriation of the vlog technology appeared to fall into two categories:

- The challenges of how to integrate the new technology into *existing teaching practices*, and/or how to develop *new teaching practices* using the new technology, and
- The challenges associated with the pedagogical *content* represented on the training videos.

### 6.3.1. Challenges Related to Media and Practices

Multiple factors come into play when evaluating educational technology. We can consider how the technology itself influences practices, and also how decisions are made about what educational content (information) is conveyed. Of course, these two factors interrelate, as certain kinds of technology are better for conveying certain kinds of information. For instance, as we discussed in Chapter 5, video is a highly robust way of representing motoric information, and may be more effective than textual descriptions in educational situations (Schmidt 1998). However, *how* that video gets used in an educational setting matters greatly. Do students passively watch a video segment once through? Or do they watch a video several times, stopping frequently for critical discussion with a group? Indeed, as we have seen previously, the medium and method used have an inseparable relationship and they are both therefore key components for the design on instruction (Kozma 1994). Instruction is an integration of media and methods. This view necessitates a careful consideration of the media together as part of a broader ecology of instructional methods.

One of the barriers that instructors faced when appropriating the video blogging system was in developing ways of teaching that incorporated the vlog. Moreover, instructors were faced with the burden of having to learn how to use the blogging technology, and then teach students how to use it. Contrary to my original assumptions when envisioning and designing the system for implementation, many of the instructors and students in the program were not familiar with blogs nor had they engaged in the practice of blogging. This came as a surprise to us, as one of the reasons we had chosen a vlog format was because we thought it would be familiar to the user population and not require much additional training to use. On the contrary, we were often called upon to provide technical expertise while engaging in fieldwork.

This unfamiliarity provided an interesting barrier to usage of the system. For instance, in a post-semester interview in 2005, the head instructor mentioned:

As far as the video blogs, well that was definitely new for all of us faculty...and I think a lot of us, you know, would kinda forget how to use it, or don't don't haven't used it enough, so that every time I go to open up the vlog, I'm kinda confused.

In contrast to other accounts that describe strong institutional level resistance to educational technology implementation (Jaffee 1998; dePaula 2004), initial resistance to the vlog technology in our case was seen at the classroom, as opposed to institutional, level. For technology to be appropriated, it needs to be meaningfully integrated (i.e., into social, work, and incentive structures). Despite all the efforts to seed the information spaces with appropriate training and despite the support from the school administration to promote the introduction of the vlog system into the clinic, many challenges were put up against changing classroom practices at the level of the instructors.

DePaula (2004) points to several factors that account for the challenges to integration of technology in classroom settings. Below, I list three challenges mentioned by dePaula (2004) that pertain to this study and detail how they pertain to the instructors in this study.

1. *Lack of meaningful incentive structures.* DePaula (2004) notes how teachers rarely take risks in implementing innovations whose benefits are not directly associated with their own tangible institutional interests. Often designers hope that the apparent or perceived benefits of a technology will provide enough 'momentum' to bring the technology into meaningful classroom structures. In this study, there was no extrinsic incentive for instructors for integrating the vlogging system into their pedagogical practice (i.e. financial, status-related, etc.).

2. *Lack of time.* Because of ongoing time pressure, teachers see a high cost to use new technology. They face the dilemma of how to balance the time needed to get instruction done and the additional time needed to learn an innovation. Furthermore, training students on how to use technology often falls to instructors, in addition to covering all the course material laid out in the curriculum. Often, curricula in professional education are highly impacted, and time is already short. In our case, several instructors reported resistance to the technology relating to the additional training and instruction they had to take on. Indeed this was part of the reason that we decided to implement the system on a web browser, as opposed to a separate software system that would need to be learned.

3. *Merging existing with new structures.* The introduction of a new technology often requires institutional and social changes to accommodate the new structures called upon in its use. For example, we faced several hurdles in deciding how to negotiate the resources required to host the vlog. We looked into what would be necessary in order to have the main server at the community college host our vlog. The IT department required that we submit a full version of the vlog content for revision several weeks before we needed it hosted. Because of the constantly changing nature of a blog, this was impossible. Furthermore, the IT department required the vlog to be made “accessible” – that is, contain background code that can be read and translated by equipment for hearing and visually disabled students. This would have required constant updating and coding of all new material at a level above my, or any other available resource’s, ken. The solution we arrived upon was using software downloaded from a free blogging service (Blogger.com), hosting the main page of the vlog on the Higher Education Center’s main server, and hosting all the “big” video files on our server in the Distributed Cognition –Human-Computer Interaction lab at UCSD.

One way that may help maximize the chances of the integration of new technology is through "seeding" - that is, creating a bridge between existing practices and the innovation through guidance from those behind the implementation of technology (Fischer *et al.* 2001). Seeding is an integration process through which the structures embedded in the design of the technology interact with the social structures of the local context. A seed is a bridge between existing practices (and the sociotechnical structures embedded in them) and the innovations (and the sociotechnical structures embedded in the design of the system). Fischer *et al.* (2001) present several recommendations about seeding activities. Below, I draw parallels between some of the

- *A seed should provide social structures that promote collaboration and connections between users.* Collaborative social activities were facilitated by the vlog technology – as evidenced by the fact that students created meaningful collaborative activities around watching the vlog together (see Chapter 3). Furthermore, instructors created activities around the vlog, such as group viewing and discussion of content that can be “highlighted” an expert. Collaboration was promoted by hardware features, such as the openness of the clinic architecture and the

proximity of the individual workstations – near enough to be viewed and heard by more than one student. Furthermore, the flat screen monitors were at a height that facilitated viewing, and they were attached to swivel arms so that they could be configured in many orientations.

- *A seed should also be built on structured activities that help integrate the use of the system and everyday activities, thereby facilitating its adoption.* Though I suggested structured activities that instructors might consider implementing in 2005 (such as the creation of individual student blogs that could be used like learning journals), instructors preferred to stick to their familiar practices, allowing students to use the vlog on their own. However, over time, instructors developed structured activities incorporating the vlog. The sharing of these practices amongst each other helped to seed and integrate the system into daily practices. An example of a practice that became ‘seeded’ amongst instructors that I saw evolve during 2005, in the third month of the semester, was an instructor watching the most current videos posted to vlog in the beginning of a clinical meeting along with her workgroup (see Chapter 3 for the section on “Instructor Highlighting”). Interestingly, this practice became picked up and ‘institutionalized’ in later years (2006).

Many of the challenges to the technology related to the integration of technology into current practices may have been mitigated because the design was well-suited to match current activities in the classroom, that is, integrate into solo practice, partner practice, and group activity, and be easy to use. These practices are discussed in detail in Chapter 3. Based on analysis of digital video data taken while practitioners worked with the vlog in clinical practice, I identified three modifications to these activities that appropriated the vlog:

- *Following* – during solitary work, students often practice instrumentation while simultaneously watching videos. The video content on the vlog was filmed from a “first-person” perspective, allowing students to make visual comparisons between themselves and the expert onscreen. Based on survey data, this appeared to be an important activity for students in both 2005 and 2006.

- *Context-Supporting* – during partner collaboration, the video supported a context of relevant speech and demonstrations that the students could view together and comment upon. As the head instructor commented in 2006, the vlog would “give them words to express what they're challenged with.”
- *Instructor Highlighting* – during group work when an instructor is present, instructors often highlight (Goodwin 1994), or indicate relevant features of a video with speech and gesture during group viewing. This may support the development of ‘professional vision’— seeing the world as an expert does.

Over the semester, there was a gradual increase in use of the system that appeared to be “seeded” by students themselves (e.g. nearby students see an “early adopter” of the technology (Rogers 1963), and begin to appropriate the same practices). Interestingly, this increase did not seem to be promoted by instructors recommending or assigning technology-based activities, as I only witnessed one instructor of the four actively suggesting to students that they make use of videos on the vlog, or specifically assigning video watching as an activity. The other three faculty members were fairly apathetic about the vlog – they knew about its existence but did not adopt it into practice.

Nevertheless, despite the barriers to integrating the vlog into instructional practices, the vlog was used during 2005. In 2005, our observations showed that the students’ use of the vlog appeared to be student-driven; that is, by students seeing each other use the system in the clinic, in contrast to having instructors explicitly create assignments or learning activities that would incorporate the vlog, or directly telling students to use it, as only one of the four clinical instructors actively promoted its use.

It was not until 2006, the second year that the blog was used, that instructors began to embrace teaching practices that explicitly called upon using the vlog, a process that evolved over the semester, according to one instructor (I am **AB**, the Clinical Instructor is **CI**):

**AB:** So one of the first things I wanted to know about is in clinic, when did you introduce the computer technology, who showed the students how to use the computers, or?

**CI:** In clinic, because I knew about the program, and it was actually the first time I was teaching pre-clinic in quite awhile, in three years I think, I introduced it the first day, to my morning and afternoon groups. So 12 students got the website, and I pulled it up at school. And told them that it was there, and they copied down the web address-

- AB:** Web address, right.  
**CI:** And, I told them that it would be a wonderful reference throughout the semester. So I introduced it on the first day. Not every instructor did.  
**AB:** Not every instructor did.  
**CI:** No. No.  
**AB:** When did they introduce it?  
**CI:** I really don't know. I think when students began talking about it, because there's only 36 students, and when a third of them have the information, they're going to share it with their classmates, then the question came up.

During post-semester interview with the head instructor in late 2006, she made reference to a number of new classroom practices that she was using which incorporated the vlog. One was explicitly assigning video watching as part of the day's clinical activities:

We have them (students) bring them (videos) up so that they can watch things that we're teaching. A lot of times we make that part of our instruction is to watch the blog together...

Another classroom practice was to assign the viewing of specific sections of the vlog to students who had particular problems that she had noticed and diagnosed. In an interview done with the head instructor in 2006,

And um, or if they weren't using the blog, they were doing something else, and we'd get over there and say, 'Well, pull the blog up. Really take it step by step as the blog takes it, and that will help you to do it right,' especially if you catch something that you know is discussed on the blog.

In this instance, we get a description from the head instructor of recommending a 'following' activity to students (described in Chapter 5). We can also infer from her statement that she sees the vlog as a reliable reference to recommend to students. Furthermore, she mentions, "especially if you catch something that you know is discussed on the vlog." This indicates that the head instructor has developed such a familiarity with the content presented in the videos that she can assess whether the problem a student is having is something that is discussed specifically on the vlog.

What another one of the clinical instructors says supports this:

And, the video blog became more important progressively through the semester, and it was actually written on several of the students' worksheets, they were advised, but um, when the instructor made comments, we were to discuss with the students, or write what we witnessed them doing that day and what they might do to improve, and many of us wrote, "Review video blog," repeatedly, especially if a student was struggling with the concept of fulcrum or clock position or whatever it might be.



Recommending the viewing of specific segments was a new activity that developed in 2006, as instructors became more familiar with the technology and the content presented.

### **6.3.2. Calibration of Practices and Transparency through Technology**

In this section, I discuss some of the larger ‘political issues’ brought up by the presence of the vlog. In particular, these issues pertain to the way decisions about video content were made, managed, and negotiated between faculty members (and myself).

#### **6.3.2.1. Phase 1. What is faculty calibration, and why is it important to members?**

In the initial ethnographic portion of the project, I discovered that there were often small inconsistencies in the instrumentation strategies that various instructors demonstrate to students. I also was made aware of this issue in interviews with the dean of the college (a former dental hygienist), and the director of the program, who revealed a concern with *faculty calibration* – a term used to describe a perceived alignment and standardization of content knowledge and practice. Often new instructors base their teaching of instrumentation skills upon their years of experience practicing dental hygiene. Professional hygienists, when working in a dental office, employ a diverse set of instrumentation practices. Because of the independent nature of the profession, an individual hygienist’s practices are often based on individual preferences, and hygienists evolve their own personal style through years of practice.

However, instructors in the dental hygiene program report that a lack of consistency in taught technique is a challenge for novices. Therefore instructors in the program strive for “calibration” of the practices that they teach. Therefore, practitioners believe that it is of particular importance that instructors in the program converge on a shared set of practices, so that new students are receiving relatively standardized instruction, especially if students will be expected to perform to these standards in clinical evaluations.

Portrayal 6.1 represents one of the first times I witnessed problems with instructor calibration affecting the students in a negative way, and my first discussion of my initial observations in an interview with a faculty member.

### **Portrayal 6.1 10/5/04**

While I was taking a lunch break with the students, I overheard Cassie and Donna chatting about their explorer proficiency, which was given today. From what I was able to glean, Cassie lost several points on her proficiency because she hadn't kept the tip of the instrument properly oriented with the tooth, and her exploratory strokes weren't "oblique" enough. She told Donna that her examiner had criticized the fact that her strokes were horizontal. "And when I asked her if she could show me what I was doing wrong, because I did think I was doing oblique strokes, she asked if I even knew what horizontal was!" Clearly Cassie was upset because she felt that the examining instructor had much different expectations on technique than her previous instructors. (The students rotate amongst instructors week to week).

I was curious about this situation because I realized its potential significance. It's indicative of a fairly major pedagogical issue – a lack of instructor calibration and consistency. The students are obviously upset and frustrated when shifts between different instructors mean having to learn a new set of practices. It appears to be especially problematic in this case because a very competent student failed a proficiency, which is a permanent mark on her academic record. If Cassie should have passed by another professor's standards, then these exams aren't serving their purpose.

Later that day, I met with the director of the dental hygiene program, updating her on the state of my research. I asked her to address the issue of faculty calibration.

"Yeah, I know it's a problem," she said, anticipating my taking this line of questioning.

I commented how I had observed some differences in instruction, and she responded by defending the program, "Believe me, we are so much better than some schools. We are even a lot better than we used to be. Truly, ... (Head Instructor) has really worked on unifying things. And I try to be a stickler on this; everything should be by the book. None of this fancy stuff that people do out in practice – I don't like it when instructors confuse students by bringing that stuff into the introductory course. When I was teaching, I would pull out the textbook and point to the page where it shows what I'm suggesting the student do to make a correction."

I asked her if she thought that the different instructors were expecting different things on proficiencies, and if this was a problem.

“You know, I thought it could be, because a few students were complaining that they hadn’t been graded fairly. But we brought this up in our last faculty meeting and kind of dismissed it, because we discovered that most of the students who had issues about being told different things were really passing okay. What we’ve resolved to do is to let students re-take their proficiencies with different faculty members to kind of even out what is expected from them, in case it might be different. If the grades are substantially different, then we’ll know there’s a problem.

“What would be the most optimal solution, of course, would be if we instructors were all looking for the same thing.”

During Phase I of my research, I sought to more deeply understand how the various faculty members understand calibration: what it means to them, why they believe it is important, how they make assessments about it, how eventually the video blog might affect it. The following is a transcribed passage from an interview done in early 2005 with one of the clinical instructors, in which I ask her address the nature of the term ‘faculty calibration.’ (I am **AB**, the Clinical Instructor is **CI**).

- AB:** I just want to make sure that I completely understand what the term faculty calibration means, so-
- CI:** Okay,
- AB:** If you could just explain to me like what in your (1.1) understanding, what is- what does faculty calibration mean.
- CI:** In my words.
- AB:** In your words.
- CI:** (2.0) Um, 'cause this isn't by any book, this is my understanding of it. Okay?
- AB:** Yeah, I don't even know if it's in books, it's just kinda what you've picked up, like, in your experience.
- CI:** Okay, I think that perhaps calibration is more, is a term more relative to, or relevant to, tasks (1.0) versus, (2.1) a didactic kind of situation, so, in clinic we talk about calibration as to um (1.0) being on the same page with the technique that we teach (1.3) um, and how we teach it. (1.5) Uh, in dentistry as in lots of different ((clears throat)) areas, there's different ways to skin a cat (2.1), but when you're teaching a student (1.2), especially a new student, it's best that they're all taught the same way (2.0) to do a certain task...

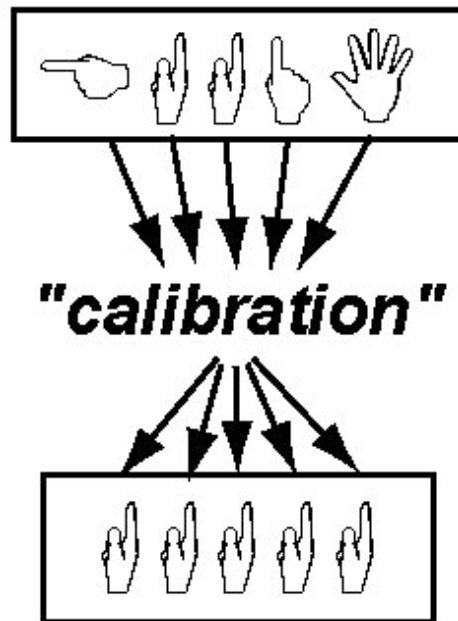
Here the clinical instructor discusses the term calibration as referring to “tasks.” She contrasts this situation to that of a “didactic...situation.” By “didactic,” she is referring to a lecture-style classroom

situation. On many occasions, I witnessed instructors referring to the classroom component of courses, or classroom-based courses, as *didactic*, as in “Dr. X teaches the didactic part of that class.” Furthermore, the clinical instructor uses two important aphorisms in her account of calibration. Firstly, she characterizes calibration as “being on the same page with the technique that we teach and how we teach it.” Commonly, to “be on the same page” means to be in agreement, or have a mutual awareness of what another party is doing or feeling. Another aphorism she uses to describe her impressions of the professional world of dentistry is that practitioners employ “different ways to skin a cat”. This indicates that her cultural model of what happens in dental hygiene is that in a dental practice there are many means of accomplishing a prophylactic dental cleaning. For instance, there are multiple ways of using a periodontal instrument. As an instructor, she feels it is important to teach new students “the same way to do a task”. In her model of instruction, teaching a single means of executing a procedure is important.

Even the term “calibration” itself is a metaphor, wherein the members of the instructional body are collectively likened to tools or pieces of machinery. According to the Oxford American Dictionary, *calibration* is “the process of correlating the readings of an instrument with those of a standard in order to check the instrument’s accuracy.” As individual instructors, their job is to serve in the educational machinery, and being calibrated would be educating students in a consistent, correlated way.

Note, however, that I don’t think she means that calibration refers to teaching via consistent discursive practices; rather, she means teaching consistent techniques. Different instructors have different strategies for instruction. In Chapter 3 I discussed several discursive practices that instructors employ during clinical teaching. Individual instructors may show a propensity for using one technique or another, preferring to use guidance over molding, for instance. Calibration refers to the content of instruction, not strategies for conveying the information.

My aim was to establish a cultural model of calibration. Figure 41 shows a representation of what the process of calibration means to field site members, based on how they use of the term in the ethnographic accounts, such as the interview excerpt above. It also involves an interpretation of the term based on my experience in the field.



**Figure 41.** A Cultural Model of Calibration

In Figure 41, the top box represents a state of a system where a set of instructors (each represented by a hand icon) is demonstrating how to use of a certain periodontal instrument to a group of students. Each different hand shape represents a slight variation in the technique; for instance, slightly different grasp, wrist orientation, relative body position, movement trajectory, or order of execution. Within the state represented by the top box, the system has four different techniques. Problems arise when students, trained by the various instructors, are evaluated, especially when evaluated by a different instructor than the one who trained them.

Through the practice of calibration, differences are brought into alignment through a negotiation of some sort. The negotiation may be “top-down,” that is, imposed by one in a position of authority, or the negotiation may be more flexible and fluid, involving more of a collaboration amongst many. An example of the “top-down” kind of negotiation would be a calibration process where a head faculty member makes a decision about how a particular instrument should be taught, such as by “following the textbook,” and informs the clinical faculty. An example of the collaborative kind of negotiation might happen for

instance in a “faculty summit,” which is a bi-annual meeting where curriculum decisions are made about the program.

This characterization is somewhat misleading, however, showing calibration as an intentional, purposeful activity, with a clear trajectory from one state to another. In reality, the process is much more messy and complicated. Indeed, instructors draw upon the concept of calibration in specific interactional situations, and depending on the context, how they use the term can differ. How do involved parties differentially understand and evaluate the term? How do faculty know when they are or are not in a state of calibration? How do individuals move through the space of negotiating the subtleties of slight variations in technique?

In an interview, one clinical instructor explained the problem with not having instructors calibrated using an example a practical scaling exam. During such an exam, a patient is brought in for evaluation – a practitioner will use an explorer to determine where on the teeth calculus exists, and an instructor will go back over those teeth and determine how successfully a student has assessed the patient’s dental health. Faculty will assess a student’s performance based on how well their evaluation matches the student’s. The problem is, determining how much calculus exists, and where, is a subjective judgment.

CI: And so the students go kind of crazy because, you know, Professor A when she explores, she doesn't mark down a single solitary thing that feels rough, whereas, you know, Professor B (2.0) calls out every single solitary anything that feels a little rough to them as calculus, and then the student's marked down for it. So there's another thing (1.0) on calibration, (1.0) we need to (1.1) like get faculty on the same page with what are we calling out as calculus, even though it's a matter of personal belief, preference, how we've been taught, what we practice in our own practices, that dictate how we come to making a decision.

In researching a professional practice we might begin to explore how members of a community reach an alignment of perception (here requiring an alignment of tactile sensitivity and spatial awareness). Indeed, Goodwin (1994; 1997) notes how even tasks as seemingly ‘primitive’ as classification of color, when executed in scientific arenas rely on frameworks embedded within the complex material and social lifeworld of the profession. Professionals are attuned to perceive and classify phenomena in a standardized way. What happens when those standards are brought into question? In the passage above, the instructor reports on the consequences of when such a perceptual judgment is misaligned – she says,

“the students go kind of crazy.” According to the instructor, such diversity in perception is unacceptable – she says, “we need to (1.1) like get faculty on the same page...”

Another implicit facet of the model of calibration is the question of why instructors should strive for being calibrated in the first place. Based on interview data, faculty members believe that new students are easily confused by diversity, and so they should strive to ‘stick to the basics’ of technique.

CI: But (2.0) when students are new especially, they have to be limited to about ten ways to remove calculus (1.0), or they go (1.2) crazy. And so if faculty isn't calibrated, er you know teaching it all that technique the same way, all the given ten different ways to take off that piece of calculus and stick to those ten, they start addin' in all this other stuff, the students are beside themselves. (2.0) So that's calibration.

This passage indicates what faculty believe is relevant for novices to learn about, and what instruction would be irrelevant, or may even prove harmful to the skill development of new learners. However, it is important to keep in mind that the instructors’ model of student learning is not necessarily what a model informed by educational research or cognitive science might say. Other options exist. For instance, should students be taught a small, explicit set of options? Moreover, should the process of sharing and comparing practices amongst faculty be considered a lateral, as opposed to top-down practice? It could be even the most experienced experts can benefit from others who have a different/complementary skill profile.

#### **6.3.2.2. Phase 2. Calibration as a Social Practice**

Dourish and Anderson (2006) argue that we may be able to initiate more effective design interventions by moving our attention away from information and its regulation and instead looking at what they term 'collective information practices' - the ways in which "social action is sustained and reproduced through the formulation and flow of information." They point out that often "flows of information serve as markers of social boundaries, providing a means to negotiate, demonstrate and sustain patterns of identity, membership, and affiliation in social groups." (p. 322) To that end, an important contribution to discussions about technology design is an investigation into the social systems within which information technology is embedded.

Of particular interest here is defining who has the power to produce curricular information; who has control over the flow of information; who is a purveyor, and who is a consumer. If we read such power as potentially endangering social structures and "cultural truths," instead of something ascribed to isolated individuals, they note that different social collectives will have different levels of trust in the technology depending on their position relative to the social structures that may be in question. Those who are placed in more or less stable social positions might have alternative perceptions of the technology.

In Chapter 4, I discussed the institutional considerations that went into the decision to use a blogging system that could be accessed from computer workstations in the training clinic. Some of these same institutional factors played an important role in how the blog technology was appropriated by faculty members. These impacted how we implemented the blog technology. The original director of the program was promoted to Dean of Higher Education, and the head instructor of the introductory course was put into the program director position. In order to fill the vacancy, two weeks before the start of the fall semester, one of the clinical instructors was promoted into the head instructor position. The lateness of this reorganization led to the head instructor having only a very short period of time to prepare for her new role. This was the first time she had taken on the head instructor position.

The head instructor is responsible for managing the course syllabus. While the entire faculty decides what goes into the curriculum, it is at the discretion of the head instructor to decide at what point during the semester to teach particular topics. Individual group instructors are responsible for managing the grades of the students in their group, which they periodically report to the head instructor.

This institutional reorganization impacted the project in several ways. Firstly, I had worked very closely with the head instructor (now program director) on brainstorming the design of the blogging system. We had even spoken about some new class activities that she might initiate in the fall, such as requiring students to maintain their own individual blogs, or make weekly contributions to web-based discussions. When I first heard about the reorganization of the faculty, I was concerned if the project would even continue to go forward at all. However, as I had also been in contact with all of the faculty members, the new head instructor was familiar with the project and agreed to let it continue. She did not have interest, however, in developing blog-based class activities with me in the same way the previous



head instructor had, in part due to the short time line she was facing for familiarizing herself with the new responsibilities. In an interview/organizational meeting we had before the semester began, she said,

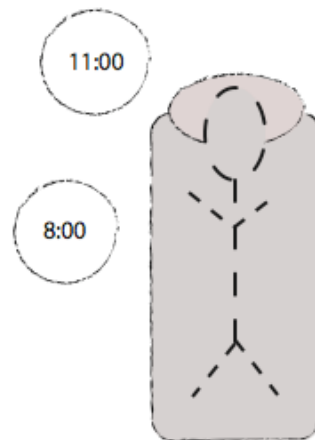
We're going to keep things the same way \_\_\_\_\_(program director) always did them. She told me to 'go by the book,' which is what I'm planning to do. If students want to look at your videos that's fine with me, but it's going to be impossible to take any more time away to work out anything new this semester.

By using the pronoun, "your" to describe the videos on the vlog, she demonstrated to me that she did not feel an ownership in the project in the same way that the program director did. In our conversations, I sensed that she did not envision possibilities for what the video technology might do, or how it might be incorporated in the pedagogy of the course in the same way that the previous head instructor had. On the positive side, she did agree to let me continue with the project. I also had previously developed a rapport with this instructor (as she was one of the clinical instructors I had observed in depth in 2004).

The institutional changes took place in the dental hygiene program during the summer of 2005 had an effect on the social and institutional hierarchy in place in the program. This restructuring impacted how the vlog was perceived and appropriated by the faculty members who had the ability to use it. Reluctance to appropriate the vlog appeared to come from issues pertaining to the *content* presented in the videos, rather than a resistance to the technology itself. Indeed, some of the encounters I witnessed and/or participated in were emotionally heightened, indicating that issues of power, identity, and social restructuring were at play. Portrayal 6.2 describes one of the most emotionally charged situations that I witnessed, which was regarding a dispute with content presented on the vlog.

### **Portrayal 6.2 - 9/13/05**

Today the head instructor came up to me at the end of class with some concerns. I was in the office writing up my field notes. She said that apparently one of the video clips showed the program director in the 11:00 position while exploring maxillary posterior teeth. (That is the "alternate position" that the program director sits in because, as she reported to me, she has an easier time with positioning as she sits there, but this is not the correct position as shown in the book, which is 8:00). Figure 42 shows a diagram comparing the two positions.



**Figure 42.** Circles represent the two operator chair positions relative to the patient's prone body (shown in dashed lines).

The head instructor said that during class, students reported to her that they were confused because the video is not showing what's shown in the book, and there is no explanation of the difference. She seemed a little upset about it, and said that she would talk with Theresa. I said that I was sorry the videos were causing confusion, and she replied, "Well, we've always been inconsistent, the videos are just making it more obvious how we aren't teaching things the same way."

The next week, the head instructor showed up to the filming session I did with the program director on Monday morning. I had invited the course instructors to participate/observe the filming session so that they could provide their input, and also see what was going to be on that week's video blog postings. As I was filming the program director, she once again sat in the 11:00 position in order to begin demonstrating scaling. The head instructor confronted her about this. The two instructors had a rather heated discussion, which resulted in the head instructors storming out of the filming session, rather upset. The program director told me that she planned to discuss this further with the head instructor, and not to be concerned. What was the problem here? As far as I can tell, it has to do with conflicting agendas:

The program director sat at 11:00 because she can "demonstrate better from that position." She had previously told me that she has trouble with getting her body into a good position at the site recommended by the book. If she is going to have her demonstrations available in a public arena, she wanted to be "as ergonomic as possible."

The head instructor wanted to stay consistent with the text so to minimize the diversity in techniques being presented to the students.

Who is ultimately in charge of the policy adopted in the classroom? Is there a way to resolve this situation where both parties feel heard and in control of what content is presented?

### **6.3.2.3. Whose Content Speaks?**

In the following portrayals, 6.3 and 6.4, I describe two instances where discrepancies in the content on the video blog came into question. In both cases, as the person in charge of managing the video uploads and new blog posts, I was placed in the awkward position of having to negotiate the boundaries of observer/researcher and active participant in the management of the technology.

#### **Portrayal 6.3 - 9/27/05**

*Today I overheard one of the instructors, Professor Jackson, reporting erroneous things to the students about the content in one of the videos on the blog. I was observing her section, making notes in my notebook from a distance. She was working with her group of six students, demonstrating how to use the probe. At one point a student asked about what to do once they had moved around the tooth to reach the line angle. She said, "The video says to take it out (the probe at the line angle of the tooth), but you don't do that because it wastes time." She said to just back track along the gum line and move to the distal portion of the tooth, rather than taking out and re-inserting the probe.*

*The thing is, the video doesn't say that. I don't know what she is talking about. I'm positive that what the head instructor actually says in the video is that "the book says to take the probe out, but at SWC we don't." She points out how reinserting the probe at the line angle can cause more damage to the gums, so it's better to back track.*

*How can the videos gain acceptance amongst the students if the instructor of six is undermining the content? Why would Prof. Jackson say that about the video? Is she threatened? I'm not even sure she's even watched the video to be familiar with the content, or if she just assumed that it would be replicating what's in the book. It's interesting, because her group doesn't use the online materials much*

*at all, preferring to use their books and paper-based notes. Maybe that's because those media are what Professor Jackson is validating, as opposed to the vlog.*

At the time I wrote Portrayal 6.3, I was baffled by the instructor's reasons for panning the material on the vlog, and attempted to get a grasp of her intent – ‘Why would she tell them a falsehood?’ However, the more important question is not why she said what she said, or whether she knew at the time what she was saying wasn't consistent with the material shown in the video. What is more important is what the outcome of her expressed characterization of video material is. It is important how this action might impact the use of the system.

Portrayal 6.4 describes a similar incident where the head instructor makes a request for me to adjust content that she perceives to be incorrect that is present on the vlog.

**Portrayal 6.4: 11/17/05**

*Today the head instructor approached me at the end of class as I was packing up my things in the back office. She said, “One thing I noticed in the video is that it is starting on the mesial surface when demonstrating the sickle, as opposed to the distal line angle where they are supposed to start, because you know they are supposed start on the distal line angle, then flip to the opposite blade and work mesially. Some of the students commented on this and were confused.” I agreed with her that what the videos show should be consistent with what is being taught in lecture and shown in the book, and I said that I would take down the video and contact the director about re-filming it.*

*However, when I re-examined the video file, I saw that in the file that she was referring to, the director is simply demonstrating how to make strokes with the sickle scaler on one area of the tooth, not moving across or scaling an entire tooth. She is discussing stroke production, and later in another clip she shows how to move around the tooth. I'm not really sure how to handle this – it's not technically an inconsistency as far as I can see. I can suggest to the director that we create another segment that shows the ordering of scaling a posterior tooth, but I now don't think that we should re-film the whole thing. I will talk about it with the director and let her make the ultimate decision.*

In this situation, I felt particularly trapped between conflicting viewpoints about what content should be presented on the vlog. Ethically, I felt that given my role as the ‘purveyor’ of technology, it was not up to me to make decisions about the content presented on the vlog, even though I could exercise this power. The head instructor perceived that what was presented on the vlog was technically incorrect, and wanted it replaced. However, the program director did not. When I asked her about re-filming the section in question, she did not want to, stating that she felt satisfied with the content of the video that was initially created. Like I had anticipated, she stated that she had intended the segment to be about how to execute scaling strokes in general, and not about how to ‘move’ the instrument across the entire surface of the tooth during cleaning.

My ultimate decision was to create a short summary that was posted on the vlog along with the video segment where what exactly the video is showing is described – that is, that the segment shows how to make scaling strokes.

<b>Thursday, September 29, 2005</b>
<b>Intro to the Sickle Scaler: Stroke Production</b>
<i>This clip shows Director Program explaining how to activate the sickle to produce scaling strokes. She also discusses the elements that make up a scaling stroke, as well as how to keep the working end at proper angulation during the stroke.</i>

Moreover, in the following week, I asked the program director if she would demonstrate during an additional video segment about how to order the strokes across an entire posterior tooth surface with the sickle scaler. She was happy to do this, and so we filmed that segment that week, and I posted it up on the vlog.

<b>Saturday, October 01, 2005</b>
<b>Posterior Sickle Scaler ~ Order for Scaling</b>
<i>This clip shows Director Program explaining how to use the sickle scaler to scale in posterior regions, including how to scale an entire tooth, distally to mesially.</i>

Though this situation eventually was resolved, from interview comments during the semester, it was clear that it, as well as other small content/calibration conflicts had made a major impression on how the head instructor's overall perception of the vlog and the project. During a post-interview in January 2006, the head instructor made reference to such situations several times; calibration seemed to have been a significant issue affecting how she perceived the vlog. Below is a passage from the interview. The Head Instructor is listed as HI; I am listed as AB.

**HI:** So the vlog I felt was both good and challenging. In the course I found it to be easier if we just go one way for students in- in th-the the beginning, and I felt like the blog actually caused some confusion, because it was teaching things a different way. It was like having another faculty member in there with different ideas. (2)

**AB:** Yeah,

**HI:** You know. Yeah, that's kinda, well it touches on some of the issues, um with faculty calibration, and having a different set of teaching practices.

She calls the vlog “challenging,” because it caused the students some “confusion.” The head instructor pointed out how the blog was “teaching things in a different way,” and that “it was like having another faculty member in there with different ideas.” Indeed, the vlog *did* allow another instructor’s ideas to be part of the course content – those of the program director. But the fact that there were multiple viewpoints on teaching periodontal instrumentation is not “caused” by the vlog at all – the vlog simply made such discrepancies more transparent.

Though calibration is reported to ‘always’ be a challenge for instructors (see Calibration section in this chapter), the video blogging technology appeared to foreground such issues. That is, though lack of calibration may have always existed, because instructors never watch each other teach, they were not fully aware of such differences. For the first time, in video blogs, instructors were able to watch each other teach, and lack of calibration became starkly obvious.

Despite the benefits of the bottom-up approach that I took to design, particularly by offering the community a sense of ownership and control over the design processes, local challenges and socio-political barriers and costs in the introduction and use vlogging system in this highly institutionalized work environment outweighed the benefits envisioned in its design for its use. Not only did the system require some learning effort, it also called for a reexamination of the current work practices so as to enable these benefits to come about. The benefits of the vlogging technology were not directly apparent; rather, they hinged on the need for users to create authentic practices for integrating their use into the clinical arena.

#### **6.3.2.4. Appropriation: Year Two**

*What happens to technology after the researcher leaves?* This is an interesting question – and one that isn’t often addressed in traditional accounts of educational technology, with notable exception (such as Cole 2006). Unless the research design is reporting on longitudinal use of a technology, our observations of technology use in classrooms are merely snapshots of moments in time. In reality, educational settings, like all settings of human activity, are constantly evolving and in a state of dynamic flux. Take, for instance, a recent article from *The New York Times* describing how high schools in New York State that were issued free laptops as part of a research study have recently banned their use in

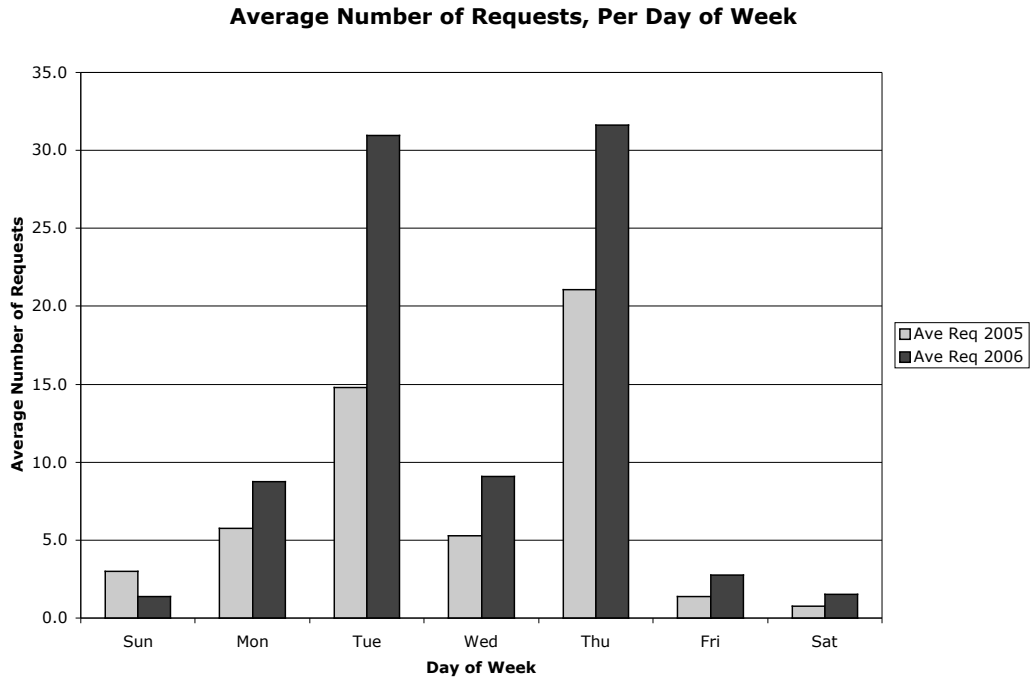
classrooms (Hu 2007). Administrators failed to gather evidence of significant achievement gains, and were instead overwhelmed by students using laptops in unintended, undesirable ways. In this case, we see how fragile the cognitive system created during an educational technology research study can be. Often, the presence of researchers, and structured educational activities, are an essential part of a productive system. When researchers leave, technology can be abandoned completely, or new practices with technology may develop, some of them unintended or counter-productive.

I stopped actively visiting the dental hygiene program in the spring of 2006. I periodically monitored traffic on the web site. In contrast to the New York State example, I discovered that the school continued to make use of the video blog after I had stopped attending clinical sessions. Curious about the activity on the web site, I went back to the dental hygiene training program in the end of the fall semester 2006 in order to do interviews with four faculty members and four students about how they were using the video blog.

How had they instructed students to use the vlog? Were they creating new posts? How were they dealing with the negative aspects perceived in 2005?

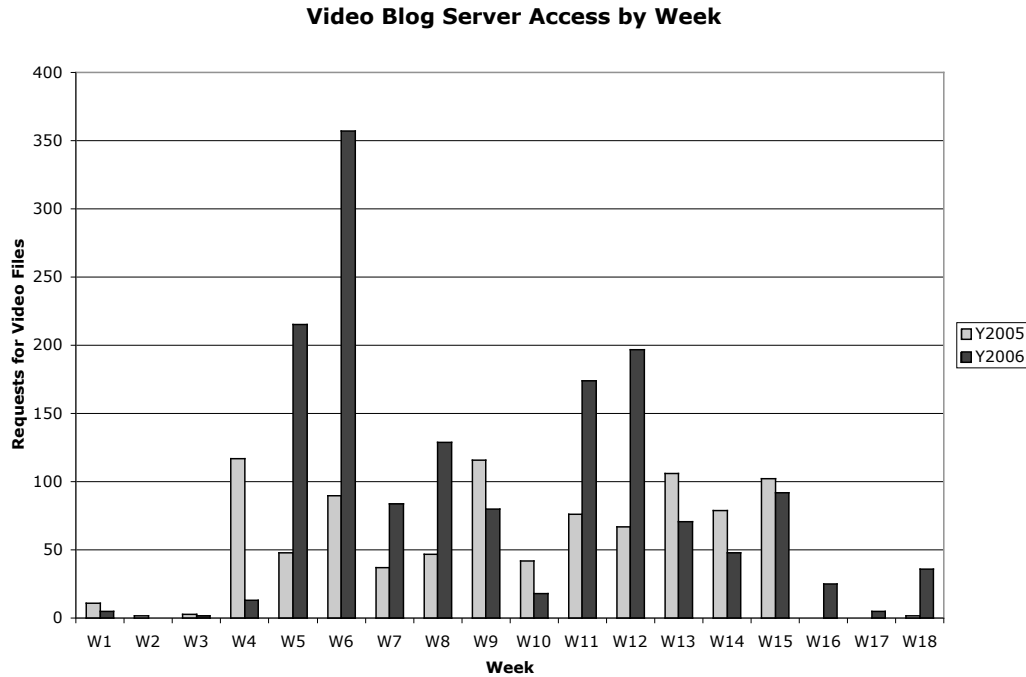
I was surprised to discover that faculty integrated vlog technology to a much greater extent than in 2005, as evidenced by what they expressed the post-semester interviews. Moreover, in completing a comparative analysis of web server log data (Figure 43 and Figure 44), I discovered that vlog use appeared to nearly double in 2006.





**Figure 43.** Average number of requests for video files from the class vlog, divided per day of the week. Data from 2005 is shown in gray and data from 2006 is shown in black.

Note that the weekly trend is the same for both 2005 and 2006 – the most popular days being Tuesdays and Thursdays, which were clinical meeting days, followed by Mondays and Wednesdays.



**Figure 44.** Total number of requests for video files from the class vlog, divided by week of the semester. Data from 2005 is shown in gray and data from 2006 is shown in black.

Figure 44 shows the total number of requests for video files from the class vlog, divided by week of the semester. Though the pattern of activity for 2006 appears to be much more sporadic, the same basic trend exists – a steep onset of activity in the first few weeks of the semester. In Chapter 4, I argued that this might be related to the fact that video-based material was not relevant for students in the early part of the semester (e.g. in Weeks 2 and 3, students typically learn about clinic safety and positioning, material for which no videos were created or posted on the vlog). Unfortunately, I cannot report on other specifics of events in the clinic during the course of the semester in 2006, as I did not engage in fieldwork after 2005.

This shift in technology valuation, between 2005 and 2006, holds important insight into how social and cultural constructs may lead to the acceptance and integration of new technology. It appears that the instructors became more familiar with the blogging medium in the second year that the system was used. During post-semester interview with the head instructor in late 2006, she noted, “So we’ve used

it (the vlog) a lot more this year and um, they've had a lot more practice with the blog this year too, you know, which is really great.”

Note that this was the same instructor who previously had expressed resistance to the vlog. What changed in the intervening months? According to dePaula (2005), appropriation is an interpretive process emerging from the interactions between technology and the social setting. We can understand appropriation as a balance between the plasticity of the technological medium and flexibility of the social system, and the process of creating effective new sociotechnical systems involves evolving the technology and/or the social practices in place. As a community begins to create practices for appropriation, perceptions about a technology can shift. This is an important part of the process of intentional design of learning environments.

As stated by dePaula (2005):

...appropriation is not just about the effectiveness of a design to adapt and fit into particular social settings, but more important [sic] about the creation of conditions for the expression of individuals' (or the collective) identity and aesthetic, for the enactment of meaningful actions and interactions, and the development of balance between existing traditions and the transcendences embedded in the design and use of a technology.

#### 6.3.2.5. Transforming Institutional Practices

In this case, it seems that through the process of creating authentic pedagogical practices of their own design may have led to previously resistant instructors changing their perception about the vlog technology. In the following passage, I question a clinical instructor (CI) about the head instructor's perceptions about the vlogging system at the beginning of the semester.

AB: So um so there's a couple of things I still wanted to ask about...so do you feel like there was some kind of aversion that HI was experiencing in the beginning of the semester to introducing it?

CI: Absolutely. Absolutely. Because she expressed that specifically at the beginning of the semester.

AB: Yeah. At the beginning.

CI: This was her first full year where it was now, and she's getting into the rhythm of being, this is her class, this is her decision to make on whatever direction we're going, I think she began to realize that there's gotta be some flexibility, because some students did better at different clock positions.

AB: Yeah.

CI: So there isn't- uh PD, uh-er our last head instructor had the most structured approach where there's one and only one way, and um, and so she kind of progressed with it as the semester progressed. She witnessed from the primary instructor's position what was going on. What I admire about HI is that is her flexibility. And she began to

appreciate the program more because it is hard to teach that many students this much information and so I believe when you talk to her you'll hear that she referenced the video blog a lot also."

The clinical instructor notes that the head instructor "expressed specifically" an aversion to introducing the vlog to the students. However, she notes that there was a shift that took place over the course of the semester that, in her perception, had to do with a changing philosophy about calibration. The clinical instructor states that the head instructor "began to realize that there's gotta be some flexibility" in her approach.

A different clinical instructor, in a post-semester interview, supported this observation. In this passage, I was asking her to describe how she began to use the vlogging system with her students, and her interactions with the head instructor.

CI: And I talked to the head of the program- er the head of this class, ... and I told her I had introduced the blog to the students. She mentioned there was some conflict in the positioning etc.-

AB: Right.

CI: And I said, "Well they have the web address, and I wanna look at that because I think it's still a good reference," and a couple of weeks later she agreed. So as we talked more about it, and the semester progressed, and she began to realize that there are differences in technique, where there would be slight deviations in clock positions for example...so as she experienced it, and had the problems come up with the students, began to realize that "wait a minute, we need to be more flexible about how we're presenting this material, there isn't one and only one way."

This instructor agrees that a shift in technology valuation took place during the semester, especially on the part of the head instructor. She also uses "be more flexible" to describe a contrasting approach to introducing instrumentation technique, noting that "there isn't one and only one way."

So what exactly does a more flexible approach mean? Is anything acceptable, or should some kind of consistency be maintained. From interviews, it appears that having internal consistency is still important to instructors. However, that consistency can involve a set, as opposed to just one, of instrumentation techniques.

In an interview, the head instructor described using the vlog as a tool for instructors to maintain awareness of each others' teaching. In an interview done with two of the instructors, HI (head instructor) and CI (clinical instructor), the following discussion resulted.

HI: There's always a lot of things we all need to know and have familiarity with before we start teaching.

CI: The calibration is always a challenge.

HI: It is. Especially in this course. We really need to get together, watch the blog, know what to refer to in the blog, get the books together, we all need instruments and typodonts so that we can practice together how we're gonna show the students. I think having everybody up on those blogs is huge, too, so that we can be in agreement on everything.”

In the context of discussing the importance of calibration, the head instructor mentions how the viewing of videos on the vlog might serve as a mechanism for maintaining a calibrated way of teaching. While it is not clear whether or not this activity is currently in practice, or just a suggested activity for the future, it does mark a shift in the valuation of the technology. The sense of what “calibration” means seemed to shift too; no longer did it simply mean to teach the same thing the same way, but that a few diverse practices, explicitly spelled out, were acceptable.

In the following passage, the head instructor describes how instructors responded to the wide availability of demonstrations on the vlog.

I think we were affected by the blog and maybe questioned some of our teaching uh instruction...and looking at the blog, see maybe there's a better way to teach that instrumentation, and have the greater variety supported, but have everyone on the same page on that.

Note that here she makes reference to having a “greater variety supported, but have everyone on the same page...” By variety, she is referring to diverse instructional practices. Her statement implies that no longer is it ideal to necessarily teach the same instrument the same way; but rather, that a few diverse practices, explicitly spelled out, might be acceptable.

#### **6.4. Discussion**

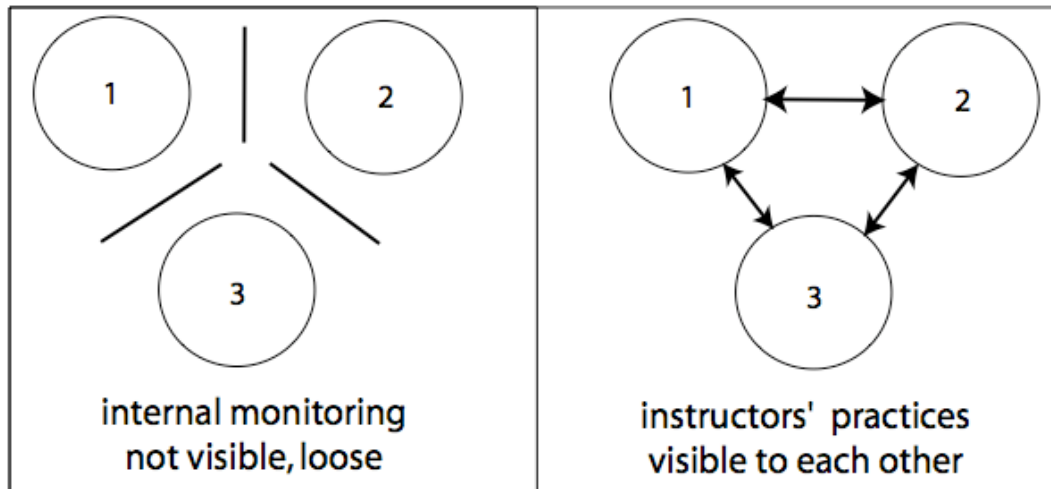
This chapter has described the evolving dynamics of a learning ecosystem. I have focused on the way that introducing new instructional media caused a perturbation in the ecology, and how the practitioners navigated that perturbation, returning back to a state of “lower energy.” This trajectory, though seemingly subdivided into neat divisions of technology design, and intervention, gives a false sense of the complexity of what really went on. Indeed, the standard separation between design and use, although sometimes methodologically useful, can create an unrealistic view of the process of design and

introduction of an innovation into a sociohistorical context of use (dePaula 2004). In this case, the process of technology appropriation was much more inconstant, sporadic, and involved several complex variables, especially because I used a methodological framework involving participatory design. At several points, technology appropriation involved a negotiation between technological features and social practices.

For instance, following initial reluctance or ambivalence, instructors began to create their own novel methods for incorporating use of the vlog into teaching practices. Also, through exposure, they became more familiar with the medium of the blog. Furthermore, the availability of videos on the blog revealed inconsistencies in the content of what was being taught. Though presumably such inconsistencies existed prior to technology implementation, the nature of available media allowed the lack of calibration to remain hidden from scrutiny. To some extent, inconsistencies were suppressed. Prior to the video blogging system, the representations that faculty possessed and had access to were oral and ephemeral (like an oral tradition in non-literate cultures). Furthermore, several descriptions in the textbook are suitably abstracted to warrant multiple interpretations (for instance, textual descriptions of bodily positioning or movements). In contrast, the video records provided on the vlog are situated, concrete, and more accurate than hearsay. They are not redescriptions of what was said or what was taught from another person's perspective (though they are filmed from a particular perspective). Video records are unique kinds of representation that preserve what a faculty member said in class on a particular day. Now for the first time, faculty members could watch each other's practice. Differences became clear. Not surprisingly, when this lack of calibration became apparent, conflict arose. This "high energy state" was relaxed when the instructors reconfigured their practices – for instance, by making agreements about representing a small set of diverse options, address this in a unified manner, and even using the segments present on the vlog as a means to achieve such unification.

Figure 45 shows a schematic diagram comparing instructors' awareness of each others' teaching in 2004 and 2005/6. On the left side of the diagram, we see a representation of the monitoring behavior of the three clinical instructors (shown as circles) in the clinical laboratory. The barriers between the circles represent a lack of attention to each other's teaching, as instructors cannot monitor each other while simultaneously engaging in instruction themselves. On the right is shown the monitoring behavior of

instructors enabled by the presence of community-accessible video records. The instructors are now able to attend to each other's teaching, as the vlog supports asynchronous access to clinical activity. The availability of video records in the community helped make instructors' practices more visible to each other.



**Figure 45.** Diagram comparing internal monitoring of instructor calibration in 2004 (left), and 2005-06 (right). The three instructors who teach in clinical sessions together are represented as circles.

In order to maintain the existing model of calibration (i.e. that instructors must teach students to use instruments the same way), decisions must be made about which practice is ‘right,’ and what should be taught. Should instructors ‘follow the book,’ or ‘follow the material presented in video?’ It complicates matters for a clinical instructor when the head instructor has said to follow the book, yet the videos contain the program director presenting technique not in agreement with the book material. The discrepancy is embroiled in notions of autonomy and power – is the head instructor in charge of curricular content, or is the program director? How is this tension negotiated?

One solution that the community evolved was to change cultural practices. Instead of altering the media, which involves negotiating the battle of ‘who is right,’ the instructors might have adapted their perceptions – they agree that some level of diversity is satisfactory. However, it also becomes important to convey 1) which practices are acceptable, and 2) how students should make informed decisions about which of the set of possible alternatives to pick.

Indeed, Brown (1999) claims that one thing that makes a learning ecology so powerful and adaptable to new contexts is diversity. Diversity helps to create the texture of knowledge assets and also enables it to be used in ways that might never have been originally imagined. Moreover, the knowledge of a learning ecology is more than static content. It's in a dynamic, living, and evolving state of flux.

However, what prevents such diversity from evolving into mush, an anarchy of individuals where anything goes? Indeed what gives a professional community of practice its power is its ability to communicate, standardize, and propagate knowledge. Without standards, a profession fails to exist. So, in essence, what Brown describes is more like a democracy, where the people (i.e. practitioners) have a say in what is standard practice. How can this be achieved? It seems that in this case, *transparency* is paramount. Practitioners need to be aware of what others are doing. The presence and use of community video records allows practitioners to stay informed about what is acceptable practice, to monitor each other's practices.

## **6.5. Conclusions**

Participants must create systems of meaning and practices for making use of technology in order to accept it. Reports from 2006 show that faculty integrated vlog technology to a much greater extent than in 2005, as evidenced by web server logs (Figure 43 and Figure 44), observations, and post-semester interviews. Several instructors who did not promote technology in 2005 integrated video viewing into their teaching practices. Based on interviews, it appears that two main reasons explain this shift in technology valuation: 1) developing a familiarity with the technology, such as recognizing how features of the system could be integrated into teaching practices, and 2) developing a familiarity with content on the vlog, and adapting instruction to include diverse options for instrumentation practices.

It seemed that an initial lack of acceptance of the vlog was related to tensions surrounding the represented content. Though presumably inconsistencies in instruction existed prior to technology implementation, the nature of available media allowed the lack of calibration to remain hidden. In contrast, the video records provided on the vlog were a new kind of representation that revealed details not so obvious in the past, and so for the first time, faculty members could watch each other's practice.



Differences became pointedly clear. Not surprisingly, when this lack of calibration became apparent, conflict arose. This “high energy state” was relaxed when the instructors reconfigured their practices – for instance, by making agreements about representing a small set of diverse options, address this in a unified manner, and even using the segments present on the vlog as a means to achieve such unification.

The findings from this research project include a deeper understanding of how vlogging technology impacts the social and educational processes engaged in a hands-on training program for clinical instruction in dental hygiene. Digital video records of community practices bear great promise as an effective means for representing multiple strategies of accomplishing professional tasks, provided that such technology integrates into the social and cultural systems in place or being created in a community of practice. We found that successful deployment of such technologies in live learning contexts requires that dynamic content can be developed, edited, reused, and negotiated within a community of professional practice. Vlogging technology has potential application in a wide variety of professional training domains, especially in the training of novice practitioners in medical domains in which a significant portion of what is learned involves fine manual skill development (e.g. dentistry, nursing, surgery).

## Chapter 7. Final Thoughts

### 7.1. Cognition and Ecologies for Learning

This dissertation has touched on many themes in contemporary cognitive science and human-computer interaction: learning ecologies, cognitive artifacts, expertise development, environmentally-coupled gestures, situated activity, technology appropriation, adaptive change, perception for action, and action for perception. I started this investigation with a question of how untrained hands begin to grasp the skills of a profession (a process that really involves a network far more extensive than hands). I chose a dental hygiene training program as a field site so that I would have the opportunity to observe the explicit training of highly complex, detailed, tool-based manual tasks, accompanied by conceptual learning. I performed two years of ethnographic fieldwork, which included a preliminary observational phase, a design phase, and detailed observation of evolving practices as the community appropriated the technology.

As a result, I have described a living *learning ecology*, the discursive practices in place for instructing novices, the technology intervention that changed the nature of information that members had access to, and the processes of adaptive change(s) that took place. Is the analogy of an ecology a useful one? It's possible the term may be based on Gregory Bateson's use of it in "Steps to an Ecology of Mind" (1972). In this work, Bateson raised several important questions about human culture, such as, how do ideas interact? Is there an analogue of 'natural selection' that determines the survival of some ideas and the attrition of others? What conditions are necessary for the stability of such a dynamic system?

There are several pitfalls of relying on biological metaphors, as metaphors can be deceptive when over-applied, deceiving us into looking for mappings where perhaps none exist. Nevertheless, I believe that the metaphor of an ecology, or ecosystem, is quite fruitful for understanding the real-world places where learning happens. *Ecosystem* calls to mind concepts like evolution and adaptation, relationships across living systems, relationships to physical reality, symbiosis, connectedness, organic growth, natural order, interdependence, and holism. This results in quite a paradigm shift in how learning is traditionally conceived. In conventional educational models, knowledge is considered to be a static and monolithic

form of information. In other words, the knowledge is pre-determined, and in a sense, particulate, packaged, and consistent through media. Like genes, ideas can be replicated by the machinery of instruction and be passed from individual to individual.

Again, we should beware of taking the biological analogy too far: knowledge and culture are not like genes. They are not particulate; they are dynamic, more loosely constrained, and they are inextricably situated. Static knowledge doesn't really exist<sup>23</sup>. The analogy of a learning ecology highlights important features, such as rich interconnectivity and interdependence, and allows certain inferences about the interworkings and features of the system to be drawn.

In order to fully understand the dynamics of a learning ecology, it is necessary to extend the unit of analysis beyond the brain to include the material and social environment, as well as how present cognitive activity incorporates products of previous activity (Hutchins 1995). This is a challenging proposal, revealing the cracks in many presumptions we have about learning processes and educational technology. For instance, seen through the “lenses” of distributed cognition, it is not possible to place 'learning' cleanly inside or outside of the person, because components of the learning process involve interactions with the world – such as other people, artifacts, and other environmental structures.

Moreover, the development of a student's knowledge does not have any significance in the absence of the world onto which it is situated. As social creatures, we are constantly engaged in the process of meaning-making that is at the center of the human experience. When learning is viewed as a purely “internal” process, we ignore how the world structures learning, and how humans construct meaning as they engage in learning activities. Using a distributed cognition approach, we can view expertise development as not just a process of information transfer, but more a process of alignment of resources. A student does not receive information as a passive sponge, she produces changes in her brain and motor system as she learns to see and act in an expert manner. What counts as expertise involves the coordination of perception and action. Rather than having information transferred, perhaps expertise development is a process of alignment and reduction of ‘degrees of freedom’ in a system.

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<sup>23</sup>But unfortunately, the conventional educational bureaucracy is reliant upon this conception of knowledge and learning. Thinking of learning within the model of a learning ecology marks a profound shift. However, this change is not merely an ideological or theoretical one. It is a fundamentally practical and concrete change that has significant implications for the existing institutional design.

Ethnographies of learning technology in higher education are beginning to show how a polarized focus on 'the technology' can blind us to what students' real activity consists of, and can mislead us about how to design supportive tasks and environments (Crook and Light 1999). Now, a growing number of researchers recognize the importance of addressing the social, collaborative and community aspects of learning (Lipponen 2002). A more complete understanding of human cognition and learning processes can be achieved by looking at the dynamics of how meaning is constructed in real instances of situated cognitive activity.

Indeed, the process of technology appropriation is a meaning making process. Members develop practices around technology that allow them to arrive at an intersubjective understanding of the technology's role within the ecology. By attending to the social aspects of how technology gets used, what it means to a community, and where areas of conflict arise regarding the technology's use can help us better understand the factors to which we need to be sensitive when designing educational technology in the future.

## **7.2. The Development of Expert Skills**

'Expertise' develops over a period of several years and contexts. I recognize that though I proposed to study the development of expertise in dental hygiene instrumentation skills, the scope of this project made it such that only a small piece of this process could be studied – that is, the development of instrumentation skills that took place over the progress of the semester-long introductory clinic course. Nevertheless, it is possible that the principles that describe how instrumentation skills develop over a short time also extend to how they develop in the longer term, and therefore, examining such short-term development was a fruitful research endeavor.

Moreover, in performing this research, I also became aware of the project design's limitations. I've had colleagues ask, "So did the technology work? Did the students learn instrumentation faster/better with a video blog?" I've had this question posed to me many times, and have had to reiterate that the goal of my research was not an ostensible measure of the '*effects*' of a new technology *on* improving learning. Though this kind of research is widespread amongst the educational technology literature, it has received

some criticism from media researchers such as Papert (1990) and Kozma (1994)<sup>24</sup>, who unpack the fallacy of making comparative claims about technology implemented ‘in the wild.’

Still, I’m interested in the issue from the standpoint of ethnography – how in making claims about educational ‘improvements’ seen in students, a researcher must impose a viewpoint not authentic to the community. Surely it is the field members who are uniquely poised to make such claims. Indeed, improvement is a subjective judgment, and as ethnographers we should be wary of making uncritical statements that ignore the community’s processes of interpreting students’ behavior, of finding ‘improvements’ or ‘lack of improvements’ within it. In essence, through such an approach a researcher takes over members’ interpretations, treating it as a matter of fact rather than a meaning constructed in a specific context for a particular reason.

Far more appropriate, I believe, as a social scientist, is to report on changes in observable behavior, social impacts, institutional consequences, etc., relying on elicitation of members’ descriptions. Indeed, this was a large reason for my choice to complete research in an independently functioning, real-world environment<sup>25</sup>.

This approach certainly marks a deviation from traditional educational research studies that objectify knowledge and simplify learning processes to changes in neural architecture. Furthermore, in many ways manual ability defies explanation, perhaps because it is based not in language but in action (for which we have much poorer representational frames). This has given me some unique challenges to collect systematic data from which I would be able to say something concrete about the development or improvement of manual abilities per say.

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<sup>24</sup> See also discussion in Chapter 4.

<sup>25</sup> Here, I am specifically referring to the divide between naturalistic, “real-world” environments as opposed to “experimental” or “laboratory-based” environments. Much of the research on motor learning expertise, in particular, has been conducted under experimental paradigms in laboratory environments, where “subjects” are brought in and taught arbitrary tasks that are evaluated by experimenters. An increasing body of literature (cf. Hutchins 1995; Hutchins & Palen 1997; Goodwin 1994; 1995; 1997; 2000; Cole 1996; Clark 2003) documents that cognitive processes in naturalistic environments is different from that which may go on under controlled experimental conditions. The research done in this dissertation was completed in a situated environment populated with individuals invested in the outcome of their practices. On the other hand, I carried out my research in a formal training program, which uses explicit instructional practices. Educational research has pointed out that learning processes in these environments differs from that which may occur in informal, or apprenticeship, learning environments (Lave 1993).

How did the technology get used? What changes took place in the ecosystem? What institutional challenges were revealed through appropriating the technology? These are the kinds of questions that I have been able to answer in my research. However, do these questions relate to how students acquire professional skills? I believe they do.

### 7.3. The Dynamics of Learning and the Development of Expertise

One of the primary goals of practical instruction is to develop skillful performance. As we have seen, expert skill includes an integrated set of perceptual and motor abilities. During practical training, instructors deploy a set of discursive practices that nurture skilled performance in trainees. These practices scaffold particular patterns of movement, patterns that students can assimilate and subsequently use to guide or govern tool-based actions. Moreover, in many professional domains, bodies are being trained not only to use the instruments of their trade, but also to *BE* instruments, honing the skills of perception and those skills necessary to make relevant actions in their professional lifeworld.

This dissertation has investigated several practices used to entrain students with professional perception and expert action, such as:

1. The physical limitation of movement in *guidance*
2. Engaging the imitation system through *demonstrations* of specific movements
3. Calling upon prior movement schemas through the use of *embodied* imagery and *metaphor*

Skilled human action arises from how an individual selects a set of actions from the unlimited alternatives within the constraint space as defined by the person-to-environment interactions. It is possible that an expert's self-organized constraint space is more structured than a novice's. Certainly, an expert scales teeth exhibiting less wobble (i.e. degrees of freedom in movement) than novices do. Perhaps learning might be facilitated by engaging in structured activities, revealing reliable correlations between motor activities and perceptual input derived from interactions with a specific environment. Indeed,

instructors make use of a set of discursive practices that categorize and constrain a novice's potential movements. Such practices serve to scaffold the learning process.

One of the important issues that this study touched on is exploring the relationships between professional perception and expert action. Transfer from perception to action is well documented, for instance in the form of observational learning. What about transfer from action to perception? A recent set of experiments done by Hecht *et al.* (2001) provide evidence that transfer between perception and action is bi-directional: practicing certain movements primes for visual perception. This might indicate that the link between developing professional vision (perceiving) and developing particular skills (acting) is tightly coupled, and not unidirectional. Intuitively it seems as though technological intervention that can help develop professional vision may lead to improved action as well, though more research is needed into how these processes are linked.

Perhaps video-based methods may be more useful in early stages of learning, where vision may be the most important perceptual modality to develop in order to learn the more fundamental skills of dental hygiene. However, much of dental hygiene practice involves working in visually occluded areas, and *feeling* features of the mouth through the instrument. For instance, expert hygienists can feel specific features and deposit morphology on a tooth surface through a dental instrument, even in visually occluded, sub-gingival areas. Therefore, video-based representations may be more useful to junior-level dental hygiene students than senior-level students, who are often engaged in learning more subtle aspects of dental hygiene skills, such as micro-movement adjustments to position, tactile perception mediated through an instrument, pressure regulation of the instrument blade, etc.

Various educational studies show that students' embodied reasoning processes, obtained from a lifetime of experience in a body moving through the world, play an important role in how they learn scientific and mathematical concepts (diSessa 1993; Wright 2001). What role do conceptual processes play in skill acquisition? Early work in motor learning showed that conceptual knowledge of mechanical principles involved in a task improves skill acquisition in bicycle riding (Judd 1908). However, in this example, subjects were given formal training in mechanical physics to guide their understanding. Polanyi (1958) cites a counterexample of a champion cyclist who did not know the mechanical principles involved

in maintaining balance on the bicycle, implying that explicit knowledge of such principles aren't critical for learning, and even mastering the task. Still, though the cyclist did not have a theoretical knowledge of physics, he did have an embodied, motoric knowledge of the dynamics of bicycle balance and a layman's understanding of what he needed to do to how to effectively stay aloft (i.e. turn the wheel towards the direction of leaning). This work indicates that our everyday, embodied experience of the world can entrain us with conceptual understandings that allow us to make inferences when applied via cross-modal transfer to other domains.

Indeed, as we have seen in Chapter 3, students and instructors construct conceptual metaphors that can scaffold their ability to perform specific instrumental actions. By attending to an instructor's actions, gestures, and speech, learners join in the sequence of actions that leads to a functional, practical outcome. Simultaneously (in theory), students engage in the construction of meanings associated with those actions. In doing so, students rely on instructors to provide the sequential organization of activity and to prompt and guide until the novice, through experience, develop the conceptual resources to guide their own actions and meaning-making. These activities, too, unfold within a particular cognitive ecology.

Even when appearing to perform the activity entirely on their own, learners may rely on conceptualizations that are less rich than those the teacher has attempted to construct, and they may come to rely on these simpler conceptualizations for some time before problem situations demand inferences that these conceptualizations fail to support. Even after an extended period of apparently successful performance, discovering conceptual relationships that link conceptual models used in different aspects or phases of an activity can lead learners to deeper levels of understanding and thus greater flexibility in the instantiation of functional systems to solve new problems. As such expertise emerges, learners may still tend to rely on the simplest conceptualization that works for the task at hand, constructing more complex conceptualizations only when the situation warrants. Alternatively, they may tend to rely on the conceptualization used most frequently in similar situations in the past, even when a simpler conceptualization might be sufficient. Further research is needed to see whether more explicitly guiding a student's conceptual processes might make a difference in their ability to develop instrumentation skills.



This research will help further develop our understanding of where conceptual processes, perceptual abilities, and action interconnect.

One such idea that would address the topic of scaling, leverage, and fulcruming, would be to construct a tutorial of some kind that can guide a student through a demonstration of the physical properties of levers. An animated multimedia module might provide a useful way of conveying some of the spatiodynamic properties forces involved in such a system. As we have seen in the examples described in Chapter 1, students may more easily grasp examples of systems from their everyday world, like seesaws. It would be interesting to measure how the use of such a module for entraining conceptual knowledge might improve or not affect the acquisition of instrumentation tasks.

There is an important relationship between how a profession perceives the world it is focusing its attention upon and how members of that profession are trained to act upon that world. In domains where much of practice involves producing specific actions upon the world, the processes of action and perception are inextricably intertwined. A profession is organized socially and cognitively by deploying a set of discursive practices that shape objects and events in the world into phenomena of interest. That is, discursive practices bring phenomena of interest into existence (Goodwin 1994). Within this framework, the ability to perceive relevant entities is not a property of an individual brain, but rather a socially agreed upon practice within a community of competent practitioners.

By working in concert with experienced practitioners on relevant tasks, the body of a novice is transformed into a ‘tool of the trade.’ This is the essence of practical training. Competence as a professional is gained through embodied practice, by working with the relevant materials and enacting skills judged in circumstances evaluated by expert instructors. Practical education manipulates bodies, as novices are taught, “Sit this way, move this way; hold your arms, chest, and shoulders precisely like this.” Though some degree of variance is allowable, the range of acceptable bodily action is rigorously constrained. This is in part related to the design of the instruments themselves, which must be held and activated in a certain manner in order to function effectively. In the case of dental hygiene, another set of imposed constraints is placed by institutionalized principles of ergonomics – certain bodily configurations lead to repetitive stress injury, which students are explicitly instructed to avoid.

This research demonstrates the importance of addressing how the technological aspects of the environment participate in cognition, action, and social interaction. Nevertheless, a good deal of research remains to be done in order to have a complete account of the ways in which objects feature in specific courses of action and interaction. We have relatively little understanding of how objects enter into and are interconnected with social organization and how they feature in practical activities, such as collaborative learning.

The advent of new forms of technology provides us with opportunities for instruction that we haven't had before. Digital video technology is becoming widely integrated into several aspects of professional education and training (Fortkamp 2002). However, thoughtful application of this technology will require investigation into current practices. This dissertation research provided an exciting opportunity to examine the development of expertise in detail, in a real-world, naturalistic setting. Moreover, I had the opportunity to discover how new forms of digital video technology were appropriated by the community.

What was learned from this study has general application to many other domains where hands-on training is an important component, such as surgery, medical training, dental training, etc. It is likely that a similar set of action-scaffolding discursive practices are used during the training process, and video-based technology would integrate in well with the kinds of instructional strategies employed in these programs. We opted to implement digital video records on a vlog, which required basic Internet skills, rather than specialized software such as the digital video program DIVER, which would require additional training and instruction, largely because of practical constraints, such as the challenge of working with a diverse participant population having varying computer literacy. In other training environments, technology that enables video editing and annotation, or can support split-screen viewing and comparison of novice and expert practice might hold promise for further encouraging reflective learning. Of course, as I have learned through my research, the appropriation of new technology is unpredictable, and can be fraught with unanticipated challenges, especially as video often reveals information about interactions that had not previously been represented.

This research has brought together an important range of phenomena that are relevant to the organization of human action, including interaction with other humans, the environment, and technology-mediated representations. Learning how to become an expert member of a profession requires acquiring more than just mastery of the ‘tools of the trade:’ it also involves learning how to construct cognitive artifacts that provide relevant representations of the world. Supporting tool and artifact use are groups of functional perceptual frameworks, the ability to perceive what and where to activate the tool. Moreover, I was able to glimpse how these structures are passed from one member to the next through examining hands-on (practical) learning practices of a profession. Our understanding of these practices can help guide the design of technology that can support these processes. Further naturalistic design experiments with different technology-mediated representations can help us make informed decisions about what sort of technological support is more efficacious in instructional settings where professionals are being trained.

#### **7.4. Studying the Perturbation of Learning Ecologies**

In this dissertation, I looked broadly at the evolving dynamics of a learning ecology. I have focused on the way that introducing new instructional media caused a perturbation in the ecology, and how the practitioners navigated that perturbation, returning back to a state of “lower energy.” In this case, at several points, technology appropriation involved a negotiation between technological features and social practices.

For instance, following initial reluctance or ambivalence, instructors began to create their own novel methods for incorporating use of the new technology into teaching practices. For example, I observed instructors viewing videos from the vlog while discussing content with their small groups of students. Instructors would often *highlight* salient features of video records, giving students an expert perspective on what to look for in the video segment. As well, students created practices incorporating the vlog into their learning strategies. Students working while watching videos would often *follow* along with the video demonstration. Moreover, by watching videos in dyads, students were afforded *contextual support* with which to begin to formulate understandings about the material under review.

Furthermore, the availability of videos on the blog revealed inconsistencies in the content of what

was being taught. Though presumably such inconsistencies existed prior to technology implementation, the nature of available media allowed the lack of calibration to remain hidden from scrutiny. To some extent, inconsistencies were masked by the nature of the class format. Video records, as a new kind of representation of activity, preserve objectively what a faculty member said in class on a particular day. For the first time, faculty members could watch each other's teaching, and differences became clear. This lack of calibration was met with a degree of conflict – a change in practice was demanded. Instructors reconfigured their practices by agreeing to support a small set of diverse options, addressing these options in a unified manner.

Brown (1999) claims that one thing that makes a learning ecology so adaptable to change is diversity. It would hold that a community's acceptance of some degree of diversity would only serve to make the knowledge assets of a community of practice more robust. Indeed, the knowledge of a learning ecology is dynamic, living, and evolving state of flux. Diversity may render communities of practice all the more viable.

The findings from this research project included a deeper understanding of how video blogging technology impacted the social and educational processes engaged in a hands-on training program for clinical instruction in dental hygiene. Technology, when implemented in institutional settings, has social and political consequences. A technology's perceived usefulness is constructed in the context it is implemented within, and members develop activities (or not) to incorporate new technologies. Objects and artifacts are not inherently public or private; these categories are negotiated in use as information is strategically deployed to shore up or break down boundaries between people and social groups (Nippert-Eng and Melican 2004). By leveraging a background from ethnographic observation, I was able to maximize the chances of successful implementation. Nevertheless, implementation involved a complex negotiation process that hit up against boundaries.

### **7.5. Future Directions**

In late September 2007, I got a phone call from one of the instructors in the introductory clinical course. She was calling because she and her students had experienced recent trouble in loading the video

blog, and was wondering if I could help her. I hadn't realized they were continuing to use the site. We originally chose the blog format for presenting videos and course material because it stayed current, and could be readily updated – new material was posted each week of the semester in 2005. However, it appeared that the school continued to access these video records using the vlog as an online database or repository. Indeed, in 2006, I'd heard that the faculty was in the process of creating a formalized set of video demonstrations for a DVD that would eventually replace the vlog. I asked the instructor who'd called me about this. "Oh, we ended up having to table that project," she admitted, "Funding issues."

"Ah," I said, "Well, I'm afraid your access problems are due to my reorganizing some of the file structure in the folder where those videos were stored on my lab's server. I'll see what I can do to rectify that." I reconsidered, "Or perhaps a better solution would be for me to give you all the video material on a disk, and then you can have the entire thing stored in-house." It occurred to me that our lab could not continue to host the program's video records indefinitely.

"Okay," she agreed. "Though I'm not sure how we'll get another blog put together."

"Well, maybe some of the students might like to take it on as a project," I suggested, reminding myself to be clear about my boundaries as a researcher, and not take on additional work outside the scope of the project. "Making a video blog is relatively easy, and a lot of people now have experience with blogging." Indeed, there has been exponential growth in Web 2.0 applications even over the duration of the research study. Students who may have been unfamiliar with self-publishing applications like blogs in 2004 may now likely be using them.

Nevertheless, I rang off, and was struck by how the instructor's impression of the vlog had shifted from when it was first introduced. The technology had become so deeply lodged in the community's practices that reverting back to what had been done before was unsatisfactory enough to motivate the phone call. Indeed, during the course of the implementation (2005-2006), I witnessed a striking change in how the instructors talked about using the vlog – from unfamiliarity and uncertainty with the system in 2005, to solidified use practices in 2006, such as recommending specific video files that address diagnosed common problems. A large body of research on technology and user acceptance models indicates that often the "perceived usefulness" of a technology strongly determines the degree to

which it will be appropriated into practice (see for instance Davis *et al.* 1989). From where does ‘perceived usefulness’ arise? Presumably it has strong social influences, and is deeply intertwined with community use practices, as when a community begins to develop systems of use around a technology, it likely becomes more use-ful. But is perceived usefulness something we can parameterize, and measure? Certainly, as social practices shift to accommodate new technology, the perceived value of that technology shifts. Unfortunately, many studies that measure perceived usefulness do so on an individual level (such as Davis *et al.* 1989). Thus, if the perceived usefulness of a piece of technology is a property of the system (which includes multiple individuals), should it not be measured as a property of the system, not just one individual? Moreover, when should such an assessment take place, if perceived usefulness can shift through time? Part of the problem with such user acceptance models is largely due to methodological and empirical constraints – it’s much easier to tabulate and analyze survey data completed by many single individuals at a given point in time. But just because well-established scientific paradigms for survey administration exist does not mean this is the best way to measure the evolution of community use practices, and the way technology valuation changes over time. Certainly, much of scientific understanding is shaped by where we turn our scrutiny: where we aim our telescopes, focus our microscopes. Darwin’s evolutionary theory was undoubtedly influenced by his voyages to the Galapagos, where he was able to observe species divergence on neighboring islands. Such a confluence of phenomena gave him data that may have allowed him to see more clearly patterns he might not have been able to see before. We may see different things if we study the gestures of biochemists over molecular visualizations (Becvar *et al.* 2005) versus those between two experimental subjects describing cartoon segments to each other (McNeill 1992). Presumably those seen during dental hygiene training reveal different phenomena as well, especially as instruction takes place in a setting where the material world is actively employed. A complete picture of human cognition should transfer and extend to all these domains, and as yet, we have an incomplete picture of how human cognition integrates with the material and social world we are always immersed in. Certainly investigations of embodied human interaction in diverse settings will help us to describe principles of cognition and interaction that are more universal.

In completing the research that went into this dissertation, I have learned about the power of ethnographic methods for guiding technology design and studying how human ecologies adapt to technological change. I feel that I've been trained to be highly aware of how technology impacts culture and cognition, and how people develop practices around technology. As eloquently stated by Dourish and Anderson (2005):

Usability cannot be an afterthought in the design of an interactive system. A system cannot be made usable through the application of a user interface, because usability is not limited to the user interface itself; it is a pervasive feature of system design. It is a pervasive aspect of how the system will be used, the context in which it is put to use, the values it is used to support, the interpretations others will make of its use, and so on. (p. 17).

In the future, I am interested in applying my acquired expertise in ethnography to tackling the problem of how to create meaningful interactions with technology in a more fully embodied way. In particular, I would like to explore how current trends in embodied cognition can be used to motivate HCI designs that encourage a more holistic relationship between the human body, the environment and technology, creating interactions where bodies and the world they live in are viewed as integral, not peripheral or subservient, to human cognition.

## APPENDIX 1.

### A.1. Cartoon Transcripts: Why I use comic conventions

I was given Scott McCloud's book, *Understanding Comics*, in 1998. Back then, I was enthralled with the book as a piece of information technology – how it teaches by showing, conveying the right kinds of things in images, and the right kinds of things in words.

I returned to McCloud's work in 2002, while taking a seminar on information visualization. I ended up pursuing work on how to use comic conventions for showing movement-based information – namely, representing multimodal interaction through time for research purposes. And now, in 2007, while struggling with ways of representing the multimodal data in my dissertation, I came back to the idea of comics, and settled there.

Comics do a stellar job of representing two things that are important in multimodal interaction. Comics depict salient elements of an interaction, and they convey the passing of time.

While in interaction with others, we seamlessly attend to certain features of the world, while ignoring others. Speech and the movements of our body, like gesture, eye gaze, and body posture, provide cues as to the salient features of an interaction. Cartoons do a really good job of foregrounding or highlighting certain elements while backgrounding the periphery. This relates to the process of 'iconization' that McCloud discusses in *Understanding Comics*. Digital video data of real-world activity is very complex, and there are some elements of a video record (irrelevant coffee cups, notebooks, uninvolved people) that don't necessarily warrant further consideration, and may even detract/distract from the overall representation. On the other hand, there are certain elements of a scene that should be emphasized. The bold outline style of comics is quite conducive to showing relevant features, while leaving irrelevant ones to the imagination. Moreover, comics are relatively true to the modalities they represent; that is, image-based information, like movement, gesture, body posture, is represented in gesture, whereas verbal information is represented as text, and attributed to particular speakers. It can be rather ineffective to ask your readers to decode a written description of a gesture, when a few images and motion lines can do the same thing so much more efficiently.



Furthermore, comics "imply" motion through time by relying on comic conventions. Motion lines, traces, and arrows are used to indicate movement. There is even some evidence that motion lines and traces replicate what goes on in the visual system when we perceive objects in motion (Cutting 1986). Furthermore, comics are sequential. To "read" a comic, we move our eye over a series of frames that both preserve some structure and change others. It is our own internal representation what is in between two frames of a comic that adds motion to the series of static images.

In order to 'work,' comics rely on cultural conventions. This means that they rely on shared agreements between people of a readership-culture as to what the symbols and symbol systems mean. Comic conventions are fairly ubiquitous in literate culture. As members of this culture, fellow scientists who might be reading articles on multimodal interaction will be familiar with them.

One reason why written transcripts of discourse are so effective is because they convey the gradual passing of time, not inherently in themselves, but as readers read them. They allow readers to simultaneously 'move through' a scene, and see it all at once. The ability to 'see' multiple places in time may invite scientific insight; allow us to perceive important patterns that may not have been visible otherwise.

As McCloud says in *Making Comics*, "our choice of moment – which moments of time to include in a comics story and which to leave out – plays an important role of ensuring clarity" (p. 12). And while clarity is important – as writers we do want our readers to be able to understand the representations of our data – for us as researchers, creating representations that are true-to-life is important too. Granted, whenever science creates representations, we distort somewhat the phenomena that we are studying (Fleck 1987; Latour 1990). There are ways of minimizing distortion, i.e. by ensuring inter-rater reliability, such as by having multiple individuals examine a video record and create a set of still images that are representative.

## **A.2. How I Create Cartoon Transcripts**

Starting from a video segment, I first create a written transcript of the dialog, including relevant action. This helps me begin to select key frames that are representative of the action I wish to document.

For instance, if I were coding a segment where a person lifts their hand and waves, I might choose key frames before, during gestural onset, and when the speaker's arm comes to rest. Of course, this selection process is subject to interpretation, and introduces a level of unreliability into the data that I present. However, to a certain degree, any transcript production involves creating redescriptions of human activity, whether they be Conversation Analysis speech transcripts, textual descriptions of gestural or embodied displays, or passages of Labanotation.

After selecting key frames, I convert them into digital images in Quicktime, which are imported to Adobe Photoshop. In Photoshop, the images are processed into line drawings. Primarily, I use two different filters in Photoshop to accomplish this: "Find Edges" and "Photocopy." Find Edges runs an algorithm that estimates object boundaries. Photocopy renders everything black and white, and can be used to create really bold outlines. The method I've been using has some drawbacks, though, compared with sketching or tracing by hand. The biggest drawback is that I often end up spending a lot of time erasing extraneous details to 'clean up' the image. Again, deciding what is 'extraneous' and what is 'relevant' to a scene involves a level of interpretation.

Digital images from a single video segment are batch processed. Because Photoshop allows for customized actions to be created, it is easy to apply a similar set of filters with the same settings to a whole group of images. This is useful for sets of images taken from the same video segment, which often have the same lighting, brightness, contrast, etc. For a set of digital images, I will create customized actions for saving, finding lines, applying the Photocopy filter with certain settings, etc. Individual images are saved as jpegs.

The comic strip layout is built in Microsoft Powerpoint. After importing the jpeg images, I add bounding boxes, dialog bubbles, and action narratives below the frame. Microsoft Office has a nice suite of tools for adding and customizing comic details, like the motion lines, arrows, and dialog boxes.

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