

**The Technologies of Reflection:  
Designing Flexible Systems to Support the  
Development of Professional Expertise**

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**Abstract**

The Technologies of Reflection:  
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Development of Professional Expertise

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How might we design technology-based learning systems that efficiently and seamlessly scaffold the development of expertise in professionals' practice? This study addresses this question through a Grounded Theory analysis of the online commenting behaviors of a professional learning community and residency-based teacher education program at a large research university. In this study, a group of 20 novices and expert teachers used a novel Video-Based Online Commenting System (VBOCS) to comment on videos of teacher practice. The study draws on a multi-method examination of the video comments left by novice and expert teachers that illustrate the technology's capacity to support the metacognitive and reflective development of professional practice. In testing the ecological validity of the theory, this study uses statistical analysis and theoretical design prototyping to present further possibilities for the development of software that supports professionals as they grow in the context of practice.

## Dedications and Thanks

At the start of my doctoral program, a friend asked me a question that I revisit from time to time: “What if your personality was the sum of the five people that you talk to the most?” Whenever I return to this question, I would consult my cell phone’s history of recent calls. Year after year, the same five people have topped my list, and it is to them that I dedicate this dissertation.

This dissertation is dedicated to my parents Mark and Mona Novak, the wisest and most passionate people that I know. Every one of the thirty-six thousand words in this document are dedicated to you. Equally, my brothers Christopher, Jonathan, and Sean inspired this dissertation from an early phase. In watching their growth as practitioners in their respective professions, I have come to understand so much about the concerns of busy professionals, and also life in the great wide world.

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## Introduction

*“We shape our tools, but thereafter, they shape us.”*  
-Marshall McLuhan, *Understanding Media*

Consider this for a moment: A company’s most valuable asset leaves the workspace every evening at quitting time. Every night, machines and computers sit idle, assembly lines go still, and the company’s lights go out until the next morning. All of these physical attributes remain within the building’s walls, but they cannot produce value without the vast pools of organizational and individual expertise that exist in the company’s workforce. That expertise is the thing that transforms a company from a collection of metal, brick, and silicon pieces into a machine that produces valuable products and services.

At present, it is an article of common knowledge that it may take expert performers ten thousand hours of practice to develop and hone their skills. This may represent between five and seven years of an individual’s career, and sometimes much more. Further, professionals must engage in the ‘right’ kinds of practice in order to develop their expertise in rich and adaptive ways, a process that can be labor intensive and riddled with pitfalls. Due to their rarity and cost, domain and adaptive expertise are high-value commodities in the larger world of professional practices and services. Organizations thrive and fail based on the kinds of expertise they possess at key moments of change, as well as their ability to continuously develop and improve their workforce’s expertise. For this reason, every organization that employs specialized labor holds a stake in the cultivation of expertise in adult populations through continuing education, professional development, performance improvement technologies, and life-long learning programs.

Organizations that adopt and adapt solutions to augment their workforce's expertise may gain a competitive advantage over other actors in the market place of dollars and the marketplace of ideas. But how might instructional designers, learning scientists, and professional development leaders construct systems that support learners as they build their expertise in practice across the career-span?

This study will examine the question as it played out in the first year of a single professional learning community at a major university in the Pacific Northwest of the United States. In this study, coaches and learners engaged in a number of professional development activities with the goal of bringing novices from a low level of expertise to a level of minimum competence in a short timeframe. Through the following observations, analysis, and design, this study will examine the kinds of choices, parameters, and activities proposed by a population of teachers engaged in a community dedicated to the development of authentic expertise in a compressed time. In particular, I will examine how the community adopted and used a particular technology, a video-based online commenting systems (VBOCS), to facilitate their intellectual and practical activity. This study will draw from my own observations of the community in action and a Grounded Theory analysis of their video comments to provide theoretical and practical ways to support professional growth through the creation of technologies that support the use of metacognitive thought tools (akin to Wertsch, 1991; Gibbons, 2003). In pursuing this line of inquiry, the study will provide an opportunity to examine how the participants in the community wove together a number of ideas, norms, and technologies

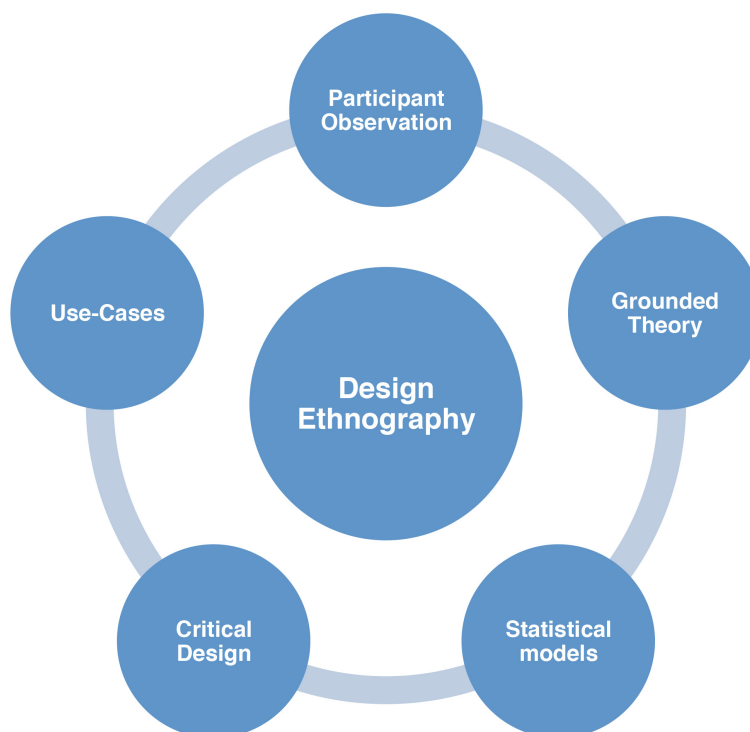
into an organic system to meet their goals, and how this process may inform the development of professional learning experiences in other fields.

## **Structure of This Study**

Due to the complex nature of this project, I have had to alter the traditional dissertation structure to accommodate the emergent nature of the phenomena of interest. In Chapter 1, I will describe the context of the study using a modified version of Activity Theory until the study's central question is articulated. Chapter 2 will use relevant literature from a variety of fields to provide the necessary language and scientific context for the study. Chapter 3 will use data gathered from the field to develop a Grounded Theory of the ways that novices and experts employed metacognitive tools to support reflective practice. Chapter 4 will test the validity of this theory through the use of statistical validation and design methods. Finally, the study will conclude with an assessment of progress on the five core goals outlined in the introductory chapter.

This dissertation will use tools provided by an eclectic mixture of disciplines in the search for ways to design flexible support for professionals as they learn in the field. To accomplish this task, the study will borrow strategies and theoretical models from education, psychology, sociology, organizational development, cognitive science, anthropology, and design theory. I have brought these strands of science together to provide a multi-dimensional view of the development of expertise in the context of practice as I observed it in a year of fieldwork with the implementation of a new professional development program in the area of teacher education. This study will use

data collected from this period of participant observation to develop a Grounded Theory of the expertise-building practices that I observed. Then it will validate the Grounded Theory statistically to determine the relevance and fit of the theory to the participant activity. Then, I will use the observations to create a critical design for a new software platform to support the kinds of expert thought proposed in the Grounded Theory. Finally, I will apply the design to other professional contexts to conceive of divergent use-cases for the platform. This cyclical process of Design Ethnography will enable us to imagine further opportunities for testing in the development of software for learning. This cycle is pictured in **Figure 1**. In concluding this study, I will provide some suggestions for future testing opportunities, and ways that instructional designers and Learning Scientists might continue to test and modify this work.



**Figure 1:** The Design Ethnography cycle, including participant observation, Grounded Theory, statistical models, Critical design, and Use-Cases

The resultant Design Ethnography (Salvador, Bell, and Anderson, 1999) will serve as a generative, formative means of guiding future research in the development of educational technologies that seamlessly and flexibly support learning in practice.

## **Chapter 1: Contexts, Questions, and Goals**

The Alternative Teacher Education Program (ATEP) Program at a university in the Pacific Northwest is currently engaged in an effort to augment the development of novice teacher candidates recruited from a National Service Organization (NSO). In this alternative teacher education program, Teacher Candidates begin to work as full-time teachers in classrooms after completing an intensive five week course of study in beginning classroom practices (as hosted by the NSO). Over the following year, the university-based component of the program integrates these teacher candidates into a professional learning community designed around a holistic and situated view of teacher practice. The activities and program of the university-based professional learning community were designed and implemented by Team Leads, or master teachers hired to serve as facilitator-mentor-coach-evaluators for the Teacher Candidates.

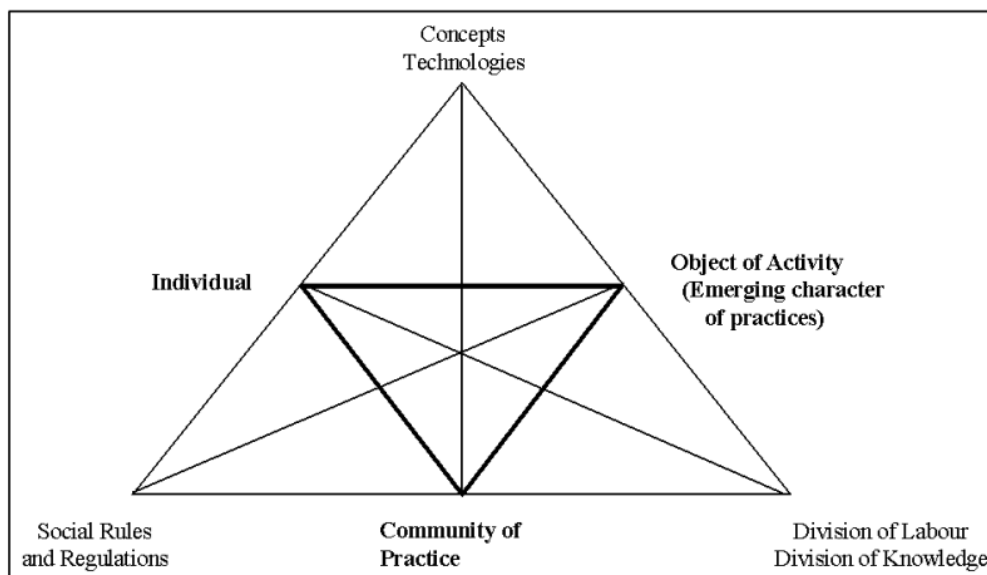
In their discussions, the Team Leads agreed that ATEP 's end vision for the Teacher Candidate is proficiency in the enactment of instructional routines, the elicitation of deeper domain-based thinking from students, and the development of the Teacher Candidate's long-term ability to learn in the context of their practice. In addition to these visions for high quality teaching, the ATEP program must also provide Teacher Candidates with the skills and knowledge necessary for the teachers to pass the state's high-stakes Teacher Preparation Assessment (TPA) and receive a teaching credential. Due to the extreme time pressures associated with beginning teaching, the Program's Teacher Candidates would need to confront both of these needs at the same time. To further complicate matters, the Teacher Candidates were also responsible to the NSO,

schools, and districts for a variety of performance and assessment observations, metrics, and assignments. Most importantly, novice teachers held the ultimate obligation to provide a rigorous education for each and every child in their classrooms, even as they were learning about the practices necessary to enact that goal.

Given these time and performance pressures, the leaders of the ATEP Program decided to make the development of a holistic technological support system central to their strategy for providing novice candidates with a meaningful and relevant teacher education experience. More specifically, the use of asynchronous video sharing technologies would serve to maximize opportunities for Team Leads to give direct feedback on the Teacher Candidates's practice, and for Teacher Candidates to reflect on their own practice.

As a participant observer in the program, the community granted me the opportunity to follow their development of a novel form of professional community of practice. During the course of my interaction with the various stakeholders in the program, I came to appreciate the complexity of the mental and social activity of the participants as they engaged in reflective learning from practice. To represent this complexity to the reader, I have created a condensed version of Activity Theory (Engestrom, 2006; Baran and Cagiltay, 2010) to bracket the necessary contextual knowledge down to a manageable form. This framework was applied *a posteriori* to the coming Grounded Theory analysis to help identify the relevant features of the system under study.

Activity Theory’s primary concerns are the relationships and tensions between macro-structures inherent in human-environment systems. These tensions form as the network of actors constantly resolves and reconstitutes itself in ongoing interactions. Thus, in specifying a particular form of activity (e.g. deliberate practice for expertise development) and a particular system (a blended novice/expert community of teachers), researchers may come to understand a phenomenon through its expressions within the various interactive threads. In this description of the study context, I will attempt to identify many of the mediating threads as they existed in the world of the ATEP participants. The Activity Theory diagram (**Figure 2**) illustrates a commonly accepted formulation of the theoretical framework, and allows us to proceed through a systematic description of this study’s context.



**Figure 2:** Activity System Components (Baran and Cagiltay, 2010)

In essence, the coming analysis in this study will focus on the top-center of the triangle formed in the Activity System model, the areas known as ‘Concepts and Technologies.’

In Activity Theory, common languages, ideas, and tools make up a core part of the participants' larger activity system. The inclusion of this category in Activity Theory comes from the important role of those shared concepts and technologies in the mediation of the achievement of actors' goals. Thus, in order to understand how the ATEP program used the specific VBOCS technology to structure their discussions of practice (and how this might inform other areas), I will provide descriptions related to some of the other components of the system. I will proceed through brief descriptions of the relevant features of the activity system as divided into four related parts: 1) the Subjects, Roles, and Knowledge Structures, 2) Community of Practice Structures, 3) Activity-Object Structures, and 4) Divisions of Labor and Knowledge. The actors, interactions, objects, and goals in this system compose a socially distributed system of cognition, wherein individual and collective thought and action are mediated via the interrelations of these components. To understand these interrelations and develop a theory of the program's use of technologies and concepts for the purposes of deliberate practice, this study will briefly examine the other elements of the activity system. In the following summary of the features of the ATEP context, I will use a modified version of the Activity Theory framework to arrange my observations from the participant observation period so that the reader may more accurately identify the various qualities of the social system developed to achieve the practical goal of developing teachers in practice. In the following sections, I will examine evidence drawn from the ATEP context to better understand the nature of the professional learning community and its use of online video-based commenting systems.

## **1.1 Subjects, Roles, and Knowledge Structures**

During the first year (2011-2012), the Alternative Teacher Education Program contained three population groups that may be distinguished by their number of years in practice, as well as their means of entry into the field. First, the program had a total of 10 Teacher Candidates, who were first year teachers engaged in a residency-based alternative teacher credential program. Teacher Candidates had not engaged in the coursework or student-teaching milestones that usually attend traditional teacher education programs, and that serve as common experiences amongst practicing teachers. Instead, the Candidates had engaged in an intensive summer program hosted by the National Service Organization, and were operating as teachers of record for the first time. Second, the program involved four first-year teachers, who had earned their teaching credentials through the University's Teacher Education Program. These teachers were invited to join the program in partial fulfillment of their two-year Masters in Teaching degrees. All Candidates and first-year teachers were simultaneously responsible for their regular, full-time teaching duties in local public schools as well as their ATEP coursework and meetings. In addition to the ATEP coursework, Teacher Candidates were responsible for training, coaching, and evaluative events run by their National Service Organization coordinators.

Finally, the program included six Team Leads, who were chosen for their expertise, vision, and leadership as teachers and teacher-coaches at the University. Most of these veteran teachers had worked for the University as teacher coaches at the post-baccalaureate level for two or more years. Team Leads were responsible for the design

of their professional development program, the evaluation of participants, and shepherding the Candidates through the complex credentialing process. Due to the wide variance in the necessary domain content knowledge and pedagogical content knowledge, novice teachers, first-year teachers, and Team Leads were divided into four Content Areas: Elementary Literacy and Mathematics, Secondary Language Arts and Humanities, Secondary Science, and Secondary Math. These six Team Leads were spread across the four content areas of the program, with two Leads in the Elementary cohort (one who served as a specialist in literacy and another in elementary mathematics), two in Secondary Language Arts and Humanities (one for each area), and one each in Secondary Science and Secondary Math (summarized in **Table 1**).

Content Team	Team Leads	Learners
<b>Elementary</b>	2 (1 Literacy, 1 Math)	4 first-year NSO
<b>Secondary Science</b>	1 (Science)	3 first-year NSO
<b>Secondary Humanities</b>	2 (1 Language Arts, 1 Humanities)	2 first-year NSO
<b>Secondary Math</b>	1 (Math)	1 first-year NSO, 4 TEP

**Table 1:** Participants in the ATEP Program, including Team Leads, National Service Organization Teacher Candidates, and teachers from a conventional Teacher Education Program

The ATEP Team Leads and program managers made the decision to divide the participants into these groups at an early phase, in acknowledgement of the idea that Teaching (as a professional practice) is inseparable from the domain-specific content that is taught. For this reason, the program created a series of sub-communities of practice that engaged in discussions around specific components of practice in their

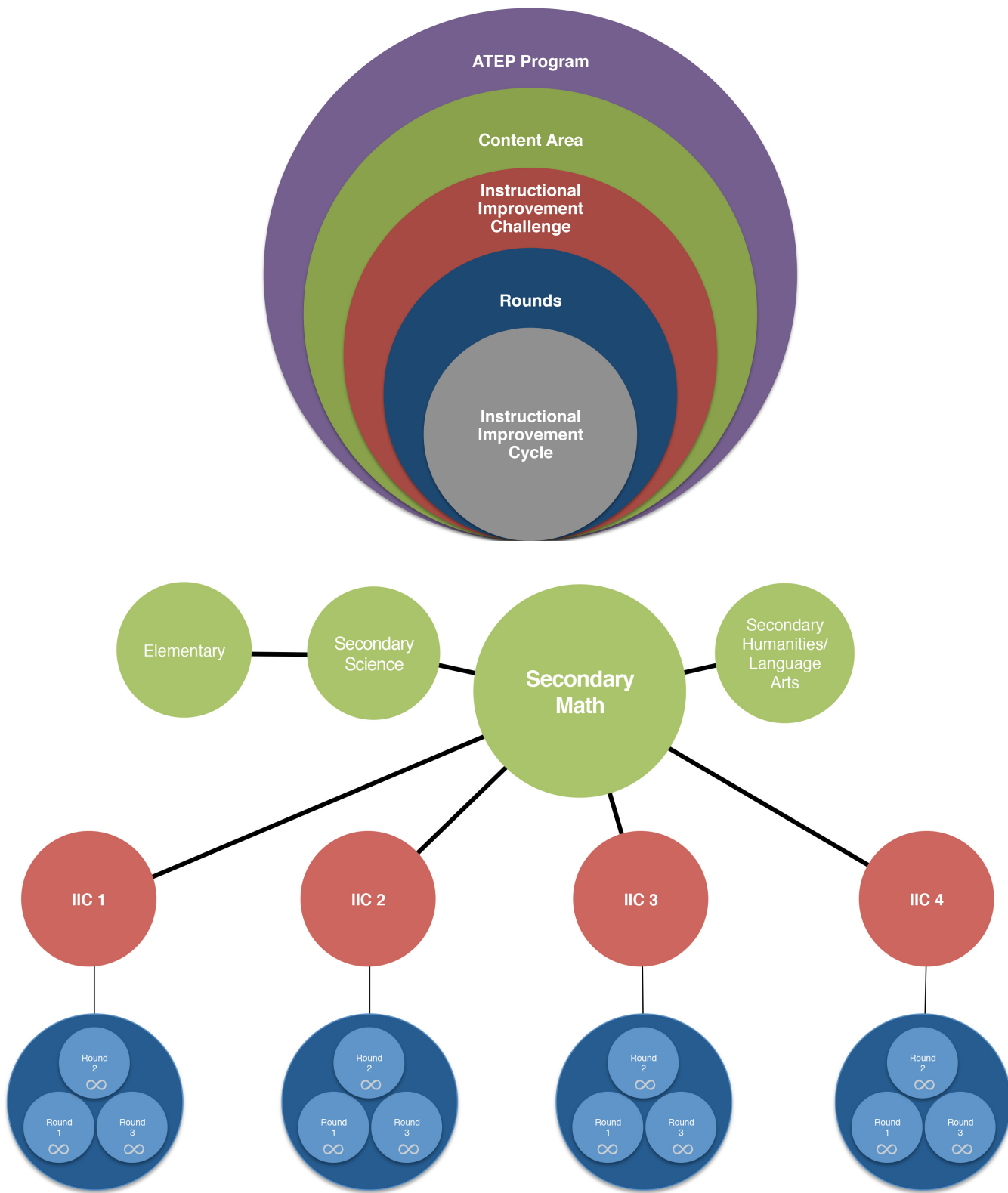
content area. This created a degree of speciation across the program, as the participants met more frequently in their small Content Area teams than with the whole group, and engaged in activities that Team Leads designed to specifically support their Content Area. To mitigate the issue of scope and goal drift, the Team Leads held two-hour weekly meetings to compare notes, strategies, and challenges. I attended these meetings in my capacity as technology steward, and often participated in the team discussions, providing technological support and helping to set up websites and portals. Beyond the local system, the National Service Organization held office hours and events to support the novice Teacher Candidates in their development, and to engage the Candidates across content areas.

Candidates, teachers, and Team Leads met in weekly professional learning groups, and engaged in a wide variety of learning activities. In some weeks, the participants engaged in microteaching activities, enacting and critiquing their lesson plans in front of their peers. In others, the candidates worked individually and collaboratively to develop curriculum materials for use in the coming weeks. In other occasions, the Team Leads showed examples of video of the novice teachers taken in the field, and encouraged learners to discuss what they saw and how the candidates might improve. The selection of these various activities was conducted at the discretion of the Team Leads, based on their assessment of the optimal instructional tool to ameliorate the novice deficits and call attention to their success in mastering pedagogical content knowledge and domain content knowledge.

## 1.2 Community of Practice Structures

After establishing the goals of the project, the Team began to design the instructional system that would provide the teacher candidates with a relevant and valuable experience through engagement with a professional learning community. A cursory understanding of the structure of the activities and roles of the community will be necessary to understand many of the findings in the coming analysis. As such, I have provided a series of graphic organizers to serve as a guide to the various components of the program at macro and micro levels of organization.

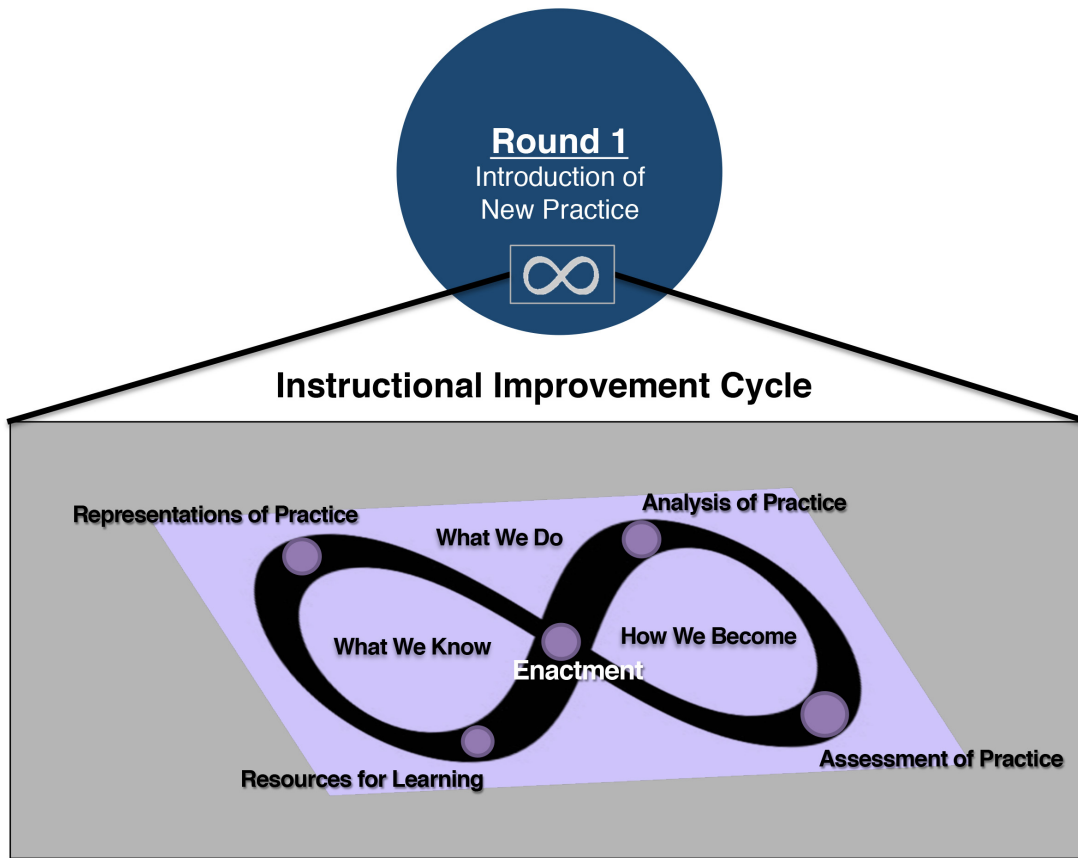
The ATEP program's structure (represented in **Figure 3**) reflects the leaders' emphasis on the importance of training teachers to think about learning through the lens of content domains. From an early phase, the project dived the participants into teams based on their content area. The team reasoned that this would allow them to work on the domain-specific pedagogical practices and content knowledge necessary to provide a rigorous learning experience for the Teacher Candidates' students. The four Content Teams during the time of the study were 1) Elementary Math and Literacy, 2) Secondary Science, 3) Secondary Mathematics, and 4) Secondary Humanities and Language Arts. Within each group, Team Leads coached the teacher candidates and credentialed teachers through a series of Instructional Improvement Challenges (IICs). These challenges provided candidates with opportunities to practice a variety of authentic, relevant, and generalizable skillsets. These IICs contain Rounds of practice, where candidates would attempt progressively more ambitious iterations of the early challenges.



**Figure 3:** Nested relationships and exploded-diagram of the program structures at the time of the study

Each Round in the IIC contains iterations of the Instructional Learning Cycle, as illustrated in **Figure 4**. The Instructional Learning Cycle structure begins with representations of practice, provides resources for learning, proceeds through the central activity of Enactment, and is followed by further analysis and assessment of practice. This process takes the participants through a sequence where they integrate what they know as teachers (from the resources, representations, and discussions) with what they do as teachers (preparation and enactment) and how they become competent teachers (through the analysis and assessment of enactments, and a continuation of the cycle). These structures are represented as a lemniscate, in order to emphasize the recursive and contingent nature of participants' pathways through the process.

For example, if a participant submits a representation of practice that is inadequate for analysis, Team Leads may ask them to enact the challenge again, or provide them with resources for learning and worked examples of practice. The Team Leads deliberately designed this community structure during the summer period before the initial launch of the program, and used it to guide their work with their participants throughout the year. Now that I have illustrated the ways that the ATEP participants were organized within the system, the next section will examine the kinds of activities and objects of practical activity that the ATEP instructional system supported and enabled.



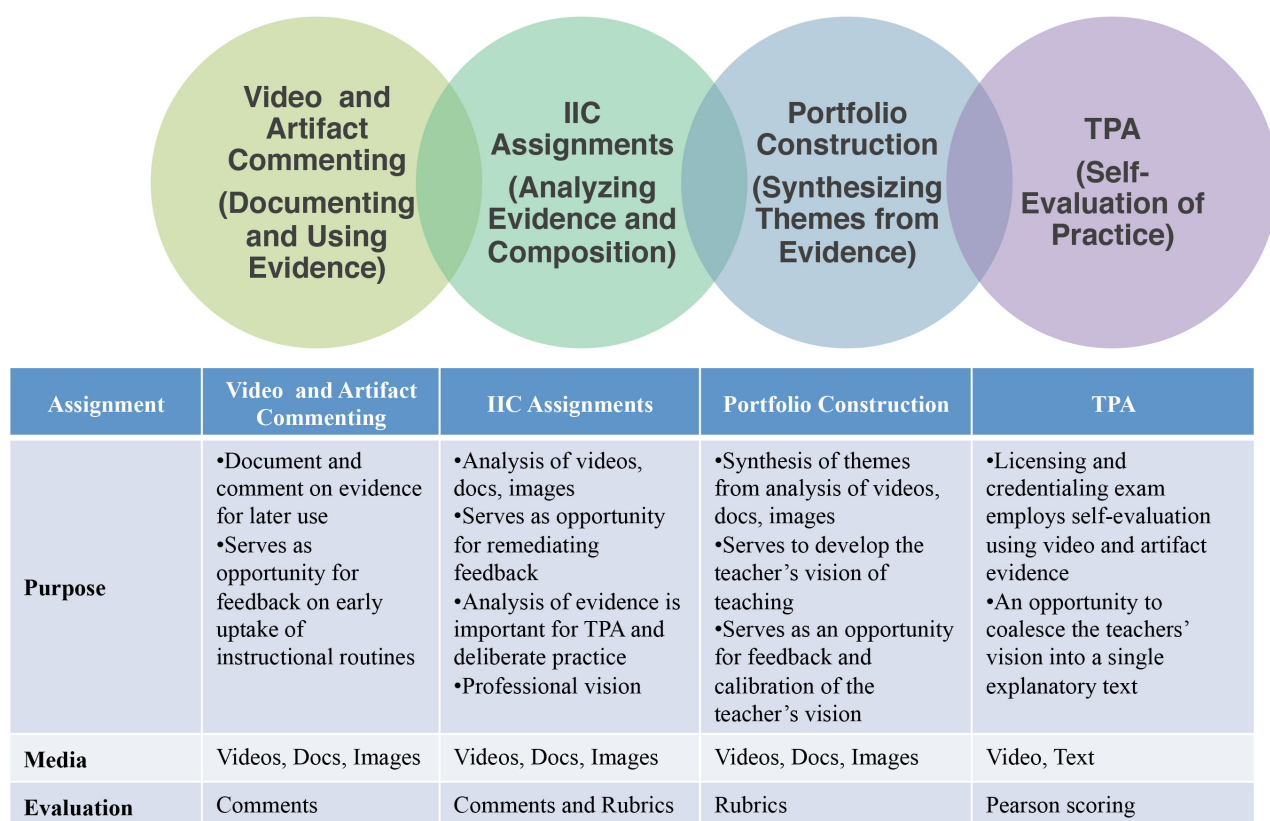
**Figure 4:** The activity structures at the participant level of the program design, with cycles of 1) Representations of Practice, 2) Resources for Learning, 3) Enactment, 4) Analysis of Practice, and 5) Assessment of Practice. These occur in the space of 1) What We Know, 2) What We Do, and 3) How We Become

### 1.3 Activity-Object Structures

The organizational development of the program structures co-evolved with a series of formative, summative, and continuous assessments that occurred throughout the year.

Within the larger structure of the program, coaches and learners provided representations of their practice and reflected on them through a number of instructional tools that were purposefully sequenced. These began with the introduction of a video-based commenting system in the first months of the program (October and November,

then throughout the year), and followed with a longer-form video paper in December. In March, candidates constructed ‘workfolios’ that contained several reflections organized around themes found in the Teacher Preparation Assessment (TPA) in the April-May period. The logic of the sequencing of these events is summarized in **Figure 5**.



**Figure 5:** The sequence of instructional instruments employed during the year

As the diagram illustrates, the Team Leads designed the activities of the program to support a smooth transition from documenting and using evidence, to analyzing evidence and composing a response to a video artifact, to synthesizing themes from the evidence in ways that were consistent with the demands of the final assessment, and concluding with a mandatory self-evaluation. The interplay of these tools provided students with a number of unique opportunities to reason about their practice and receive

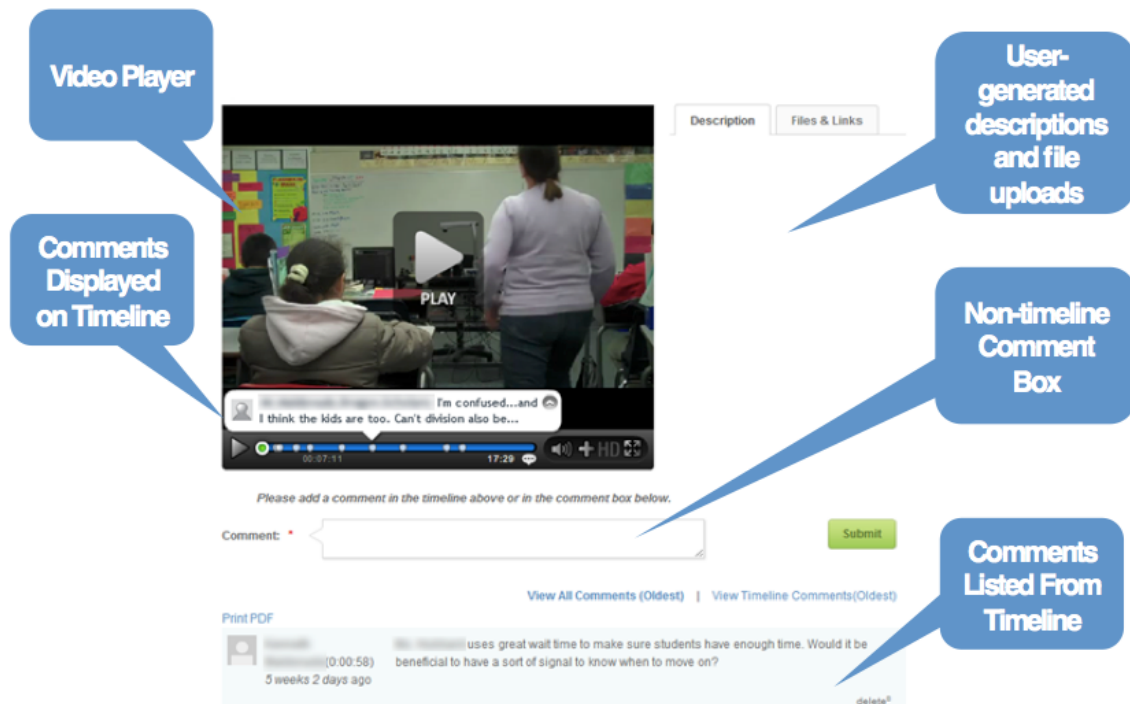
feedback from the team leads and other teacher candidates. As an instructional designer with an interest in the implementation and design of technologies for learning, I developed a curiosity about the role of the mediated technologies as they supported the program's structures, activities, and communication. Over time, I developed a further interest in the use of the Video-Based Online Commenting Systems (VBOCS) that I supported in my capacity as a technology steward for the program.

## **1.4 Tools**

From the outset of the endeavor, the ATEP Program's leaders prioritized the use of video technologies as a means of routinely reviewing and improving practice. I joined the ATEP Program in the spring of 2011 to help develop a plan for the use of technological systems to support that video-based reviewing. My portion of the plan involved three components: active technological support (e.g. troubleshooting), passive support (e.g. researching new technologies to support program activity), and ongoing data collection (e.g. recording, categorizing, and archiving data collected from the program for research purposes). Each of these activities provided me with an opportunity to engage with the participants. In my active capacity, I ran periodic refreshers and workshops on technology, built online portals and storage spaces for the Team Leads, and provided technical support and coaching to the candidates. In my passive capacity, I talked with Team Leads and Teacher Candidates about the kinds of technological tools that they imagined would best support their work, and conducted periodic reviews of new technologies. In my data collection role, I was tasked with video recording the professional development sessions for later analysis. In changing the

video cameras roughly every 60 minutes (due to battery constraints) for six months (approximately 55 separate session days), I was able to observe a broad slice of the community activities that transpired during the meetings without intruding on the discussions.

In addition to supporting video as a primary source on the development of the professional learning community, my role also involved supporting teachers in the adoption of a new online tool that would help the participants to share videos from their own practice. In working with the novices and experts, I came to appreciate the novel professional learning context and unique population as a rare opportunity to study the development of professional expertise through the use of a video-based learning management systems and online professional learning community called *Odin*. **(Figure 6)** While working in this capacity, I also provided local technical support for *Odin*, and helped the team to troubleshoot issues and plan for the integration of technology. In addition to my formal role, I also had the opportunity to work with members of the university's faculty and staff as a technology trainer for the software, providing me with insights into the technology from other professionals in the field. The process of forming these partnerships, interacting with the community, and learning the professional language of the teachers had a profound effect on my thinking about the application of the technology to reflective thought in a professional context.



**Figure 6:** An annotated view of the major features of the *Odin* system

The *Odin* system itself was a central tool in the program, and is the source of the data presented in the Grounded Theory. The online platform allows participants to upload video into the system, and place text and video comments directly on the timeline of their video. When the playhead reaches one of these comments (marked with small ‘nodes’), the comment appears in a small bubble at the bottom of the video. The comments were also aggregated and published below the video in the form of a thread, organized from earliest to latest by their respective positions in minutes and seconds in the video. Users may also submit non-timeline comments to the thread, and upload examples of lesson plans, scans of student work, photos, and draft PowerPoints.

During my involvement in the program, the *Odin* product was in beta phase, and technological hiccups required that I periodically troubleshoot issues with users over email, phone, and in person. This gave me the opportunity to talk directly with the participants about their experiences using the tool, and greatly informed my thinking in this study. In concert with my own efforts, the ATEP team received valuable technical support and input from the product developer. ATEP participants also provided user experience feedback to the developer that resulted in positively-received user interface changes to the beta.

The community's shared goal for the technological system was the facilitation of the evolving, co-constructed learning process of the Team Leads and the novice Teacher Candidates. At the start of the year, the Elementary Team Leads all introduced their Candidates to the beta version of *Odin* with a description of the tool's role in the larger instructional plan and its relevance to their work as teachers. One Team Lead introduced their group to the technology:

We want you to “practice” using *Odin* as a tool for making our practice public with each other prior to your next class session...Using *Odin* will become routine for us, so we need to build our confidence and competence in engaging with it and each other through it.

-Math Team Lead (10/15/12)

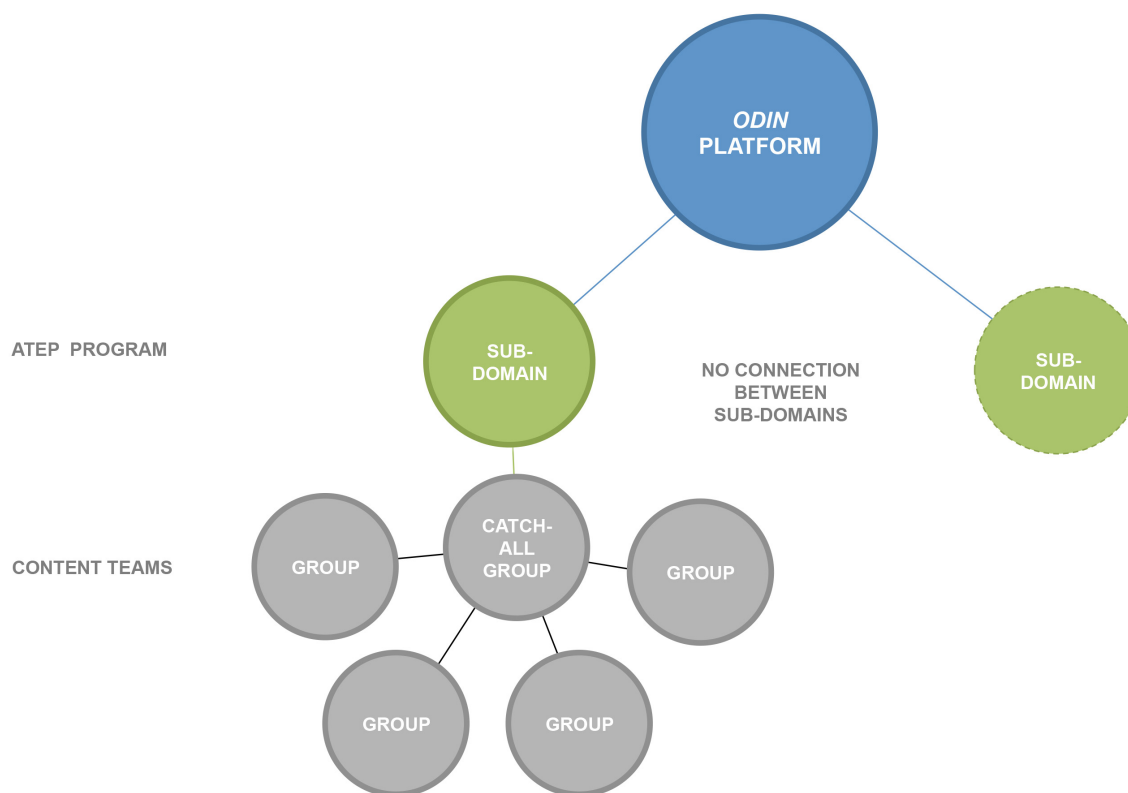
As leaders in the community, the Team Leads incorporated the new technology in a serious and deliberate way, demonstrating leadership through the implementation of the technology. After introducing the tool and its place in their learning community, users were then asked to engage in self-commenting and peer-commenting on videos of practice beginning in October. In addition to the online commenting, candidates

sometimes received direct feedback from the Team Leads on their video during in-class public viewings of videos that were uploaded to the system and via email.

The *Odin* VBOCS platform itself provides for the creation of two key taxonomic structures that were mapped to the ATEP social structures. Within the software platform, the *sub-domain* contained 20 of the participants in the study. Within the sub-domain, the participants organized into private *groups* that contained only members of their content team. **Figure 7** outlines the relations of these structures, and illustrates how the ATEP program syncretized with the platform's structures. As the drawing shows, the candidates all shared a common sub-domain (one of many in the larger system), and posted their videos to specific topic threads in their groups (with one group for each Content Team). Videos were rarely shared across groups, due to the differences in pedagogy, practice, and terminology across the content areas, but also because of the difficulty involved in bridging and erecting public/private boundaries in the software. However, Team Leads (who held administrative privileges in all groups) occasionally showed videos from the system in their class, predicated upon the agreement of all parties.

The *Odin* system was also marked by clear public/private boundaries. Individuals might belong to multiple groups in the sub-domain, but only group members may see one another's video. Further, any individual may upload a video for storage or later use, but the video would not be visible to other members of their groups until they actively

choose to assign the video to a specific thread. This structure was meant to address the public/private concerns that sometimes surfaced in discussions with candidates.



**Figure 7:** The community structures in the *Odin* Platform

As such, the *Odin* system allows teachers to work privately and in a safe environment that is conducive to the risk-taking necessary to advance their practice. While there were a number of technological issues (e.g. difficulties associated with uploading large video files), the majority of participants were able to accomplish their goals using the system.

## 1.5 Voice From the Field

In implementation, novice teachers approached the video-based commenting activities with mixed enthusiasm. In discussing the tool with them, I found that the candidates did

not always see the relevance of reflective commenting on their larger work of learning to teach a real classroom full of students. Several candidates were not wholly convinced that the video-based commenting activities were the best use of their limited time.

However, one teacher candidate (a star performer from the Elementary Team) demonstrated particular enthusiasm for these activities in an interview conducted in December:

*The videos have been awesome. I love the videos even though I don't like watching myself, but just like being reflective and like seeing other teachers and seeing their videos and [thinking] "oh that's a good idea, that's a good idea..." I purposely wanted to record myself, and other teachers said, "What are you doing? That's terrifying." I say, "No, but it's so good. Please watch my videos, I want to get better at it." That's a huge piece of it, like I just love the technology and how well thought out everything is. So it's been a great experience so far...*

-Interview with MA of the Elementary Team, 12-3-11

In considering MA's comments about the video activities, I became interested in how the technology provided a scaffold for this learning process, and how it might play a role in helping professionals 'get better at' their own practice. I wondered: What did he see when he watched his videos? How did it have such an effect on his thinking? Later in the interview, MA elaborates on the commenting process, and provides a description of his experience as a learner in the video commenting activities:

*...The last video for the literacy piece that I turned in, I talked for a long time. And, it just went on forever and there was no- like I was expecting the students to be quiet and sitting on the rug for like more than 15 minutes and they were watching the video and like talking to everyone else and they [team leads and peers] were able to notice that there was no sharing between them [the students]. Like, there was no student's voices being heard, like 'you were talking for way too long,' and 'you could have been a lot more direct on your teaching and what your expectations were,' and that wouldn't have happened if I didn't record myself...*

MA notes that watching the video and reflecting on it provided him with these insights into his own practice that he could not achieve on his own. I began to understand that these video commenting activities might serve as a real asset to professionals who are busily engaged in practice. Further, for MA, the act of sharing these videos of practice with colleagues and asking for feedback (in public and private settings) represented a commitment to providing a quality of service to his students and a commitment to a mastery of teaching practices for himself. As such, the process of reviewing his videos publicly had the effect of nurturing MA's dedication to his own growth as a professional. This would indicate a phenomenon of substantial interest to other professional domains.

## **1.6 Finding the Question Through the IICs, Comment Thread Genres, and Priming Questions**

Now that I have detailed some of the facets of the ATEP activity system, I will briefly retrace some of the incidents that prompted me to begin this research. The ongoing process of finding the question through interaction with a community and a thoughtful analysis of collected data is a crucial part of qualitative research. For this reason, I will briefly detail three preliminary studies of participant-generated materials that led me to ask the question presented at the end of this chapter.

This study began as a pilot-study analysis of the IIC Assignments, Priming Questions, and Comment Threads collected from the Teacher Candidates in December of 2011. At the time, my primary interest was in the presence (and non-presence) of time codes in

the IIC assignments. As noted in Rosaen, et al. (2004), the use of specific video evidence (e.g. time codes) appears to accompany more specific observations about the nature of student learning compared to the candidate who did not use timecodes. For this reason, I had collected a small sample of the video-based papers to analyze for evidence of this observation at play in the writings of the candidates. Despite their varying length (usually less than 80 words), these ‘noticings’ (as one Team Lead called them) contained what might be thought of as a ‘complete idea’ about a specific point in a video, but did not always include all of the themes in any given noticing.

The following passage comes from one of the Elementary Teacher Candidate’s IIC assignments. It served as my first glimpse of evidence of a unique discourse phenomenon that eventually inspired the broader coding scheme:

At 5:11 I try to emphasize the idea that the questions should be applied to more than just one sentence from our writing. I try to reinvest the students in the lesson by having them guide me through the revision of a sentence at 5:36 but In the foreground at 6:07 I appear to have lost I- and A-as they are playing. What I think would have helped at this point would have been for them to turn and talk with a partner in order to write a new sentence for my piece. I could have provided them with a few details then had them pick and choose from them to create a new sentence so that they would have had more practice writing.

– JL, IIC Assignment 1, December 2011

In this passage (and others like it throughout the IIC assignments and workfolios), JL makes a series of observations that are pegged to specific timeline events. She locates her own behavior at 5:11, describes a specific student behavior located at 5:36, makes an inference about student thinking at 6:07, and a closes with a specific suggestion for improving her future practice. While it is possible that Jessica spontaneously wrote her comments in this fashion, I considered the possibility that she learned this way of

displaying her thinking from the Team Leads and ATEP assignments, the NSO, or her local community of practice in her school. In teaching and learning with these actors in their networks, she may have acquired elements of their language and perspectives on teaching.

In contrast to this time code-based discourse structure, we can see an example from another member of the Elementary cohort who did not use time codes in the IIC video paper assignment. The following passage contrasts in tone and number of specific references to student thinking:

The biggest indicator for me that they understood the lesson was their focus during independent working time. I walked around and there were maybe three or four students that didn't get it, but overall the lesson was a success. Also, I maintained a consistent level of focus and engagement during the lesson that was evident in their participation and also in the fact that all of the side conversations were about the topic at hand. There are two students in particular, M- and K-, who worried me the most. While the whole class had written something, they had a hard time thinking about something to write. I will follow up with them tomorrow and see if a more guided time would work better for them.

– MA, IIC Assignment 1, Dec. 2011

While MA displays some reflective thought in the assignment, it lacks the specificity of description and frequency of suggestions for improvement that appears in JL's assignment. However, while JL's essay appeared to focus on suggestions for improvement, MA's less specific essay appears to focus on 'what worked,' an admirable goal as well. This presents a quandary of values; is a suggestion for improvement of a higher learning value than a 'what worked' noticing? If so, why would this be the case? It was this line of thinking that led me to consider the issue of the utility of video-based commenting systems as regards the development of professional expertise and metacognitively reflective thinking, and eventually the Grounded Theory itself.

Following this early analysis of the role of the time codes on video commenting behavior, I realized that the *Odin* system provided a test of the interactions of learners with systems that scaffold time code use in video commenting. In essence, the *Odin* system enforced the relationship between the learner's observation and the actual events of the video by collecting and synchronizing them into a hypertext. While I would ultimately find evidence of a much broader marker of expert thinking than described by Kersting et al., my early analysis of the comment threads in the system led to the observation of two core features of participant behavior in the video-based commenting system.

First, in examining the system, I observed that Team Leads often entered a priming question and used rubrics to give the online video-based analysis of practice assignments focus and relevance. By nature of their high level of expertise and role in the community, the Team Leads worked to produce thought provoking assignments and prompts that related the commenting activities to the practice in meaningful ways. These structures served two purposes in the use of the *Odin system*. First, they provided specific parameters for the assignment, including how many minutes of video to upload, due dates, etc. The second purpose of the priming question involved relating the assignments to specific strategies, goals, and values of the community. In this example from the Elementary team, I began to see the relationship between the kinds of questions that the Team Leads asked of the candidates, and the kinds of thinking that the candidates would summon forth in response:

*Upload the video of your “launch” (no more than 10 minutes in length) and comment on the video, using the prompts below.*

- *Cite moments in the clip where you are attending to the teaching practices of “effective” launches (listed below).*
- *Describe what you are doing and how you think it supports students in having access to the task.*
  - *Discussion/elaboration of the context of the task*
  - *Discussion/elaboration of the key mathematics of the task*
  - *Teacher’s work to build on students’ input and support them in developing common language for the task*
  - *Teacher’s work to maintain the cognitive demand of the task*

*Your reflections and analysis (your comments on your video) must be explicit, clear, and articulate.*

-Elementary Team Lead, Comment Thread, February 2012

In this example, the first segment of the question identifies the literal parameters of the assignment (how long the video should be, and the ‘launch’ that it should contain).

However, the latter part of the priming question contains the mirror-images of the constructs observed in comments made in the video papers of JL and MA. I could see in these examples that the Team Leads were attempting to elicit particular kinds of reflective thinking from their novice teachers by promoting commentary around specific features of the practice, including the teacher behavior and student thinking phenomena seen earlier. In addition, the elicitation of the priming question is likely to involve the production of counterfactual statements about how they might proceed in the future. I began to consider the relationships between the novice teachers’ growing knowledge of the features of practice and their ability to use this knowledge to examine their practice critically, and how I might see evidence of this in their writing. These questions ultimately led me to development of the Grounded Theory that I will present later shall see later.

Second, the Team Leads developed five recurring kinds of ‘comment thread genres’ over the course of the year to facilitate and structure discussion (or communicative purposes that shape the features and meaning of the text using known tropes, as in Swales’ *Genre Analysis*, 1990; also, Knobel and Lankshear, 2006) recurred throughout the year. The genres are described in **Table 2**. The comment thread genres provide an overview of the ways that Team Leads positioned the videos in the social process of reflection in practice. In compiling this taxonomy, I realized that all of the comment threads used the same technological interface to serve the different cognitive and social purposes in the program. From this small observation about the relationship of meaning and technology, I came to understand that the Team Leads were actively engaged in the practicalities of wrapping their practice around the technological and social affordances of the *Odin* system.

This was a profound realization for me, as I came to believe that technology should work to scaffold professional practice in ergonomic ways. I reasoned that such a system would reduce the time burden of the activity on the Team Leads and Candidates in the ATEP context, thus promoting the use of the system by reducing the cognitive transactional costs (Clark and Mayer, 2010) of the technology (e.g. frustration at the limitations of software, technical glitches, etc.). I contemplated the ways that a truly user-centered system might ease the workflow of activities that promote the growth of professional reflection in practice, and what this might teach us about learning in practice in other parts of the world of professional development. Further, at the highest levels of generality, I wondered how instructional designers might begin to build spaces

for the kinds of flexible, social, and metacognitive thinking observed in the ATEP context into VBOCS virtual learning environments.

Thread Type	Working Definition
<b>Team Lead Comment Thread</b>	Team Leads would model the commenting process by annotating Teacher Candidates' videos early on (October), and providing encouragement and further discussion later in the year. Only Team Leads commented on these videos.
<b>Self-Comment Threads</b>	Teacher Candidates upload their video and annotate the timeline with their observations.
<b>Cross-comment Threads</b>	Candidates comment on the videos of others, sometimes in response to a self-comment thread.
<b>Team-Lead/Candidate Co-Commenting Thread</b>	Candidates post a video and leave preliminary comments, followed by a round of noticing and encouragement from the Team Leads.
<b>Exemplar Comment Thread</b>	Team Leads would post videos of exemplary performers on the website, and ask each candidate to contribute comments to a collaborative discussion thread.

**Table 2: Five comment thread genres**

## 1.7 Research Questions and Goals

I began to see my experience with the ATEP project as an opportunity to examine how novices and experts communicated their knowledge through the software, and thus how these technologies might be used and improved in future circumstances. In understanding how professional communities engage in deliberate practice through self-reflective multimodal discourse with their communities, instructional designers and

Learning Scientists may find new opportunities for the development of in-practice learning experiences and tools in other professional fields. I will formulate this ultimate question in my research in the following way:

*How might we design virtual learning environments that scaffold expertise development through the training of specific kinds of metacognitive thought tools?*

To operationalize this question and bracket it further, I have identified a series of goals for the project that might be concretely measured or explained based on a blend of existing theoretical and empirical knowledge and observations from this project. These goals organize my observations into a coherent theory of a particular aspect of the candidates' commenting behaviors, and extend them into a domain-generalizable, ecologically-valid, and generative set of design parameters and questions. The goals include:

- To understand how participants used the technological system to engage in deliberate practice, as exhibited through their use of thought tools in video commenting
- To identify features of the ways that thought tools were successfully implemented in the hopes of guiding future practice and design
- To observe specific markers of this process in action, and develop a socio-cognitive theory that explains the relationships of these expressions
- To produce a design for a flexible learning platform that more accurately conforms to the needs of professional learning communities in a variety of domain and practice contexts for future testing and critique

- To consider how other professions might adapt such a platform to support continued growth of learners in their signature pedagogies

The achievement of these goals, and one answer to the study's core question, will emerge by way of an iteration of observation, analysis, and theoretical design. The observations, models, and designs generated in pursuit of the above goals will yield insights into the way that participants reified their knowledge in response to video artifact, and how this reification may systematically build their ideas through deliberate practice.

The Theory and designs also provide the opportunity to identify decision points that will be relevant to designers of professional learning communities, educational technologists, and practitioners. More importantly, the analysis and ecological validity testing of the Theory of Noticings will yield a software-scaffolded learning design that natively supports an idealized system for the ATEP community. The design itself will provide opportunities to identify further questions about the optimal use of VBOCS systems in the service of professional development. Through this process, this study will identify a more efficient way to improve the performance and quality of professional practice through the integration of learning practices and technology.

## **Chapter 2: Reviewing the Literature**

Now that I have identified the central question about the design of software for the development of professional expertise in the context of practice, this study will proceed through three bodies of research to identify existing theory that is relevant to an answer. In order to ensure a systematic review of the literature, I will begin with the most specific issue in the domain (how teachers use video-based commenting technology in their practice), and proceed towards broader theoretical literatures, including those of metacognition in the Learning Sciences and professional practice in Organizational Development. This definition of some of the properties of expert metacognition will help us to understand the kinds of ‘thought tools’ that evolve from long-term practice in technically, socially, and ecologically complex environments (Werstch, 1991). These ‘thought tools,’ a kind of metacognitive sub-routine, are a central part of the upcoming Grounded Theory, and a key tool employed by the study’s participants. Then, I will connect the idea of metacognitive reflection to the development of professional expertise through the specific professional quality known as deliberate practice. Deliberate, reflective practice has been a subject of study in the area of teacher education (Bronkhorst, Meijer, Koster, and Vermunt, 2011), but this paper will focus on common ways that professions draw on this strategy. These materials will provide the necessary language to describe and understand the coming theories and designs.

### **2.1 Video-based Teacher Education**

In the course of my research on the ATEP team, I began to ask questions about how participants used the video-based commenting systems to promote deliberate and

reflective practice in the candidates. As I developed the coding scheme above, I reviewed the growing body of practitioner-oriented literature on the use of video in teacher education. The production and use of video representations of practice have become a standard component of teacher education programs. As Sherin (2004) describes, video has become an endemic technology in Teacher Education from pre-service through professional development. She also enumerates some of the ways that teacher educators have employed these technologies to uncover unique possibilities afforded by practices built around the use of video as a pedagogical tool. She traces the evolution of these practices through the changes in teacher education pedagogy from microteaching to interaction analysis, the modeling of expert teaching, video-based cases, field recordings, and hypermedia.

Sherrin's overview of these technologies also discusses three of the core affordances provided by the use of video. These include the durability of video as a record of practice, the ability to collect and edit videos together, and the 'out-of-the-moment' discussions that video can facilitate in the professional development environment. The development of an individual's ability to use video records to inform their practice is also a key theme in research on the use of video-based reflection in teacher education. For example, Van Es and Sherin (2009) and Sherin, Linsenmeier, and Van Es (2009) note that to develop 'noticing' abilities, teachers must also be prepared to make connections between the specific examples they see and larger theoretical principles as well as to their own classrooms and social contexts. In considering the role of technology in this process, Rosaen, Lundeberg, Cooper, Fritzen, and Terpstra (2011)

observed that their teacher interns wrote more specific, instruction-oriented, and student-centered comments and reflections when they examined video representations of practice than when they tried to reflect from memory. Further, interns were able to use video-based reflection to “unpack” the complexities of their teaching practice in ways that were consistent with the important role of inductive and abductive reasoning to their noticings. This capacity for documentation and analysis between rounds of reflective practice is an essential quality of the *Odin* system, and one that was frequently cited by the Team Leads as a core support for their teaching in the ATEP Program. Rich and Hannafin (2009) extend this idea further, noting that asynchronous video annotation tools “make possible the documentation and support self-analysis using verifiable evidence as well as to examine changes in development over time (p.52).”

Hiebert, Morris, Berk, and Jansen (2007) believe that teachers must possess two core analytic competences in order to make use of video as a means of learning about their practice. The first competency is the individual teacher’s pool of pedagogical content knowledge. As one might imagine, a teacher cannot notice or critique a phenomena in a video if they do not have the ability to recognize the particular strategies of their discipline’s knowledge (similar to Whorf, 2012). Therefore, a teacher candidate with a novice level of pedagogical content knowledge might have difficulty relating phenomena if they cannot recognize and name it. Hiebert et al. also point to a need for a reflective framework of practices that they decompose into four skills: 1) the teacher’s willingness to set goals, 2) assess whether the goals are achieved during a lesson, 3) specify hypotheses for why the lesson did or did not work well, and 4) use hypotheses to

revise their lessons. While Hiebert et al. note that these analytic skills are rarely explicitly taught, they find that it is theoretically possible for novice teacher candidates to bring related analytic lenses with them to teaching from other fields and experiences (Sherin and van Es, 2003). As the study will examine in the Grounded Theory section of this project, the Teacher Candidates in the ATEP Program naturally made use of a similar set of reflective skills in ways that provide further evidence for Hiebert et al.'s competencies of teacher noticing.

In addition to the technological mediation of video, teachers form connections between their local sources of expertise and the available video evidence. Van Es (2009) notes that the social structure of video clubs may further mediate how teachers and coaches interact with evidence from practice. Van Es found that teachers' situative experience within a video club-style (Sherin, 2004) professional learning community influenced their expression and discussion style. Van Es performed an analysis of the professional vision exhibited by participants' in various roles in a face-to-face video club, and the different kinds of vision displayed by students as they took those roles. Some students became Proposers (who offer Judge-Observe-Prescribe-Reason type comments), Builders (who perform Tagging and Connecting functions), Critics (who Counter and Question), Blockers, and so forth. As the community evolved, Van Es describes the differences in the kinds of language used by the participants as they developed different roles in the club, and how these roles shape the kinds of dialog that were possible in the community. Van Es also notes that the development and ownership of a virtual community was itself a powerful mediating factor in the kinds of professional vision and

noticing that occurred in the community. As the group proceeded through the process of developing social norms and practices (Tuckman, 1965), the forms of expression and discourse changed and altered along with the roles of the participants. Thus, based on these studies, it may be possible to contend that video-based technologies and the communities that form around them have a profound effect on the content and structure of dialog and learning in ways that are qualitatively visible and non-trivial.

The technologically and socially mediated effects of video on professional practice are also visible in other elements of the literature on expertise. Since video is primarily associated with the concept of seeing (*videre* is Latin for *seeing*), an understanding of the concept of professional vision is essential in this examination of the utility of video-based teacher education. In the more cognition-oriented literature (NRC, 2000; Clark and Mayer, 2008; Darling-Hammond and Bransford, 2005), professional vision is ascribed to expert cognition, or the observable and reported mental processes associated with individual expert performers. However, the existing studies on the development of teacher's professional vision (e.g. Grossman, Compton, Igra, and Williamson, 2009) frequently cite Goodwin's (1994) formulation of professional vision. Goodwin develops his formulation of professional vision from observations of expert testimony during the O.J. Simpson trial in early the 1990s. In analyzing the discourses, he proposes that an expert's ability to notice particular features of a problem comes from an active ability to make observations (Coding), reason about those observations (Highlighting), and use discipline-specific discourse strategies (often graphical) to describe conclusions to others in their peripheral community (Lave and Wenger, 1991). Goodwin frames an

expert's ability to see (and the legitimacy of their 'vision') as an active component of engagement with their larger community of practice.

In adapting Goodwin's description of professional vision as a feature of teacher expertise and its training through video, Russ, Sherin, Colestock, Sherin, and Russ (2008) identify several domain-specific ways that teachers used video to augment their professional vision. In this study, the researchers equipped one participant in a video-club (a math teacher) with a wearable camera that attached to the participants' glasses or the bill of a hat. Then, the teacher used the camera to capture 30-second clips of his practice at his own discretion, whenever he observed a phenomenon of note. Over the course of three days, the teacher provided a variety of clips from the beginning, middle, and end of his lessons. These included whole group discussion, student group work, and student presentations to the class. The teacher offered five types of rationales for his selection of specific clips of phenomena, including 1) an example of student thinking, 2) the use of discourse, 3) teacher moves, 4) teacher strategies, and 5) student engagement. Russ et al. note that these five categories represent instances where the teacher's professional vision was 'hard at work,' indicating that the selection of moments in a video is an active enterprise that involves the application of a number of specific tools in the mind of the selector. The act of choosing clips arose from what the teacher saw in them. Though this study occurred in the context of an in-person video club, and with only one participant, it allows researchers to imagine the existence of domain-general aspects of these tools of professional vision. Further, it will provide opportunities to

imagine the possibility of software that promotes the use of deliberate and active selection processes based on structures in the teacher's mind.

## **2.2 Metacognitive Practices**

Metacognition is colloquially described as an individual's "thinking about their thinking," but this description does not begin to capture the significance or complexity and importance of the construct that is the subject of this section. Rather, this section will illustrate some of the ways that the human capacity for metacognition serves as a bridge between the individual's interior universe and their external environment. It is the constantly-resolving map of our internal knowledge onto our own ecologies and roles, and our evolving understanding of our places in those ecologies (as with Lave and Wenger). From this view, researchers may move to understand metacognition as it manifests in action; as a set of interlocking and interconnected processes that help us make sense of the world. This conception of the phenomena echoes early trends in the study of metacognition (as in Vygotsky, 1978), but also provides researchers with a new avenue for understanding the role of metacognition in professional expertise.

Following this logic, metacognition may serve as an important middle ground between the cognitive and situative components of professional expertise for three reasons. First, the predominantly linguistic nature of metacognition (Briñol and DeMarree, 2011; Son, Kornell, Finn, and Cantion, 2012; De Groot, 1965; Vygotsky and Kozulin, 1986) makes it possible to collect and analyze traces of professionals' thinking and attitudes, a feat that is not possible when analyzing other non-verbal components (e.g. 'gut feelings' in embodied cognition, Gladwell, 2007). Also, for the purposes of the study of the ATEP

program, it is important to note that Son et al. also indicate the possibility that individuals' memories of their metacognitive activity are not necessarily reliable or accurate without training. However, as Sherin noted, the use of video taken from practice can serve to bridge the gap between memory and reflection through the creation of a durable record.

Second, the research in the area has come to a broad consensus about the general features of metacognition, and the role it plays in expert performance. Due to the breadth of the research agendas represented in the area, it is possible to construct an elaborate taxonomy of metacognition (as in the excellent work of Tarricone, 2011) that provides a broad picture of the phenomenon. These constructs can be placed into a meaningful relationship for the purposes of analysis and study. The known constructs of metacognition appear to occupy an unusual place between the internal and external world, with a number of key conceptual overlaps between the known structures in the cognitive and situative research paradigms in education and psychology. As a result of metacognition's role in mapping between the world of the mind and the shared world, it is possible to imagine that a marginal increase in focus on training the relevant metacognitive skills of professionals might yield improvements in skills across other areas of the professional's learning ecology. This location between the internal and external world of the learner has caused some researchers in K-12 education to propose that metacognitive skills be integrated with disciplinary content across the curriculum and throughout the learner's lifetime (NRC, 2000).

Finally, metacognition will play a key role as a means of enabling this research to

understand how novice and expert professionals continue to connect their experiences in their performance environment with the ways of thinking that they develop in their learning environments (if those things are indeed separate). If metacognition is a mediating factor in the development of a number of core skills that professionals employ in the context of their practice, then a contemporary understanding of the phenomenon will help researchers and designers to understand and predict the expertise reification events and ‘bugs’ (Wenger, 1987; Wenger, 1998) that occur in the thought environment of professional individuals. Though there are as many as eleven possible forms of metacognition and social metacognition, this study will focus on the two that are crucial for understanding the use of VBOCS technologies in the ATEP context. These include the constructs of Reflection (a component of advanced deliberate practice) and Imagination (a crucial feature of reflection-in-action).

### **2.2.1 Reflection in Practice**

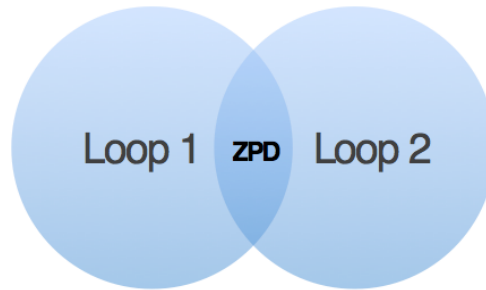
At the most theoretical level, the ATEP Program’s decisions surrounding the use of video-based reflection as a means of synthesizing knowledge shares thematic similarities with the work of Lee Shulman in teacher education. Shulman’s Model of Pedagogical Reasoning and Action (1987) places reflective practices at a key phase in the continuous process of learning, as a means of developing professional expertise. Through this model, Shulman provides a working definition for reflection as “what a teacher does when he or she looks back at the teaching and learning that has occurred, and reconstructs, reenacts, and/or recaptures the events, the emotions, and the accomplishments” (p.19). Shulman (1998) further contends that reflection (as a form of

*learning from experience*, p.519) is a necessary bridge between the “universal principles of theory and the narratives of lived practice” that characterize professional bodies of knowledge. However, Shulman’s implicit distinction between theory and practice brings forth two further questions: Whose theories are applied in practice, and how should practice be used to inform theory? These are complex and murky questions, and Shulman grapples with them throughout his work (e.g. 1986; 1987).

In order to extend this study from the teaching-specific questions asked by Shulman and towards a domain-general theory of reflective practice, this review will need to switch lenses to those of his contemporaries. The work of Chris Argyris in organizational psychology and K. Anders Ericsson in the field of cognitive science can help to develop more particular and operational descriptions of the reflective processes for the purposes of this study. Argyris (1997; Argyris, Putnam, Smith, 1965; Argyris and Schon, 1974) locates the importance of reflection in its role as a key component of the ‘double-loop learning’ cycles that characterize expert learning. In double-loop learning, professionals plan, act, analyze, and retry solutions in their environment using the constructed identity, knowledge tools, and practices available to them as part of their ‘theory of action.’ According to Argyris, the double-loop learning model can help teachers and learners understand and calibrate their behaviors relative to their desired outcomes, existing knowledge, role-identity, and available tools. Equally, a learner’s theory of action can be seen as a means of exerting control over and bracketing complex problems, another component of cognitive perspectives on expert behavior.

As Argyris notes, the specifics of the individual's theory of action can reveal information about the context of its creation. This is important, as the 'double-loop' feature of reflective learning requires learners to evaluate the underlying assumptions, strengths, and deficiencies in their environmentally situated theories of action in hopes of improving their performance between their initial effort and their future iterations of efforts. This construct is also supported by Schon (1983), who describes this process as 'reflection-in-action,' and "Research not *about* or *for* practice, but *in* practice." (Schon, 1988, p.19) While Shulman disagrees with Schon's dichotomy of technical rationality and reflection-in-action (Shulman, 1988), both scholars agree on the intrinsic value of reflection as a way of knowing about the world. In analyzing their assumptions, actions, and decisions for continued areas of improvement, Teacher Candidates in the ATEP context might learn to become autonomous and self-directed in their learning, a key element of professional disciplines (similar to Abbot, 1988).

If one imagines Argyris' double-loop learning cycle (1965; **Figure 8**) as a pair of overlapping sequences, then the area of union represents a potential zone of proximal development (ZPD; Vygotsky, 1978) for learners. In observing this quality of double-loop learning, the emergence a ZPD during the reflective period following practice may indicate an opportunity for the intercession of a coach or community in the form of a 'more-knowledgeable-other.' However, a ZPD, by definition, must exist in relationship to an entity or community that has the necessary local expertise (NSF, 2000) to recognize and alter learner behavior as they transition from Loop 1 to Loop 2 and iterations beyond.



**Figure 8:** Model of Professional Learning in Argyris and Vygotsky

Ericsson's model of deliberate practice (2006) provides the means, or techniques of practice, necessary to put Shulman's definition and Argyris' process to work in improving the reflective capacities of teachers. As Ericsson notes, optimal practice involves a balance of four variables: 1) the learner must focus on specific skill deficits; 2) the learner must receive explanatory feedback and active support; 3) the learner must practice in a sheltered practice environment; and 4) practice in ways that promote skill transfer from the practice environment to the performance environment. Deliberate practice applied over time has the capacity to help practitioners make decisions more quickly, more consistently, and with less strain on cognitive load and attention (Clark, 2008). As professionals continue to learn and solve problems more efficiently within their specific domain and context, they develop sophisticated cognitive strategies that allow for faster pattern recognition of relationships between important variables. Moreover, the proceduralization and 'chunking' of knowledge frees up the space in working memory through the development of automaticity (Clark and Mayer, 2008). Automaticity is visible as both a reified, cognitive, and neurological phenomenon that can develop in tandem with the growth of domain content knowledge. Thus, it is possible to understand how learners become more efficient in their strategy selection by

examining how they learn to construct strategic pathways in their mind through the use of deliberate practice. Following this logic, professional development systems may engage participants with a complex problem of practice, and train them to regulate their attention, emotions, and thought processes during the activity.

Deliberate, reflective practice is recast as a key component of expert behavior, as it promotes the growth and development of expert knowledge as it is used in an authentic performance environment. It is this form of metacognition that allows them to determine the relevant features of problems at hand (De Groot, 1965; Schoenfield, 1992; Cziksamiehy, 1999) so that they may begin to align the necessary resources to achieve their goals. In concluding this brief examination of the relationships of metacognition and professional learning, researchers may begin to see the opportunities provided by the thought tools present in the minds of the learners. In definition, process, and practice, metacognition provides teachers with the hope for continuous improvement and development that begins from within. In return, individuals must maintain a reflective stance supported by concerted, analytic, and regular adjustments to classroom performances. In exchange for this dedication, teachers may expect greater agency and control over the long-term development of their practice.

### **2.2.2 Imagination and Counterfactuals as a Form of Metacognition**

At the end of the individual's capacity for self-analysis, the individual's ability to posit "If" questions about the world becomes increasingly important. These questions may help to guide their thinking and actions in a number of ways that are essential to

managing and understanding the complexity of the knowledge domain, cross-domain connections, and the performance environment. Since the metaphors for these skills are predominantly associated with sight in the English language (“vision,” “seeing,” and “foresight,” as in Brann, 1991), this construct has been termed “Imagination.”

Researchers have observed the qualities of Imagination for decades, as in the work of Piaget and Vygotsky, but this work largely pertains to children. However, it is conceivable that the ability to render a vivid and naturalistic simulacrum of the performance environment in one’s mind and manipulate that model mentally is also essential to the performance of adult professional experts.

Imagination is not a frivolous concept; the evocation of new worlds and possible alternative states in our present world is serious business, and it has profound impacts on an individual’s understanding of both our internal and external worlds. For example, Leahy and Sweller (2005; 2008) find that the use of imaginative faculties in the brain’s neocortex and thalamus have direct consequences on the development of memory and usable knowledge in the expert’s mind, as well as on their ability to enact that knowledge in the world. Specifically, that the use of mental pre-visualization skills can improve recall functions by pre-priming the working memory and tapping existing automatic skills. Further, the ability to imagine alternative states is a skill that continues to grow across an individual’s lifespan (Torrens, Thompson, Cramer, 1999), and supports a number of other essential metacognitive processes. As Johnson (2007) notes, the manipulation of one’s mental model of the universe in the mind requires a strong capacity for self-reflection, affective control, an operational knowledge of problem solving strategy selection in the domain, and a knowledge of one’s own memory.

In understanding and cultivating the professional's capacity for Imagination, instructional designers and researchers may more effectively train their ability to control the complexity of their mental models of their performance environment, and integrate the various sources of information that the professional encounters. The cultivation of Imagination may serve as a means of helping learners control and interpret other elements of their multiple-entry, modular memory systems (MeMS, Johnson, 2007), including high-level executive functions. Imagination is also a necessary condition for creating, interpreting, and manipulating forces and actors in the larger socio-cultural ecology. Depending on the learner's knowledge of their environmental conditions and agency-driven goals, they may use multiple forms of cognitive, metacognitive, and social knowledge to imagine alternatives to the world as they see it.

The cognitive science and psychology literature describes three forms of Imagination (as synthesized from Byrne, 2005) that center on the deployment of one word: "If." In the first sense of the word, "If" connotes conditional inferences that enable the manipulation of mental representations in ways that are projected in parallel to the individual's existing worlds. This occurs when the individual attempts to imagine the outcomes, possibilities, and constraints that influence their ability to take action in their world (e.g. the active future "If I..." and the reflective past-tense "If I had..."). One can see this capacity when experts in professions begin to play-out their designs in the world, as when lawyers or doctors begin to plan a course of action. The second form, counter-factual Imagining, involves the conscious attempts on the part of a learner to posit alternate conditions to those observed in the shared-world of the real (Byrne, 2005). This occurs when an individual projects an "If" question that contradicts a known observation

in the shared-world, and includes activities such as thought experiments that suspend or amplify known constraints in the environment. Finally, Imagination skills are invoked whenever ritual or symbolic events are instantiated in an environment as a form of Social Imagination (Shwarte, 2009). The human social world exists in the collective imaginations of the participants that is constantly renewed, negotiated, and situated by a whirlwind of actors, institutions, and social forces (Holland, Lachiocotte, Skinner, Cain, 1998). Imagination thus plays a crucial role in professionals' ability to develop and consider multiple courses of action without risking their clients' safety.

## **2.3 Metacognition in the Professions**

*The situations of practice are inherently unstable...As the tasks change, so will the demands for usable knowledge, and the patterns of task and knowledge are inherently unstable.*

-Schon (1983, p.10)

Returning to the role of metacognition in the thinking of individuals in professions, we may begin to see some of the opportunities inherent in the integration of metacognitive activities into professional practice. In *The Reflective Practitioner*, Donald Schon (1983) begins his exploration of the particular properties of professional expertise by declaring that the professions are in crisis, and require a change in practices and conception. In the first chapter of the book, Schon identifies this crisis as stemming from a disconnect between the fields of practice and the formal learning environments designed to produce professionals. Schon characterized this disconnect as a 'crisis of confidence' in the long-standing machinery of professional education, and sought to investigate how practitioners engage with complex decisions and unknown variables in their work. Compared to early researchers in the area of professional practice and expertise

(specifically Time-and-Motion studies by Taylor, 1909), Schon was ahead of his time in critiquing the rigidly centralized, technocratic control of professional knowledge that are still at play in most professions. Further, Schon's writings since the 1980s have criticized the artificial distinctions between theory and practice that are still a core part of Law, Architecture, and Education.

In advocating for the removal of the artificial divisions between the world of professional practice and the world of ideas and research, Schon was able to create a compelling vision for a new relationship of professional thought and practice. However, while Schon was correct about the existence of a crisis, the scope, scale, and true origins of this crisis could not have been apparent to him at the time of *The Reflective Practitioner's* writing. Nearly 30 years later, we have seen a widening of the disconnect between the modes of creation of professional expertise in schools and universities, and the roles that professionals must play in their work context. The current structures created to support the continued education of professionals are misaligned with the needs imposed by the instability of practice described by Schon.

Professional experts are also unique in that they engage in *practice* at multiple levels, each with shifting challenges. In the first sense of the word, professional practice refers to the act of rendering services to clients in ways that are legally proscribed and in accordance with the norms of a professional community (Abbott, 1988). This aspect of practice is referenced when a legally-binding event occurs, and when individual practitioners are required to put their name, reputation, and professional standing on the

line as collateral (as when the individual's imprimatur – a stamp, a signature, a report card, or prescription pad – are employed). This quality of practice is commonly referenced, but it contains two important ideas that will inform our future discussions. First, the parameters of this feature of practice occur in the context of a community that establishes rules and norms (as in Wenger, 1998). Thus, the identifiable expertise that results from this practice is necessarily bounded by the social constructs developed over the historical development of the discipline. This is similar to the 'fossilized artifacts of culture' described in Vygotsky's socio-historical and developmental theories (1978). Second, this definition reinforces the importance of the idea that professionals are the source of their own means of production (Freidson, 2001). In operating an institutionally approved practice with appropriate licensure, they are administering a therapy directly to a client (Argyris, 1965), regardless of the location of that practice. Thus, professionals like accountants, lawyers, teachers, and doctors are found in all parts of the economy, from the private sector corporations to the public sector.

In the second use of the word, practice can also take on its more common meaning (similar to Shulman, 1998): repeated attempts at completing tasks in uncertain conditions, undertaken over a long period. This definition of practice is non-trivial for three reasons. First, it establishes the idea that individuals must continually apply and test their theories-of-action on their performance environment. This would imply that professional practice grows and changes over time as new experiences and environmental challenges emerge. Second, it is possible to see the specialization of skills that professionals exhibit as a result of repeated trials in known and unknown conditions.

This specialization could be seen as a tangible result of the interplay of the influences of the first meaning of practice (the social and institutional environment) on the second (the behaviors of the individual).

## **2.4 Professional Expertise**

But why might researchers choose to study *professional* expertise and practice? While some researchers have chosen to study the development of domain expertise in children (Chi & Koeske, 1983; Gobbo & Chi, 1986), the University of Washington Learning in Informal and Formal Environments (LIFE) Center notes that an individual's learning continues for a lifetime. Professionals may be of interest to researchers in Education because they are atypical learners in unusual circumstances; they are learners who spend decades engaged in deliberate, complex, and concerted learning in practice. In much the same way that education researchers have enriched the field and provided new possibilities for change by studying the lives of low-income and low-skill workers (e.g. Rose, 2005), researchers may look to the other end of the spectrum of knowledge to see new opportunities in the exceptional and sustained performance of professional learners.

In Ericsson, Perez, Eccles, Lang, Baker, Bransford, Vanlehn, and Ward (2009), the authors note that expert performers 'exhibit superior performance on tasks that capture the essence of expertise in the critical domain' (p.7). The authors reason that the study of these professional experts can help to reveal new knowledge about human learning through an understanding of the ways that professionals deal with novel domain tasks in naturally occurring activity. As they note, the expert performance approach to learning

and support specifically identifies ‘mechanisms’ that mediate superior performance, and has been successfully applied in professional development across a number of domains. Ericsson et al. note that studies in professional expertise across domains have found that specific kinds of reflective practices (achieved during solo periods of deliberate practice) were strongly associated with the growth of expertise in the domain. The mechanisms at the heart of reflective practices, like those noted earlier in this chapter and found in the ATEP context, can thus be identified through a close analysis of user-generated metacognitive products.

## **Chapter 3: Building the Grounded Theory**

At heart, this study represents an exploration of the interaction of metacognitive ‘thought tools’ that growing professionals employ in analysis of their practice within a novel form of mediating technology environment (the VBOCS system). But how might this study make explicit the kinds of implicit mental tools that the participants used, and how would a researcher know if they have identified a potential avenue for sharpening those tools through deliberate practice? To answer these questions, I propose to produce a Grounded Theory of Noticings that names and describes various thought tools employed by professionals while watching video of practice, and reified to others through the VBOCS system. In naming and measuring these employed thought tools, this study will make generalizations about differences in the ways that the experts in the ATEP program community ‘notice’ key features of professional practice in their domain. In building this theory, I will integrate my observations and findings into the design of a software platform that scaffolds professional learners as they grow in their capacity to reason about practice.

Drawing from my experience as a participant observer in the program, I will now propose the use of Grounded Theory (Glaser and Strauss, 1967) to explore the relationship of the practical and theoretical lessons learned from the implementation of the program’s instructional technology armature. Grounded Theory is appropriate for this project, as the phenomena under observation occur in a variety of venues (formal and informal) and across several media (visual, audial, and textual). In particular, Glaser’s idea that “All is Data” allows for the use of multiple sources of evidence and

methods of analysis to create meaning and theory from closely examined data. This perspective allows theory to emerge from the artifacts, participant observation, interactions, and discussions that were produced in a particular socio-historical context. In many ways, the cycles of investigation and theory development that occur in Grounded Theory are ideal for the study of participants' uses of technology in authentic contexts. Technological tools are deeply bound to local actors, social structures, and resources (Baran and Cagiltay, 2010), and Grounded Theory's techniques of thematic analysis (Glesne, 2011) can help to identify recurring trends in interactions and tool use.

The use of the Grounded Theory approach to data analysis also serves four larger purposes. First, Grounded Theory provides a framework for the analysis of learners' thinking as they interact with the digital artifacts and technologies in their learning-performance environment. The close analysis of the effects of media on the language used to describe their practice will help instructional designers to determine future uses for the technology. Second, Grounded Theory's generative approach to the development of a flexible and evolving theory was useful in maintaining an open stance towards alternative and conflicting explanations of phenomenon. Third, the Grounded Theory of Noticings developed in this study provides a new set of lenses, tools, and language for describing how novices and experts make meaning of their practice through the analysis of learner-generated videos through their video comments. These evolving theoretical tools provide generative opportunities for future testing and development.

Finally, at the field-level, I have chosen Grounded Theory as the primary mode of investigation because the methodology enables us to address a prevailing problem in the world of education technology. Instructional systems designers in the field often fail to consider their clients' cognitive, social, and technological needs when creating professional development systems. Thus, instructionally designed tools are rarely as effective or supportive as professional clients' needs warrant. For this reason, this study has a meta-goal of assessing the utility of Grounded Theory as a means of generating design principles for instructional technologies from the close study of participant behavior. While this study will not be the first to use a Grounded Theory to re-envision a technology (Rogers, 2012), it is a process that is poorly detailed in the larger literature. In selecting this method of analysis, I plan to decompose the participant behavior into basic tools of thought, and provide a means of integrating the support of these cognitive phenomena into a technological platform.

After examining the main components of the Theory of Noticings and elaborated on its nature, this study will test the ecological validity of the Theory and method through an analysis of the Relevance, Fit, Workability, and Modifiability (as specified by Glaser and Strauss, 1967). These qualities will be assessed through 1) the potential for using this scheme to augment the practice of professionals in context, 2) the creation of a statistical model based on the coding schemes, 3) the development of several strategies to actively support the Theory of Noticings through a software interface, and 4) the potential for modifying the Theory to suit other professional contexts. The elaboration of this process will also serve as a starting point for other members of the educational

technology and instructional design community as they endeavor to develop more effective tools that use principles of learning theory to augment learning experiences. In deriving designs that reconcile naturalistic participant behavior with theoretical models of learning, these new tools will serve the professional development goals of the end-user.

### **3.1 Data Collection**

This study will draw select evidence from the project's substantial corpus of data collected from the first cohort of the program (2011-2012). From May of 2011 through June of 2012, the project recorded more than two hundred hours of video from weekly professional learning community meetings, collected more than 80 participant-generated videos, and conducted numerous interviews and observations of program participants. The project also collected samples of Candidates' lesson plans and student artifacts, as well as written responses and 'workfolios' that were produced in anticipation of the TPA exam.

In assembling a subset of the data for this study, I collected video-based comment threads directly from the VBOCS site, applied pseudonyms for each participant, and uploaded the documents to an online Computer-Aided Qualitative Data Analysis Software (CAQDAS; Glesne, 2011). Our purpose in delimiting the data to this source is to provide a narrow-band focus on the commenting practices of the learning community, as these bear traces of the qualities of the participants' expertise. While the number of participants in the system is small (N=20), this study draws from a total of 61 video-

comment threads. This includes a total of 894 individual comments, spread across the four content areas and across the Team Leads and novice teachers.

The CAQDAS software (known commercially as *Dedoose*) helped to manage the complex task of indexing these relationships, and had a substantial influence on my ability to ask specific questions about the relationships that emerged from the coding process. The use of a computer system to augment the Grounded Theory development process provides substantial new opportunities for identifying and validating findings in the data. The producers of the Dedoose software explicitly designed the system logic to scaffold the processes of Grounded Theory (including audit trails, memos, and multi-level tagging hierarchies). For that reason, I found the software indispensable in maintaining good analytic habits and consistency throughout the research, providing accurate frequency counts for code occurrence and co-occurrence by participants and groups, and managing the document workflow associated with the coding processes. The dataset itself became a key artifact in this study, as an interactive representation of the hyperindexed meanings of the participants' discussions.

The software influenced my analysis process in three core ways. First, CAQDAS systems easily support recursive rounds of coding over an extended chronological period. The system maintains a close link between the evolving definitions of codes through the use of metadata, and allowed me to revise and change these definitions as more instances of a phenomenon became apparent. Second, the ability to hyperlink specific documents to virtual memos during the analysis process allowed me to keep a

strong audit trail of the theory development. As my definitions and ideas changed, I recorded these changes in my memos and hyperlinked them back to the source documents. Finally, the CAQDAS system's use of code 'tags' allowed me to keep a close count of the occurrence of phenomena in the comment threads. This allowed for the close connection of the theory to evidence over time, and allowed me to ask some of the more specific questions presented during the validity tests. It is to this coding process that will take focus, as it is an essential part of this study's methodology.

### 3.2 Coding Process



In accordance with the theory development methodologies associated with Grounded Theory, this study will examine the user-generated comments from the participants in the ATEP program by following a four-phase process. In the first phase, I organized the sampled data in the online CAQDAS platform. I then tagged the data with a series of 'Base' Codes. The second phase involved the process of Open Coding. In this phase, I used a broad lens to identify many recurring tropes in the data, and to try to discern several types of thinking that occurred in the participants' ecology. The identification of these factors is predicated on the idea that the participant's understanding of the affordances, limitations, and theorizations of tools (digital and non-digital) directly influences the products that they create (as in the relationship between media and messages, McLuhan, 2008 and thought and tools in Vygotsky, 1978).

In the Axial phase of the coding process, I consolidated and pruned the coding structure to exclude coding structures that did not contribute to the emerging theory. This process had the effect of narrowing the study's focus from 24 individual codes down to eight stronger codes that illustrated the beginnings of a theoretical relationship. Finally, in the Thematic phase, the codes were consolidated further around three theoretical poles: Literal, Inferential, and Critical. In naming these larger structures of commenting activity, I was able to generate a testable theory of their relationship that provides a lodestar for the development of future technologies that support the process of video-based reflective commenting. Now that I have outlined brief overview of the process, I will proceed through each phase in order to better understand the construction and rationale for the theory.

### **3.2.1 Base Coding**

In the first phase of coding, I tagged each video comment with a series of 'Base Codes' and descriptors. Base Codes provide important factual information (Content Area, Commenter Name, etc.) associated with the selected artifacts, and serve as controller/delimiter tags for data management and visualization. In starting from this process and maintaining rigorous accuracy in base codes across the analysis, I was able to take advantage of the software's ability to rapidly count all of the links between given codes. This meant that I could use the system to rapidly answer many of my questions about the specifics of participant activity using a form of Boolean logic. This made possible much of the statistical analysis that comes in the validity tests, and also made it possible to ask deeper and more complex questions about the relationships between what

each actor's thinking. Further, the creation of Base codes and their incorporation into the system is crucial to maintaining a strong relationship between the single instances of individual behavior and larger, aggregated instances of group trends. This is essential for the development of a strong, flexible Grounded Theory across the other coding phases.

### **3.2.2 Open Coding**

The second phase involved the process of Open Coding. During this phase, I attempted to discern the underlying tools in play in the composition of the video comments.

However, from early on, my lack of experience with the terminology and features of the Teacher Education domain caused me some difficulty. Beyond my previous role as Technology Steward in a Teacher Induction program at the university, my own practical work occurred mostly in the world of corporate education. And while Instructional Design has a dialect of its own, the words used in the teaching of expert adults can often differ substantively for those in the fields of K-12 education.

In October of 2011, I came to the realization that I knew little about the nature of the first-person concerns of teachers in practice, and the coaches who help them. This humbling realization brought forth two insights about my research activity that would later inform the coding process. First, I realized that in order to serve my community most effectively in my participant role as technology steward, I would have to learn more about the participants' concerns, goals, and philosophies from a phenomenological perspective. Second, I realized that I would need to interact with the participants on a routine basis in a variety of settings to better understand the kinds of things that were

important to them. Over the course of my interactions with the participants in the program, I was able to develop a familiarity with the vocabulary, values, and practices shared by the Team Leads and their novice teachers. In working with the Team Leads, I was fortunate to have access to resources, books, and anecdotes about teaching that most directly influenced their research and thinking. These resources would become invaluable to my understanding of the thinking of the experts in the community, and for giving names to phenomena. In changing the video cameras in the classrooms, I also had opportunities to watch teaching rehearsals, discussions, and work sessions involving the novice teachers, and to hear some of their thinking. It was in these casual observations that I began to find a language to describe the phenomena, and to use it to identify the features of the video comments.

The codes generated during this phase began with relatively naïve forms and evolved into more specific forms as I added comment threads to my pool of data. As I spent hours coding comments in the CAQDAS system, I asked myself again and again: What were these participants trying to communicate to one another through these comments? It was in this way that, over time and through thought, the generalities of “Trying Something Differently” and “Content Discussion” gave way to codes that represented the deeper, underlying kinds of thinking that the participants were representing in their comment writing. It was when I reviewed the IIC video paper described earlier in this study that I began to see more elegant tools of thought in action. The complete results of the Open Coding are enumerated in **Table 3** below, in the event that they may inform some future researchers’ interests in other kinds of observed constructs:

Teacher Behavior
Student Behavior
Specific Student
Student Thinking
Suggestions for Improvement
Pressing
What Works
Acknowledgement of Error
Talk and Discourse Moves
Specific Pedagogical Strategy
Content Discussion
School Environment
Trying Something Differently
Student Need
Evidence, Priming Questions
Future Discussion
Wonder
Wow
Request for Help
Discussion Norming
Values
Success
Unsuccess
References to Camera Position

**Table 3:** Results from the Open-Coding Phase

### 3.2.3 Axial Coding

In narrowing the coding scheme to a more specific band of interests, I selected the eight strongest codes based on their count in the database of codes. While count was not my only consideration, it provided a valuable way to understand the frequency of specific kinds of thoughts represented by the participants, and the symbolic relationship between frequency and thought tool instantiation. In order to clarify the meaning and nature of these selected constructs, I have provided definitions and examples of ‘pure forms’ (comments that contain the phenomenon of interest and few other relevant open codes). This created a series of strong constructs that may be placed into apposition to illustrate

a theoretical relationship. The codes are arranged from lowest-inference to highest-inference, where ‘Noticing Teacher Behavior’ is the most literal of the codes and ‘Pressing’ is the most abstract or critical.

### **Noticing Teacher Behavior**

**Definition:** An observation of a teacher’s speech, actions, or pedagogical choices, as exemplified in specific instances

#### **Example**

*Here I am providing another strategy - looking for synonyms.*

– CR, Secondary Humanities Candidate, February 2012

In this instance, the novice Humanities teacher makes a comment related to her own practice about the specific strategy that she used in the video. In addition to simply noticing and recalling her past behavior (*providing another strategy*), she gives this behavior a name (*looking for synonyms*) that came from discussions in the PLC. Nearly half of the total comments in the system contain a Noticing of Teacher Behavior, as it is a core source of evidence for other kinds of claims about causal event chains.

### **Noticing Student Behavior**

**Definition:** An observation of a student’s visible behavior, including their speech, writing, or interactions with one another.

#### **Example:**

*Here G- is able to identify P-s' idea of a utopia as Hawaii, because of the setting (sunny beaches, volcanoes), and the culture of the people.*

– CB, Secondary Humanities Candidate, March 2012

The ability to observe the activities of participants and give a factual account of their behaviors is a key part of the basic skills of an expert's practice. This is because professionals must be able to fluidly use their capacity to classify events or objects to identify patterns in the broader world. The Noticing Student Behavior code was applied when teachers made observations of students' activity in a general way. In this example from Secondary Humanities, CB delivers a factual account of the interaction of two students and how they created a source of common meaning.

### **References to Specific Student**

**Definition:** An observation that contains a specific reference to a student in the classroom, either in the context of a description of a lesson, or as a representation of a specific instance of a larger phenomenon.

### **Example:**

*H-'s bio: Academically, H- is high in the mathematics. He does not receive ELL or Special Education assistance. After watching the interview video and after conversing with him it is clear that H- only understands the procedural steps of computation. Similar to J-, another student in my class, H- will benefit from visual demonstration (arrays) and explanation of why breaking numbers into smaller numbers and multiplying works.*

– EG, Elementary Candidate, March 2012

Since every student in a classroom has a unique character, knowledge, and background, References to Specific Students are a key tool for representing the practitioner's implicit knowledge of the minds in their environment. In codifying this knowledge into a written comment, the novice teacher has an opportunity to form these ideas into patterns using the domain language that they have acquired from other teachers and in the PLC. In this assignment, EG was asked to perform a cognitive interview with one of his students, and

submit the video to the online system with observations and brief biographies of the students. In this comment, the teacher is using the distance of the video to diagnose the student in a more clinical fashion by drawing on his knowledge of the student's background. Further, the teacher compares H- to J-, a different student who exhibits similar behavior, generalizing the observation to larger trends in his local environment.

### **Talk and Discourse Moves**

**Definition:** Calling attention to specific instances of a known talk or discourse move.

Also includes a domain-specific sub-construct called '*Specific Pedagogical Strategies*,' where teachers and coaches note and name instances of teaching-craft.

### **Example**

*that's a teacher move to sit down while talking to students*

-MR, Secondary Math Candidate, October 2011

In this simple example, MR makes specific reference to a 'teacher talk move,' a type of discourse strategy that allows teachers to elicit specific kinds of responses from their students. MR calls out this talk move in the ocean of interactions occurring in another teacher's video. In a dramaturgical sense, the calling out of a Talk and Discourse Move in a video is similar to 'breaking the fourth wall' in theater. These structures make the explicit the implicit and shared social protocols of the teachers' world of practice (typically invisible, but felt, by clients). This knowledge of the critical dialogic and interactive feature of teaching students is related to the commenter's knowledge of domain-specific content terminology, as they must be able to identify and name the behavior seen in the video in order to recognize it.

## **Inferences About Student Thinking**

**Definition:** An inference about students' internal mental models, their emotional states, or their needs/desires based on an observation or past experience.

### **Example:**

*I think that knowing that perimeter is one of the things they need to understand helped more of my students access the problem so that they could say the next part of the problem is area. Thus far in class perimeter has gone hand in hand with area. I'm not sure if their guesses of area have to do with an inherent understanding of area and what it means in this problem or if their guess of area is more of a prior knowledge application of if we're talking perimeter we're going to talk about area.*

– AJ, Elementary Teacher Candidate, January 2012

In this comment, AJ uses his knowledge of the meaning of the domain content to make sense of how students are processing the new concepts in the classroom. In reviewing the video and making this comment, AJ is puzzling out the relationships between the sequence of instructional practices and its influence on student thinking. He considers the way that his instruction has related area and perimeter, and the way that students have come to link these processes in their mind. AJ also attempts to build a justification for why his inference might be an accurate interpretation of the student thinking that transpires in the video. It leaves open the possibility that students might be responding for alternative reasons (e.g. a prior knowledge of the relationships of area and perimeter). The video serves as a memory prompt for post-hoc deciphering of inferences about student thinking, and as a means of drawing participant attention to the evidence that supports. However, one thing that is unclear in this form of inference is whether the instructional sequence was successful or not, a factor examined in the next code.

## **What Worked**

**Definition:** A teacher's behavioral routine or choice that resulted in what they perceive as a positive outcome for replication in the future.

### **Example**

*N- was very different from F-. She has a strong conceptual understanding of division and was able to demonstrate that in her word problem. The problem she had was solving the division problem. She is the reason why I decided to show students the connection between multiplication and division because it would allow her to see division as a form of a multiplication problem.*

– JL, Elementary Teacher Candidate, March 2012

In a What Works code, teachers identify successful features of their practice in ways that require a combined inference about their performance in the video with a judgment about the effectiveness of the behavior. This process is important, as the observation of satisfactory behavior may reinforce that behavior in the long term. However, the What Works form of commenting does not push the candidate to put forward specific and actionable future changes to performance, a crucial part of the double-loop learning cycles described by Argyris. In this comment from JL, the teacher reflects on her recorded discussions with students about their thinking. In assessing the effectiveness of her strategy as sufficient, JL does not leave an opportunity for potential suggestions for alternative strategies, resulting in the truncation of the double-loop learning process.

## **Suggestions for Improvement**

**Definition:** A specific recommendation for future performance changes when phrased as an assertion that posits a counter-factual state. Suggestions for Improvement are known to be a reliable hallmark of expert thinking in other contexts.

## Example

*In retrospect, I could have had the group I spent so much time with share what we talked about regarding how the graph stretches.*

- CR, Secondary Math Teacher, October 2011

In this simplified form of the Suggestions for Improvement code, the teacher explicitly forms their thought around the idea of retrospection. In reviewing her past behavior ('spending so much time' with a group), she posits a counterfactual wherein she would instead choose to have that group share its knowledge with the class. This pattern of dialog provides two forms of evidence that might inform the teacher's double-loop learning cycle. First, it identifies and describes a particular sequence of moments in the video (when the teacher is working with the group), identifying the past behavior that was somehow unsatisfactory or requires changes for other reasons. This is essential at the conclusion of the first loop. Second, the teacher has connected their sub-optimal past performance with an alternative strategy that they have seen, heard of, read about, or otherwise encountered at some point (or perhaps invented). This forms a crucial part of the ZPD in the start of the second loop, as the teacher implicitly considers alternative courses of action in the future. However, in the comment from CR, the teacher stops short of phrasing the Suggestion for Improvement as a form of future potential action. Rather, it is a counterfactual comment that stops short of the critical part of the second loop in the learning cycle.

It is possible that a commenter's tendency to stop before the critical phase of the second loop has something to do with differences inherent in individual reflection and collaborative reflection. In their review of 63 studies on video-based reflective teaching

practices, Tripp and Rich (2012) note that several studies found teachers benefitted from a blend of individual and collaborative commenting activity. However, it may be that, in commenting on the video of another person, the collaborative commenter's role as the more-knowledgeable-other in the activity allows them to call attention to features of practice that require remediation in the future. A comment by JL provides further evidence for this idea:

*I feel a little unclear about the transition from your personal story to the "when we read" portion. I think it would also be really great if all of us could do some lesson plan rehearsal! During your story I saw that you referred to your notes quite a bit and I think it would feel more natural if you could deliver it without the notes.*

– JL, Elementary Teacher Candidate, November 2012

In commenting on the video of a peer teacher, JL makes several specific recommendations for future improvements and practice activities, beginning with a reference to specific phenomena in the video (the transition from personal story to reading activities). These suggestions also include the simple directive to try delivering the lesson without notes, but also provide evidence of a push towards autonomous collaborative activity (the collective lesson plan rehearsals). In comparing this structure to the socially-instantiated *Pressing* code, the next code provides evidence for the idea that learners can traverse the first phase of the double-loop by themselves, but benefit from the vision of others in venturing into the second loop.

## **Pressing**

**Definition:** A specific recommendation for future performance changes in question form (also known colloquially in the ATEP context as a 'wonder') that is phrased as an

interrogative. This phrasing can subtly suggest areas for the participant to focus on in their discussions and thinking without raising threat alarms.

### **Example**

*This is a great question from one of your students! It's thought-provoking at gets at the heart of what you're working on mathematically. I'm wondering about asking him what he would do instead of giving him the explanation that you do...if students are engaged and asking questions about the math ideas, then a nice teacher move is to direct the question back to them. To say, "Hmmm that's interesting, what would you do in that case and why would you do that?" You'd be able to see what he really does/doesn't understand about factoring. You're pressing him on the mathematical reasoning and justification. What are your thoughts about this?*

– Elementary Team Lead 2, October 2011

In the final code in the Axial sequence, I have selected an instance of discourse that directly relates to the nature of the reflective learning sequence. Pressings occur when a commenter uses a suggestion for improvement that is couched as a question, and is most frequently observed in expert comments. In this comment, the Lead notices student behavior (the question from the student), notices the teacher's response to the behavior (the explanation given), and suggests a future course of action (turning the question back around), and models the counterfactual scenario. They then conclude with the question ("What are your thoughts about this?") that invites the original video poster to respond to this as an idea, facilitating further construction of knowledge through the articulation of how the strategy would (or would not) serve the poster's context. Later parts of this study will explore the role of the Pressing comments in the Thematic analysis, as it is one of the advanced form of interactive commenting that will guide our selection of thematic criteria in the next phase of coding. In concluding the axial phase of the Grounded Theory analysis, I have summarized the remaining definitions and codes into

**Table 4** for quick reference, as they will be important throughout the coming cycles of synthesis and design.

Code	Working Definition
<b>Noticing Teacher Behavior</b>	An observation of a teacher’s speech, actions, or pedagogical choices, as exemplified in specific instances.
<b>Noticing Student Behavior</b>	An observation of a student’s visible behavior, including their speech, writing, or interactions with one another.
<b>References to Specific Student</b>	An observation that contains a specific reference to a student in the classroom, either in the context of a description of a lesson, or as a representation of a specific instance of a larger phenomenon.
<b>Talk and Discourse Moves</b>	Calling attention to specific instances of a known talk or discourse move. Also includes a domain-specific sub-construct called ‘ <b>Specific Pedagogical Strategies</b> ,’ where teachers and coaches note and name instances of teaching-craft.
<b>Inference About Student Thinking</b>	An inference about students’ internal mental models, their emotional states, or their needs/desires based on an observation or past experience.
<b>What Worked</b>	A teacher’s behavioral routine or choice that resulted in what they perceive as a positive outcome (also known as a ‘Wow’)
<b>Suggestions for Improvement</b>	A specific recommendation for future performance changes when phrased as an assertion that posits a counter-factual state. Suggestions for Improvement are known to be a reliable hallmark of expert thinking in other contexts.
<b>Pressing</b>	A specific recommendation for future performance changes in question form (also known as a ‘wonder’) that is phrased as an interrogative. This phrasing can subtly suggest areas for the participant to focus on in their discussions and thinking without raising threat alarms.

**Table 4:** Consistent and visible discourse phenomena

### 3.2.4 Cast-Off Codes

As I proceeded from the axial to thematic rounds of coding, I found that several other kinds of structures existed in the VBOCS system were too weak (in terms of code-count and theoretical relevance) to include in the final theory, but strong enough that future researchers may see them as valuable in some way in other contexts. For this reason, I have included **Table 5**, containing the codes and the working definitions that I constructed before abandoning the codes.

<b>Cast-Off Code</b>	<b>Working Definition</b>
<b>Request for Help</b>	In these cases, commenters identify a particular problem of practice in their video and ask the community for help. This occurred in only a few specific interests, and may indicate a feeling of team ‘safety’ and the developmental stages of the commenter.
<b>Discussion Norming</b>	A meta-comment on the discussion itself, calling attention to the constructed nature of the dialog. This occurred mostly in relation to the formal assignments.
<b>Expression of Values</b>	A comment that involves the expression of particular shared values that originate from the level of the professional community. Values are a central concern of the community, and other researchers may find deeper structures.
<b>Environmental Observations</b>	A comment about the room, school, or environmental layout of the performance environment captured in the video. These occurred mostly in early comments, when Team Leads provided feedback on room layouts.
<b>Content Discussion</b>	A discussion about domain-specific content, central to development of other kinds of professional skills.

<b>Specific Pedagogical Strategies</b>	The naming or description of a particular form of teaching practice, and an attendant justification or description of the rationale for the use of the strategy. These occurred frequently, but were too specific to generalize to other domains.
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**Table 5:** Cast-off codes from the Axial Phase

In general, these codes center on the more specific teacher education activities that were core to the interest of the professionals under study, but are not of interest to this study’s broader theory about professional activity. For this reason, I have excised the codes from the theory in order to develop a thematic construct that applies more broadly to the world of professional expertise in the context of VBOCS technology environment.

### **3.2.5 Thematic Coding and the Grounded Theory of Complete Noticings**

After I compiled the codes into the subsets above, I began to consider the existential nature of these codes. While the literature has much to say on the matter of how noticings are made, how might researchers characterize their nature as psycho-social constructs and artifacts? Did they exist only within the tagged documents in my dataset, or did they represent some authentic operation or syntax in the mind of the participants? And how did they know to do things this way? In considering the construction of theoretical relationships between these observed and recurrent structures, I wondered to myself: “A Grounded Theory of what, exactly?”

It was only after constructing the model that I fully understood that the codes that I identified in the VBOCS comments made by the candidates represented a form of metacognitive sub-routine, or ‘thought tool.’ As in Kersting, Givvin, Sotelo, and Stigler (2010), it may be argued that more expert participants in the community will have routinized dialogic processes to a more fluid degree after years of discussing their practice with other members of their larger community of practice. Equally, novices will need to learn to use these tools to communicate with others in their community about matters of practice. They are the ‘tools of thought’ described by Vygotsky, and tools of the trade that are valuable in any professional context where recursive thought and reflective practice are necessary.

In calling back to the literature review, I had encountered the concept of ‘noticings’ many times in my interactions with Team Leads, and I believe that this ‘concept-in-use’ (something the participants use to frame their work) may be reconceived as a ‘concept-in-theory’ (a codified set of theoretical parameters). This will allow the study to define the concept of a ‘noticing’ in terms of the interactions of discrete mental constructs that emerge in the context of community activity. They are recognizable (but instantially unique) modes of verbally-constructed mental scripts that are co-evolved by participants in the professional learning community in response to their learning and performance environment. This reframing of ‘codes’ into ‘thought tools’ allows us to generalize the phenomenon from the context of the ATEP program to the larger world of professional learning, as I believe that there is a strong argument to be made for the existence of these thought tools in other professional contexts.

In transitioning the coding scheme to the higher levels of theory, this study will need a language to describe the generic roles of any hypothetical type of professional learner in a professional learning community. In moving from the domain-scale of the axial codes (where codes indexed specific instances of teacher behavior) to the general world of professional learning, this study will need a way to generically describe analogous forms in other knowledge domains. To advance the coding from one specific professional domain to the level of all professional domains, I combined two sources of tools. The first, Actor Network Theory (ANT; LaTour, 1996; 2007) from the field of Sociology, provides a way to describe the transactional relationships that occur in professional learning communities. However, this required a second language drawn from work in the sociology of the professions (Abbot, 1988) to provide a name for the roles that occur in facilitating these transactions. The resultant meaning system for describing the activities of a professional learning community is visualized in **Figure 9** (note that any one human actor may occupy one or more of these roles at a time).



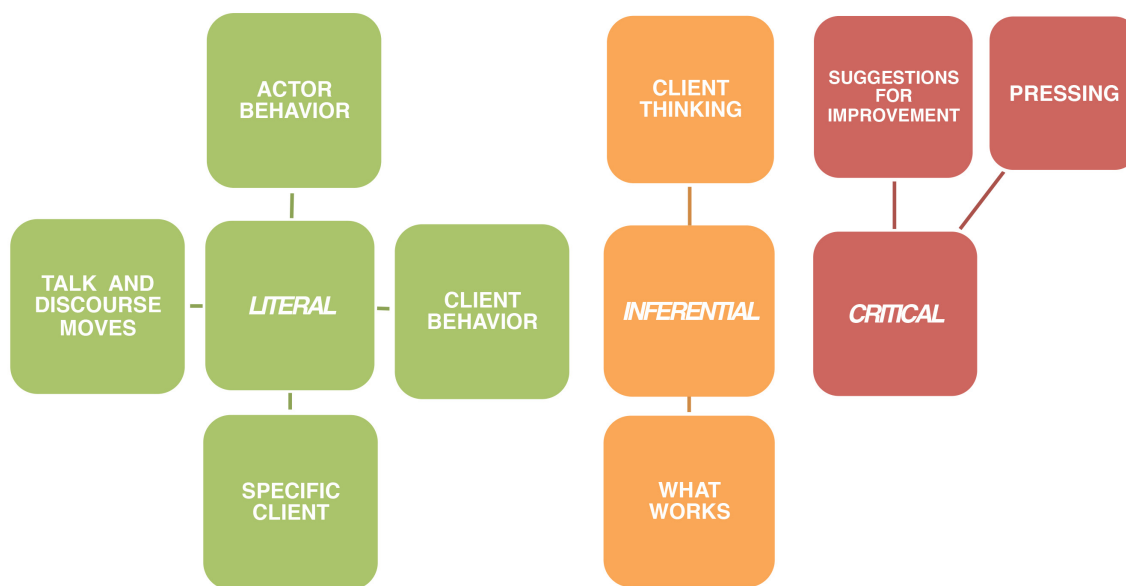
**Figure 9:** Relevant Roles in Professional Learning Communities

In this language and from this great height, I may now describe the function of the person in the video not as ‘teacher,’ but as ‘actor.’ They are the person whose actions catalyze a response from a ‘Coach,’ or someone who has the power to focus attention on specific moments and diagnose performances, or a peer Commenter. Actors can also serve as their own Commenters by providing comments on their own performance, and coaches may also come from peer or expert groups. These Actor-Coach transactions are facilitated in specific ways by ‘Actant’ systems, or sets of interrelated tools, resources, and work environments that provide the space and armature for interaction and growth. As in the theoretical work of LaTour, Actants may be machines (like the *Odin* system) or organizations (like the University). Rather than defining these structures as subjects, actants are defined by their transactional roles in the professional community. Actants may (or may not) possess a physical body, but they do have a real effect on the

movement of information, goods, and services throughout the professional community. Finally, the interrelations of the actors, coaches, actants, and the whole of the professional learning community exist to serve clients, the most important of the stakeholders. These clients require the best quality professional services that are available, and thus the best quality professionals. The tensions between these forces are mediated through the professional learning community, where issues from across the various interwoven systems (of the NSO, of schools, or universities, of the various governmental organizations) may be brought to light.

In moving towards an evolved thematic analysis of the individual thought tools, I will recast the codes from the Axial phase as thought tools common to all professionals, but glimpsed first in the context of teachers. In renaming and reworking the codes, I clustered them around three thematic categories that describe the qualities of tools as employed in the comments. These include Literal, Inferential, and Critical categories (illustrated in **Figure 10**). Literal codes make reference to factual components of the video, such as the actor behaviors, identifying specific clients, client behaviors, and talk and discourse moves. At a more abstract and cognitively demanding level are the Inferential codes, where actors and coaches make inferences about what the clients' thinking, as well as inferences about actor behavior that brought about a positive conclusion. One level of complexity further is the Critical level of codes, where the actor or coach posits a counterfactual statement or hypothesis. The counterfactual/hypothetical qualities of these tools differentiate Suggestions for Improvement and Pressings from the other kinds of observed phenomena; they enable the commenter to use their own

knowledge and experience to posit alternative scenarios for occurrences in the video. This is akin to the metacognitive phenomena associated with ‘imagination’ and ‘creativity’ that occurs in other kinds of literature in psychology.



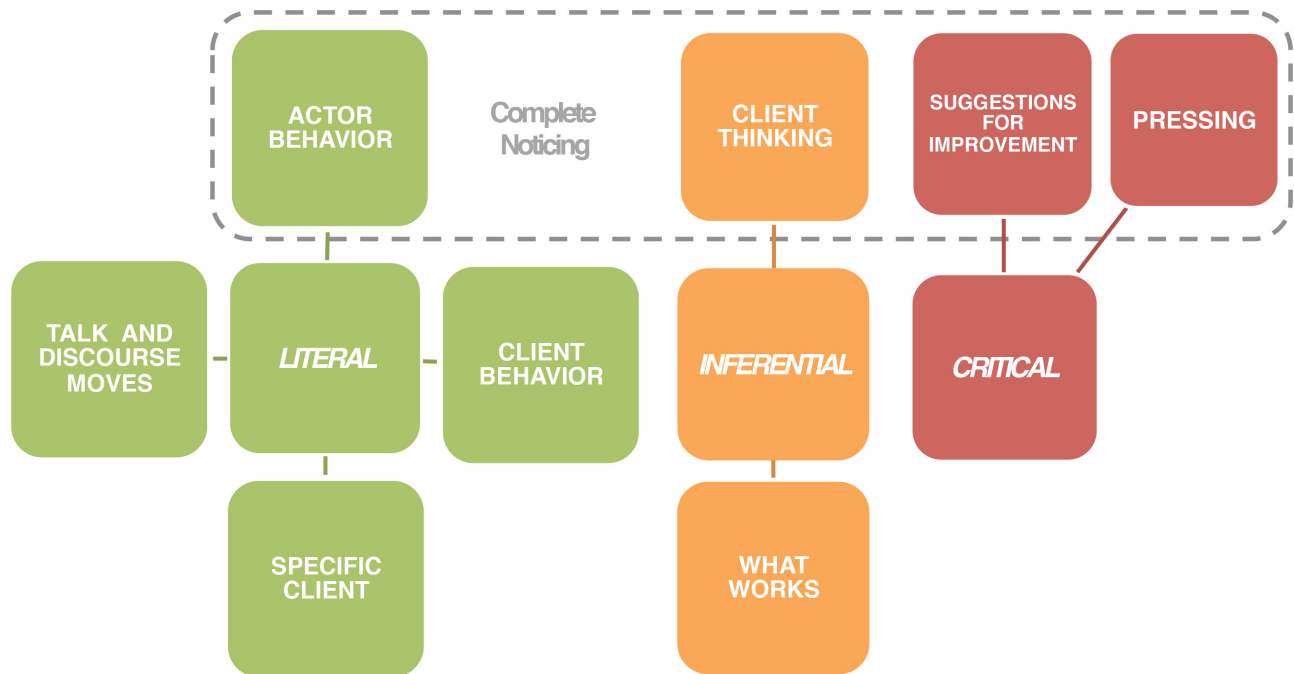
**Figure 10:** Elements of the Grounded Theory of Noticings

I chose a central theme and assembled the relevant coding themes around it, leading to a preliminary theory about the relationship between the various features of noticings. I chose to follow the assertion of Hiebert et al. that a primary goal of noticings should be the generation of specific suggestions for improvement. Kersting, et al. (2010) also provide statistical evidence to support this assertion as well. In their study, Kersting et al. asked 19 experienced teachers to observe videos of teacher practice using a validated video analysis rubric. The rubric measured the observers’ comments on Mathematical Content, Student Thinking, Depth of Interpretation, and Suggestions for Improvement. The researchers in the study also collected student test data from the observer-teachers’ classrooms. As a result, Kersting et al. were able to identify a uniquely predictive

relationship between the frequency of teacher noticings related to Suggestions for Improvement and student gains in math achievement. As they note, “Providing suggestions for improvement unprompted may be an indication that teachers have internalized this process to the extent that it has become routine.” Thus, the following observations will attempt to identify the conditions necessary for the emergence of Suggestions for Improvement.

This strong evidence from the literature prompted me to orient the thought tools into alignment with the Critical category as the primary orienting theme. The resulting model (**Figure 11**) aligns the thematic codes into focus around the Critical themes. Following this logic, the simplest sufficient complete noticing contains 1) a description of actor behavior in the video, 2) an inference about how clients perceived and thought about that behavior, and 3) a Suggestion for Improvement or Pressing comment for future consideration. I call such comments ‘Complete Noticings’ or ‘Hits’ because they contain what I believe to be the minimum set of necessary thought tools to engage with key features of practice in a deliberate way.

Why might the Complete Noticing represent an ideal form of noticing? The rationale for this decision comes from the Initiation-Response-Evaluation method of dietics proposed by Mehan (1979). Mehan (and other scholars in the area of Pragmatics and Dietics) characterize dialog as a sequence of ‘turns’ between actors, each with a particular significance in the participants’ future thinking and action.



**Figure 11:** The Grounded Theory of Noticings

From this perspective, the noticings can also describe dialogic moves, with Actor Behavior in the video as the First-Turn (Initiation), the inference about Client Thinking performing the function of the Second Turn (Response from the client), and the Suggestion for Improvement and Pressing as the Third-Turn (Evaluation). The Third-Turn (Lee, 2007) is a crucial part of the dialogics of coaches and actors because it requires the commenter to generalize their ideas one step beyond the more concrete tools, and apply it to a future cycle in the Double-Loop Learning cycle (as in Argyris, 1965). Now that the nature of the phenomena under examination has been described, I will examine several examples of Complete Noticings to see the complexity that arises from the combinations and intersections of these thought tools in action, and to provide further documentation of the theory.

### 3.3 Exemplar Comments From the Candidates

Now that I have advanced this Grounded Theory of Noticings, I will examine some exemplar Complete Noticings to qualitatively illustrate the richness of the intersections of these thought tools as opposed to the pure forms examined earlier. This section represents a broad selection of comments from across the spectrum of expertise, including four from Novice teachers and four from Team Leads. These comments serve as instantiations of the thought tools of the Grounded Theory, and allow us to pull out specific qualities that characterize Complete Noticings. Further, I will use these qualities to build a sub-theory that will provide language for describing the ways that Complete Noticings provide rich and specific comments.

In order to provide a thorough (but by no means exhaustive) analysis of the qualities of Complete Noticings, I will examine the following comments in order of ascending complexity. This study will now present a series of exemplar comments that range from the simplest novice Complete Noticings to the most complex novice comments. This analysis will provide with a broad view of the phenomena in action. In the simplest examples of Complete Noticings from the novice group, teachers tended to use their thought tools to identify specific aspects of their practice in the video that needed improvement. In the example below, a novice Math Teacher Candidate has enough knowledge to identify that something is amiss in her practice, but does not generalize beyond the specific example posed by ‘J:’

*I really need to find a way to engage J- (blue shirt). He has been distracted this entire lesson so far, and from the front of the room, I don't seem to be noticing him as often as I should.*

In this simple example, the novice teacher begins with a Suggestion for Improvement related to a specific student in her classroom, framed as a ‘need.’ The teacher derives an assessment of the student’s mental state (Client Thinking) from her observations of his behavior, and calls out a visual marker in the video. She then intimates that she was not noticing him (Teacher Behavior) as frequently as she ‘should.’ BM does not connect her recognition of this ‘need’ with the reasons for the distractedness (making a diagnosis, Abbot, 1988), or provide substantiation for why she ‘should’ check in more frequently, and what would result if she did. The word ‘should’ (often seen in novice comments) usually attends the weakest forms of the Suggestions for Improvement tool, as it implies only a vague counterfactual statement. With ‘should,’ the commenter identifies a need, but does not connect it with a specific effect. The first two tools of the Grounded Theory are functioning, but the participant’s final Suggestion for Improvement lacks specificity, and thus makes the whole comment less specific. It is this specificity that Kersting et al. describe in their study, and one of the key markers of a Complete Noticing. In the following comments, the Suggestion for Improvement plays an important role in aligning the other tools into a more specific observation.

Thought tools come into play in surprisingly subtle ways, woven through the structure of the comment text. While specificity is a key goal of a Suggestion for Improvement, the use of occluded thought tools (a thought tool that is implied or connected through a description of another phenomena) is visible in this comment from MA in the Elementary Team:

*F- was trying to solve the problem first in order to come up with the word problem. My next step with him would be to ask him what division is generally. What are you trying to solve in a division problem? Then give him another division problem he would need to write a word problem for. He would do this again in order for him to demonstrate he understood.*

– MA, Elementary Teacher Candidate, March 2012

Here, the Teacher Candidate was commenting on a video taken some weeks before, and contains part of his reflection on that performance. In the first part, MA identifies a particular process in the student's thinking, and then provides a hypothetical means of approaching the situation (Suggestion for Improvement). In this case, the Actor Behavior tool is implicitly part of the proposed Suggestions for Improvement; the Suggestions exist in response to the actual performance as recorded on the video. The Actor Behavior is the negative space formed by the counterfactual posited in the previous sentences. It contains within it a statement about what was missing from the original Actor Behavior. In apposition to BM's implied Suggestions for Improvement, the use of the implied Actor Behavior in the comment's structure does not substantially weaken the specificity of the commenter's counterfactual statements. Thus, commenters might have the freedom to occlude or imply instances of Actor Behavior and Client Thinking tool use, but must make clear counterfactual statements to create a sufficiently complex Complete Noticing. Only the transparency of the Critical code is necessary to ensure a strong progression into the second loop of learning.

In a comment by EG of the Elementary Team, a different set of structures are visible. At the outset, EG observes the activities of the students during the video:

*The students are working on one problem at the moment. Looking at the video and reflecting on the day I noticed that my higher students were done with the*

*problem quickly. Maybe pushing them to explain to me what their answer shows would have given them more of a challenge. Maybe using manipulatives would have assisted my lower students to think about the problem and what it represents.*

– EG, Elementary Teacher Candidate, March 2012

While EG's Client Thinking and Actor Behavior are implied by the text, the Suggestions for Improvement are clearly stated. The comment itself contains an implicit critique of the teacher's own performance (Actor Behavior). The explicit mention of the use of manipulatives, as well as 'pushing' his students to explain their answers, indicates that the teacher did not do either of these things at the time. In the Elementary Team context, 'pushing' is a local idiom referring to the value of ambitious teaching practices, and provides a shorthand reference for the community goal of challenging students' thinking. Clear Suggestions for Improvement create a deeper counterfactual context, that is populated by EG's mental models of his students and a vision of his own more effective solutions for future changes to his practice. As such, a depth of counterfactual context may be seen as another marker of a Complete Noticing.

However, in our most complex example, it is the transfer of the commenter's hypothetical or counterfactual recommendations back to the actor's context of practice that provides a more vivid account of how events might transpire if different choices had been made:

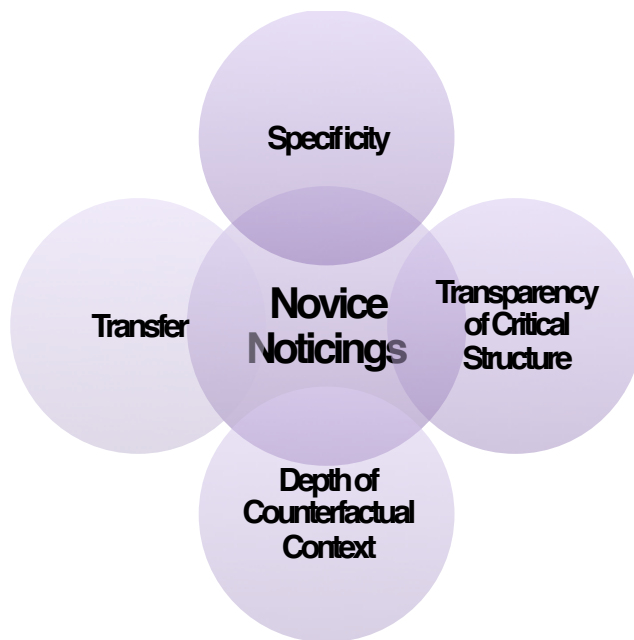
*Another great push for justification! I wonder if it would have been helpful for you to have listened in on a couple of turn and talks so that you would know which students used some strategies that you could highlight in case you didn't have volunteers for another method.*

– JL, Elementary Teacher Candidate, March 2012

At this high level of symbolic complexity, JL writes “*Another great push for justification,*” a statement that contains both the occluded Actor Behavior (the teacher’s strategies to cause the ‘push’) and the Client Thinking (an intimation about the mental state of the ones who are feeling the effects of the behavior) also characterized as a ‘push.’ The balance of the text outlines a specific sequence of events imagined by the commenter, as they imagine it might occur in their representation of the actor’s world. JL uses the Suggestion for Improvement to conjure, translate, and project her strategies to the world of the teacher in the video. The metacognitive transfer of strategies across contexts of practice indicates both the commenter’s ability to identify how specific practices might serve the situation, and a justification for the applicability of that solution to the context. This ability to transfer lessons learned from one’s own performance context to the context of another in a constructive way is a key way of honing thinking about how Complete Noticings allow individuals to access their own knowledge in providing recommendations for others.

Now that the study has examined four qualities of Complete Noticings from the novice participants, I have summarized those qualities in **Figure 12**. The study of the novice comments has identified some of the ‘naïve’ forms of video commenting practices. However, these represent only the first version of the construct, as the study now proceeds to examples of comments from the Team Leads to see higher-level deployment of the tools of Complete Noticings. In combining a construct derived from the novice Teacher Candidates and the expert team leads, the theory will grow to include a

language that represents the anchors of the novice/expert continuum and a broad heuristic model for the parameters of Complete Noticings.



**Figure 12:** Contributions of Novice Complete Noticings to the Theory

### **3.4 Exemplar Comments From the Team Leads**

The exemplar comments from the Team Leads present a different view of the Complete Noticings construct. Because experts possess a broader and more fluent sense of professional vision and domain knowledge, they can more quickly arrive at the heart of the matter of practice in particular ways. Thus, these three comments will illustrate three more qualities for our sub-theory of the Qualities of Complete Noticings. I will provide a more holistic vision of the theory-in-action (Argyris, 1974) by providing examples from the expert dimensions of commenting. Further, the social role and fluid knowledge of the experts provides our analysis with access to some of the higher social goals that

were not presented by the Complete Noticings of the novices. Because of their greater knowledge and roles as coaches, the Team Leads provided a glimpse at a different set of values that might influence Complete Noticings of practice made in VBOCS platforms. The four new values expressed in the following Team Lead comments illustrate the ways that knowledge and social role interact during the transposition into a mediated form.

The first expert noticing quality comes from the Secondary Science Team Lead, and includes all of the tools (Actor Behavior, Client Thinking, Suggestions for Improvement) described in the larger Grounded Theory. However, this comment contains a structure that is rarely seen in novice performance. This Complete Noticing contains a Pressing tool in place of the Suggestions for Improvement tool that has been central so far. The use of a Pressing as the Critical tool in the comment has distinct mutative effects on the Specificity, Transparency, Depth of Counterfactual Context, and Transfer of the Noticing (the previous, novice-identified qualities) because of the open-ended nature of the tool. Consider the phrasing in this comment:

*Even though students are side-talking, they are trying to make sense of this new information. Many of them are processing this verbally, so it sounds like an exciting "buzz" in the room. How could you use this time to support students in talking about science in a structured manner rather than shutting down this discussion to focus on notetaking?*

– Secondary Science Team Lead, October 2011

In this comment on a video from a Teacher Candidate in the Science Team, the Science Team Lead begins their comment with an inference about what is happening in the minds of the students (Client Thinking) in attributing the nature of the ‘buzz in the room’ to students’ verbal processing of their information. Following this, the Team Lead

uses a Pressing tool to ask a question that refocuses the novice actor's attention on ways of channeling the students' engagement into structured discourse. Further, the phrase 'shutting down this discussion' in the Pressing also contains an implicit assessment using the Actor Behavior tool, as the teacher is the source of the move towards note taking.

This is an example of the ways that coaching can provide an opportunity for the application of constructive discourse through the use of the Pressing tool for constructive criticism (as opposed to a more prescriptive Suggestion for Improvement). By calling attention to the moment in the form of a question, the Team Lead leaves the comment open for a third-turn comment from the other participants. The use of Pressing tools is a key feature of how experts used the thought tools to constructively model the third-turn for their more novice charges, and thus a key social quality of Complete Noticings made by experts. In using their thought tools to advance constructive dialog with their novices (a concern not always seen in novice comments), we may see how the Team Leads' social roles and advanced thinking interacted to maintain the safety and rigor of their environment.

In expanding this idea of the interactions between the advanced knowledge and the expectations of social roles that attend expertise as it is enacted in a professional learning community, the next exemplar will examine a more familiar form of this phenomenon in action. In this comment drawn from the Elementary Team, the Team Lead is responding to one of the Teacher Candidate's own comments on the video:

*You make a good point here...you're working on trying to make connections for your students and link the work in this task to other work that they do in math. Keep working on this connecting piece and linking to prior knowledge. It can also be helpful for you to ask students what they get from doing this activity so that they explain what they've learned in their own words...*

– Elementary Team Lead 2, January 2012

In recommending that the Candidate to ‘Keep working on this connecting piece,’ the Team Lead has used a Suggestion for Improvement thought tool to encourage the Teacher Candidate to continue along a particular line of inquiry, and provides a specific method for how to pursue it. In concert with the constructive quality seen earlier, encouragement may serve to maintain motivation in practice while preserving other values such as intellectual rigor, ego safety, and social trust.

In extending further from constructiveness and encouragement, experts also model their thinking through Complete Noticings in a way that the literature describes as ‘framing’ and ‘reframing’ (Schon, 1983). The following comment from the Humanities Team Lead serves as an illustration of the use of a particular rhetoric to render the expert’s thinking:

*I wonder if there's a way to display student ideas publically. Write them down on the board perhaps. That's always a really helpful way to provide multiple avenues into the conversation. When student ideas are displayed you AND your students can begin to see patterns and make connections and it's easier to USE each others thoughts*

– Secondary Humanities Team Lead, November 2011

The statement ‘I wonder...’ posits a counterfactual scenario without the use of a question, followed by a meditation on the implications of the new counterfactual scenario (one where the student ideas are written on the board), and the possible benefits of this strategy. The capacity to frame and bracket novice thinking through the modeling

of specific cause-effect chains in a counterfactual context can serve as a key quality of the social and practical knowledge of the expert as they represent their thinking to novices in the form of a reflective stance (Zeichner and Liston, 1996). The Team Lead reframes the attention of the novice to the relevant issues and values at hand (e.g. making student thinking public, multiple avenues into the conversation, using each others' thoughts).

The Complete Noticing in the Humanities Team Lead comment is achieved through modeling the important features of how the video might look in the world of the expert's theory of practice (and the frame that the expert uses to make sense of practice), and how this facilitates the shared goals of the classroom. Beyond the specific recommendations of practice, the Team Lead has changed the framing of the discussion by illustrating the direct benefits of the counterfactual chain of events to the Teacher Candidate and their students (e.g. that time is saved and 'students get that' before moving on). The connection of proposed counterfactual change to specific outcomes is thus a feature of expert Complete Noticings that is rarely seen in novice comments due to weaker models of cause and effect.

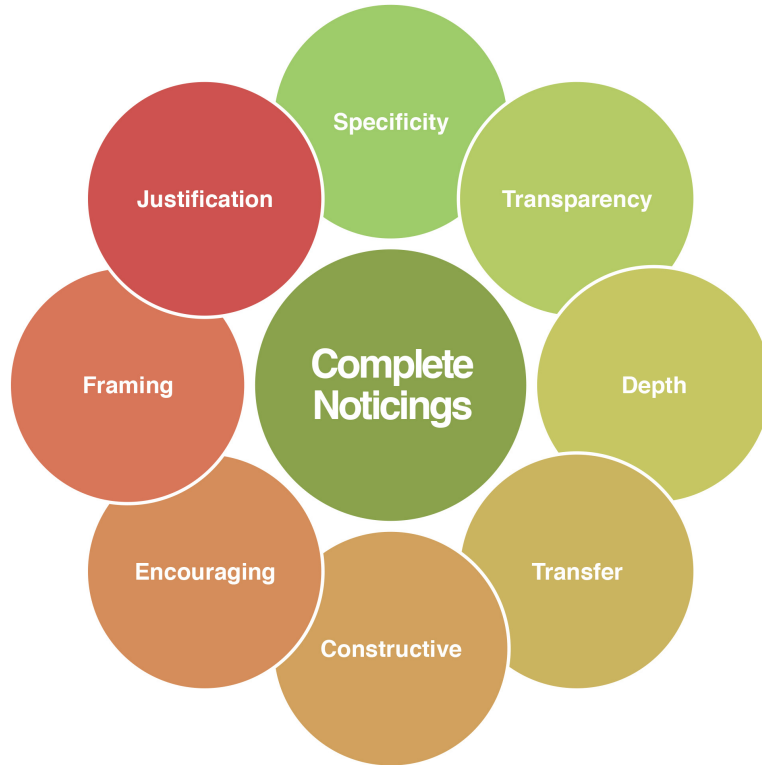
When the expert creates constructive, encouraging, and framing Complete Noticings for their candidates, their modeling typically contained a final quality that I liken to 'justification,' a pedagogical strategy valued by the community. In this comment from the Math Team Lead, the expert begins by naming the phenomenon of interest ('prior knowledge'), then proceeds to recount and rephrase dialog from the video:

*Okay, Prior Knowledge. You said, "Do you guys remember parent function?" How about, "What do you remember about parent functions? Talk to your partner for 30 seconds." Then come back to the large group, have one person share out, and even though that took some time, you save time overall because Students get that before moving on. Thoughts?*

– Secondary Math Team Lead, October 2011

Following this rephrase, the Team Lead reconstructs the novice's inquiry around a counterfactual version of the question ("What do you remember...") that focuses on specific features of the students' memory, then illustrates a model for transitioning from partner sharing to large-group work for the learner. Further, the Team Lead anticipates the novice's concern about the amount of time this will take, and provides assurance of the real benefits of the strategy, and thus justifies her counterfactual assertions. This anticipation of the novice's concerns (given the Lead's accurate read of the novice's mental model) allows the Team Lead to connect their model of cause and effect to outcomes of value for the novice (e.g. rich learning experiences and time management).

In assembling the qualities from the novice Teacher Candidates and combining them with the four new qualities derived from the Team Leads, this study now presents a rich model of the features of the Complete Noticings structure in the Grounded Theory. These features are summarized in **Figure 13** below, as the mature form of the qualities of Complete Noticings.



**Figure 13:** The mature form of the model qualities of Complete Noticings

**Table 6** summarizes the definitions of these phenomena into a short form, suitable as a basis for rubrics or other kinds of evaluative or observational materials:

Qualities	Definition
<b>Specificity</b>	The use of more precise Suggestions for Improvement that result in the positing of more developed counterfactual or hypothetical circumstances.
<b>Transparency</b>	The degree of clarity or occlusion of phenomena in the noticing; commenters have some discretion in how they use a thought tool, either explicitly or through implication relative to the video.
<b>Depth</b>	The use of commenting to create a deeper counterfactual context that takes many variables into account and aligns them in deliberate ways.
<b>Transfer</b>	The ability to translate hypotheticals about practice into actionable changes to practice.

<b>Constructive</b>	The use of Pressing to continue to ask open-ended questions that will lead to long-term growth.
<b>Encouraging</b>	The directing of attention to a particular facet of observed behavior, followed by the suggestion of continued thought along a specific line of inquiry.
<b>Framing</b>	The bracketing of a particular problem through the description of real or hypothetical cause-and-effect chains.
<b>Justification</b>	The presence of a rationale for the selection of a particular strategy or alternative based on real-world considerations and constraints.

**Table 6: Definitions of the Observed Qualities of Complete Noticings**

### **3.5 Conclusion of Theory Development**

Now that I have described the various aspects of the Grounded Theory of Complete Noticings as they operate at a high level of abstraction, it is important to reconnect this literature to the ongoing discussions in teacher education, the theory's original domain. Before the theory can be advanced to validity testing, it should in some way be shown to fit into existing research agendas. To do this, I returned to the literature to find recent examples of VBOCS commenting behaviors in other, similar teaching contexts. In extending my review from this Literal-Inferential-Critical model of reflective practice and the definitions surveyed in Etscheidt, Curran, and Sawyer (2012), I encountered the work of Jay and Johnson (2002). In their article, Jay and Johnson provide evidence for a model of how reflective practitioners ask questions of themselves during practice. The three components of the model are analogous to those discussed in this study, and are codified as Descriptive, Comparative, and Critical (as distinct from the Literal-Inferential-Critical thought tools presented here). However, the theory in this study

echoes and extends this line of inquiry to include a more specific hierarchy of relationships between these kinds of mental processes.

In considering these preliminary observations and reviewing the initial literature for further connective opportunities, I encountered an article by Copeland, Birmingham, De La Cruz, and Lewin (1993) that outlines a research agenda for the study of reflective practice in teacher education. The authors provide a high-level theoretical description of similar kinds of reflective teaching practices that I had observed in the ATEP program and in the VBOCS system. In a serendipitous way, Copeland et al. call for exactly the kind of theory that I have presented in this chapter. In codifying twelve core elements of reflective practice in their study, the researchers have generated a framework that can be used to assess the reliability of the Grounded Theory presented here.

In the article, Copeland et al. identify three key items of value for the building of the coming theory: a set of assumptions, a general three-stage process of reflective practice, and an agenda for further research. First, the researchers provide a review of the common assumptions that had arisen around reflective teaching up to that time. In their view, reflective practice is generally assumed to 1) involve a cycle of solving problems and reconstructing meaning, 2) reify as a stance toward inquiry, 3) exist as a spectrum of propensity and disposition, and 4) occur in a community of practice. Copeland et al. carefully deconstruct these assumptions before advancing the rest of their theory, and this opens a rich area of discussion. These assumptions also provide a way of understanding how researchers might recognize practice as reflective. In the case of the

ATEP program and the VBOCS commenting activities, the Team Leads and Teacher Candidates oriented their activity around cycles of meaning-making from problems observed in their videos, a factor that matches against quality 1. The use of the *Odin* VBOCS technologies also promoted an inquiry stance (quality 2), provided a scaffold for individuals to engage in reflective practice at their level of valence (3), and reflexively oriented towards community activity (4). In comparing the grounded theory to this framework, the model presented by Copeland et al. independently verifies the activity that this study has codified into theory as a form of ‘reflective practice.’

Following the discussion of the assumptions, Copeland et al. outline a three-phase process of Problematization-Solution-Testing that defines the reflective stance of practicing teachers, each containing four sub-qualities. *Problems* 1) are actively identified by participants, 2) come from a concrete situation in practice, 3) have meaning for the practitioner, and 4) are important for to the success of teaching and learning. As illustrated earlier, the Grounded Theory’s occurrences in the VBOCS system allows individuals to problematize their practice in efficient ways (1) as they occurred in practice (2) in a way that meaningfully influenced their thinking (3) and had some kind of outcome for student learning (4). These are visible qualities of the kinds of problems that participants identified in the more advanced forms of commenting associated with the Grounded Theory.

According to Copeland et al., *Solutions* 1) are actively generated by practitioners, 2) are grounded in theories, assumptions, or research and are explicitly held by a practitioner,

3) involve a critical look at the professional actions and their effects on the target actions in other actors, 4) are expected to result in positive outcomes for students. While the VBOCS system provides the scaffolding for the discovery of problems, it is the Grounded Theory of Noticings that explains how candidates explore solutions to their problems in accordance with these same characteristics. The selected comments contained solutions generated by participants (1) from their own varying levels of extant knowledge (2) in critical ways (3) that relate to student learning and teacher efficiency (4). Further, the Theory's emphasis on criticality and actor-client needs also provides a direct response to the qualities identified by Copeland et al.

The last phase, *Testing* 1) begins when a solution is actively selected, 2) continues through the process of implementation, 3) involves the evaluation for a return on investment in terms of effect on the target's student outcomes, and 4) outcomes should lead to greater teacher understanding of the practice context. This phase connects directly to the double-loop nature observed in this program, with candidates testing and evaluating their solutions through the use of the VBOCS technology. The Grounded Theory presented here also allows for the recursive and continually evolving evaluation of the solution when supported by a technological armature. Here, too, the comments represent potential solutions (1), often contain evidence of implementation knowledge (2), involve evaluation of the proportionality of the response (3), and extend teachers knowledge of their own practice (4). The Grounded Theory presented here echoes the concerns presented by Copeland et al. in their Problem-Solution-Testing model of reflective practice.

Finally, Copeland et al. present plans for a research agenda that involves 1) testing the validity of the twelve attributes, 2) identifying the relationships between reflection and other attributes of teachers, 3) asking questions about the nature of reflectivity as a practice, a disposition, and a process, and 4) finding ways to foster a reflective stance in teacher practice. I contend that this theory attends to all four of these issues. In the next chapter, I will examine the validity of the Grounded Theory along similar lines as I test the strength of the model of reflective video-based online commenting presented here, identify the relationship between expertise and complete noticings, develop a deeper understanding of the nature of reflection as it relates to professional development, and find ways to foster reflective stances in all practitioners.

## Chapter 4: Validity

In this chapter, the study will examine the ecological validity of the proposed theory of commenting behaviors. Grounded Theory's place as a post-positivist methodology frees researchers from the assumptions of positivistic, quantitative research about the ability of the researcher to establish validity in universal ways. Since there is no single 'Truth' in a study with so many intersecting actors, stakeholders, and perspectives, the issue of validity in Grounded Theory must be addressed through the probabilistic and qualitative conditions of Relevance, Fit, Workability, and Modifiability (adapted from Glaser and Strauss, 1967, to fit this context). Any theory developed through this study must deal with the relevant and real-world concerns of the participants, fit the evidence available, provide a demonstration of potential flexible utility, and consider how this theory might operate under other conditions and with different actors.

Here, I will provide evidence to assess the Relevance of the theory by examining the frequency of commenting behaviors for potential opportunities to improve participant thinking through an exploratory statistical representation of the data and an ANOVA test of the variance. This will test the strengths of the constructs based on my hypothesis that experts like Team Leads composed Complete Noticings more effectively than did their more novice counterparts, and that this may be a point of opportunity for the stakeholders. Then, in the test of theoretical Fit, I will conduct a logistic regression to assess the statistical validity of a model that uses Boolean values (the 'Hit Rate Composite,' or HRC) as a means of confirming optimal performance in the commenting system. In the Workability segment, I will combine the ideas generated by the Grounded

Theory with my own observations of the community's use of the technology to produce a design for a simplified online video-based activity system that may be tested empirically in future research. Finally, in assessing the Modifiability of the Theory, this study will consider its applications in other domains, as well as conditions where the use of such a system may be counterproductive. Each of these tests provides evidence for the ecological validity of the proposed Grounded Theory of Commenting, building from the most abstract examinations of the theory back to a concrete plan for reification of the theory in the real world.

## **4.1 Relevance**

In this section, I will establish the relevance of the Grounded Theory to the data, to the participants, and to the field through the use of a pair of statistical analyses conducted on the frequency counts of the behavior. In this phase, we will treat the thought tools as dependent conditions and both the participant's Content Team membership and their level of expertise. This will help us to determine if one PLC in particular developed stand-out strategies for eliciting the use of these tools from the participants, and to see if there are any particular phases of expertise that inspire a predisposition towards particular thought tools.

The following table contains the frequency of occurrences of participant behavior as described in the Grounded Theory, followed by the number total number of comments for each member of the system. Further, the white cells represent novice teacher candidates, the light grey cells represent credentialed teachers, and the dark grey cells

represent Team Leads. The simple count provides the starting point for a number of calculations that provide evidence for the Grounded Theory. In reading Table 7, please note that this piece of the study is looking at the frequency of use of these thought tools at the level of the comment. That is, each code application is treated as a discrete instantiation of the thought tool at least once in a comment. Conversely, any one of the total comments may include one or more of the thought tools. The table below can serve to condense a year's worth of comments into a probabilistic model of behavior.

<b>Participant</b>	<b>Actor Behavior</b>	<b>Client Thinking</b>	<b>Suggestions for Improvement and Pressing</b>	<b>Total Comments</b>
<b>JL</b>	70	61	33	105
<b>MA</b>	35	23	18	52
<b>EG</b>	85	55	31	142
<b>AJ</b>	19	18	0	26
<b>AmJe</b>	8	12	4	14
<b>BT</b>	7	8	2	17
<b>EF</b>	2	1	0	6
<b>CB</b>	24	52	13	83
<b>LF</b>	10	12	6	58
<b>BM</b>	5	3	5	11
<b>BL</b>	16	3	4	16
<b>CR</b>	5	3	6	13
<b>JB</b>	8	4	6	23
<b>MR</b>	20	0	3	53
Team Lead Science	34	29	28	49
Team Lead Elementary 1	67	52	57	122
Team Lead Elementary 2	7	8	10	24
Team Lead Humanities 1	15	13	26	32
Team Lead Humanities 2	9	4	7	10
Team Lead Math	18	9	22	34

### **Table 7: Code-counts of Grounded Theory Behaviors from the CAQDAS**

Following the assembly of these data about the Grounded Theory from the CAQDAS software, I began to construct a one-way ANOVA test of the means of these behaviors. However, because of the large range of total comments made, I chose to represent the values in percentage form by dividing the number of instances of each phenomena of interest divided by the total number of comments made by the participant. The conversion to percentages standardizes the data so that I may compare by odds rate per hundred that any given comment contains a set of thought tools. Though I am aware that an overlap exists in the application of the codes in the comments from the earlier qualitative analysis (and will attend to that issue in the Fit test), the standardized representations of the instances of the use of thought tools will allow for new questions that might be answered through statistical representations about the rates of use of the thought tools in commenting. That is, a series of ANOVA tests will verify if there existed quantifiable differences in the presence of the comments based on the commenter's group membership and level of expertise. In accomplishing this, the study will establish that experts use these tools more advanced tools more frequently than novices, and that novices require additional scaffolding in order to sharpen their thought tools.

#### **4.1.1 Test of Frequencies by Content Team**

In the first test of the frequencies, I conducted a one-way between subjects ANOVA to compare the effect of Content Team membership on the Actor Behavior, Client

Thinking, and Suggestions for Improvement/Pressing scores. This test plays an important role in this study's theoretical objectives, and allows us to discount the strongest argument against the Theory described earlier. Before I advance the possibility that participant expertise is the source of the differences in frequency of thought tool use (if there is a difference at all), I must first rule out other major sources of variance that would disprove the Grounded Theory. Content Team membership is an excellent candidate for such a test, as it is entirely possible to attribute the observed frequencies to some special practice employed by one of the Content Teams. Further, in keeping with Occam's Razor, it is easier to believe that Content Team membership accounts for the differences in commenting (if there are any) than a nebulous concept like 'expertise.' However, in performing the analysis, I found that the members of Content Team were not statistically different from one another, except in one outlier case (**Table 8**). That is, omnibus test of the dependent conditions did not find a relationship between Content Team membership and thought tool use in Actor Behavior [ $F(3, 16)=.168, p=.92$ ] or Suggestions for Improvement/Pressing [ $F(3,16)=.033, p=.65$ ].

However, significant differences appeared in the Client Thinking tool [ $F(3, 16) = 6.11, p=.01$ ]. The Tukey post-hoc analysis identified that Client Thinking was strongly associated with the Math Content Team when compared against the Science team ( $F=6.107, p<.05$ ). The Tukey Post hoc illustrated that this came as a result of differences between the Math Team (containing mostly conventionally prepared teachers, or Advanced Novices) ( $M = 4.20, SD = 1.30$ ) and the Science team (containing the NSO-based teachers), and no significant differences with any of the other conditions. For this

reason, I would identify this occurrence as an example of Type II error, as none of the other novice groups (Elementary and Secondary Humanities) demonstrated significantly different frequencies of comments in any of the categories. Thus, the tests conducted on the frequency of thought tool use would indicate that the variance in the frequency of use of thought tools by the participants is not attributable to the participant's assignment in a particular Content Team. In carrying this investigation forward, the study will now look at another potential influence on the frequency of use of the thought tools as a marker of a participant's level of expertise.

*ANOVA*

		Sum of Squares	df	Mean Square	F	Sig.
Actor Behavior	Between Groups	.026	3	.009	.168	.916
	Within Groups	.826	16	.052		
	Total	.852	19			
Client Thinking	Between Groups	.445	3	.148	6.107	.006
	Within Groups	.389	16	.024		
	Total	.835	19			
Suggestions for Improvement and Pressing	Between Groups	.098	3	.033	.558	.650
	Within Groups	.935	16	.058		
	Total	1.033	19			

*Multiple Comparisons*

Tukey HSD

Dependent Variable	(I) Team Membership	(J) Team Membership	Mean Difference (I-J)		Sig.	95% Confidence Interval	
			Mean Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Actor Behavior	Elementary	HLA	.091460566	.142414073	.917	-.31598892	.49891005
		Science	-.00998294	.156792734	1.000	-.45857006	.43860418
		Math	.033414474	.126410343	.993	-.32824803	.39507697
	HLA	Elementary	-.09146057	.142414073	.917	-.49891005	.31598892
		Science	-.10144350	.173537756	.935	-.59793847	.39505146
		Math	-.05804609	.146666173	.978	-.47766092	.36156874
	Science	Elementary	.009982938	.156792734	1.000	-.43860418	.45857006
		HLA	.101443504	.173537756	.935	-.39505146	.59793847
		Math	.043397412	.160664743	.993	-.41626760	.50306243
	Math	Elementary	-.03341447	.126410343	.993	-.39507697	.32824803
		HLA	.058046092	.146666173	.978	-.36156874	.47766092
		Science	-.04339741	.160664743	.993	-.50306243	.41626760
Client Thinking	Elementary	HLA	.022818458	.097738543	.995	-.25681345	.30245037
		Science	-.20712434	.107606594	.257	-.51498894	.10074026
		Math	.244462364	.086755210	.054	-.00374601	.49267074
	HLA	Elementary	-.02281846	.097738543	.995	-.30245037	.25681345
		Science	-.22994280	.119098675	.255	-.57068647	.11080087
		Math	.221643906	.100656752	.165	-.06633706	.50962487
	Science	Elementary	.207124340	.107606594	.257	-.10074026	.51498894
		HLA	.229942798	.119098675	.255	-.11080087	.57068647
		Math	.45158670*	.110263947	.004	.13611936	.76705405
	Math	Elementary	-.24446236	.086755210	.054	-.49267074	.00374601
		HLA	-.22164391	.100656752	.165	-.50962487	.06633706
		Science	-.4515867*	.110263947	.004	-.76705405	-.13611936
Suggestions for Improvement and Pressing	Elementary	HLA	-.19133952	.151513800	.598	-.62482351	.24214446
		Science	-.07312580	.166811203	.971	-.55037596	.40412436
		Math	-.10329851	.134487492	.868	-.48806989	.28147287
	HLA	Elementary	.191339524	.151513800	.598	-.24214446	.62482351
		Science	.118213723	.184626170	.917	-.41000541	.64643286
		Math	.088041015	.156037593	.941	-.35838563	.53446766
	Science	Elementary	.073125800	.166811203	.971	-.40412436	.55037596
		HLA	-.11821372	.184626170	.917	-.64643286	.41000541
		Math	-.03017271	.170930619	.998	-.51920860	.45886318
	Math	Elementary	.103298508	.134487492	.868	-.28147287	.48806989
		HLA	-.08804102	.156037593	.941	-.53446766	.35838563
		Science	.030172708	.170930619	.998	-.45886318	.51920860

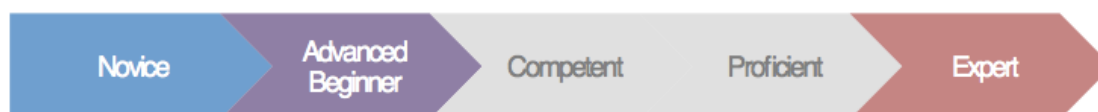
\*. The mean difference is significant at the 0.05 level.

**Table 8:** Results of the test of discrete frequencies by group

#### 4.1.2 Test of Frequencies by Level of Expertise

In testing the frequency of the three features of noticing against the participants' level of expertise, I recoded my participants to indicate membership in three of the five levels of

skill on the continuum of expertise (as conceived by Dreyfus and Dreyfus, 1986; visualized in **Figure 14**).



**Figure 14:** Dreyfus model of Skill Acquisition in the expertise continuum

First, I coded NSO Teacher Candidates as Novices because the vast majority were teaching their first full year in their current school context. I then coded conventionally prepared TEP candidates as Advanced Beginners, as they had undergone a more focused, traditional training regimen that included several weeks of student teaching. Though conventionally prepared teachers generally are legally minimally competent to practice in the profession, I would argue that the quality of competence in the Dreyfus and Dreyfus model refers to their ability to function with little or no outside intervention, a different issue than the definition of professional competence. Finally, I coded the Team Leads as Experts, because of their greater number of years in the field and the nature of their roles as ‘more knowledgeable others.’ With the data prepared, I conducted a one-way ANOVA to compare the effect of Level of Expertise on the Actor Behavior, Client Thinking, and Suggestions for Improvement/Pressing scores.

The omnibus test of the frequency of use of thought tools against the level of expertise indicates no significant differences among the groups for noticings of Actor Behavior AB [ $F(2, 17)=.013, F=.260, p=.77$ ], but did find significant differences in the Client Thinking CT [ $F(2, 17)=.15, F=4.76, p=.02$ ] and Suggestions for Improvement and

Pressing construct SIP [ $F(2, 17)=.32, F=13.65, p<.001$ ]. The following conclusions derived from the Tukey HSD post-hoc test (**Table 9**) provide a window into the relationships between use of thought tools and levels of expertise:

- Novices, advanced beginners, and experts do not show any significant differences in their percentages of frequency of Actor Behavior at the  $p=.05$  level. This serves as evidence for the hypothesis that there are no significant differences between participants' Actor Behavior percentages compared across the levels of expertise.
- There is a significant difference between novices and advanced beginners in the percentage of frequencies of noticings about Client Thinking ( $M=.32$   $SD=.10, p=.018$ ), but no significant differences exist between the novice and advanced beginners and experts in the percentage of frequency of noticings of Client Thinking. This is an unusual finding that may relate to the false-positive observed in the previous test.
- There is a significant difference between Novices and Experts ( $M=-.40$   $SD=.09, p<.001$ ) and Advanced Beginners and Experts ( $M=.32$   $SD=.10, df=2, p=.007$ ) in the percentage of frequencies of Suggestions for Improvement and Pressing, and but not between the Advanced Beginners and Novices ( $M=.06, SD=-.09$ ). In light of the means in the test, I might make the proposition that Experts are better able to make Suggestions for Improvement and Pressings than Novices and Advanced beginners.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Actor Behavior	Between Groups	.025	2	.013	.260	.774
	Within Groups	.827	17	.049		
	Total	.852	19			
Client Thinking	Between Groups	.300	2	.150	4.758	.023
	Within Groups	.535	17	.031		
	Total	.835	19			
Suggestions for Improvement and Pressing	Between Groups	.636	2	.318	13.649	.000
	Within Groups	.396	17	.023		
	Total	1.033	19			

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) ThreeLevelEx Nov	(J) ThreeLevelEx Nov	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Actor Behavior	Novice	AdvBeg	-.03727531	.130466512	.956	-.37196849	.29741788
		Expert	-.08197303	.113880508	.755	-.37411720	.21017113
	AdvBeg	Novice	.037275305	.130466512	.956	-.29741788	.37196849
		Expert	-.04469773	.142350635	.947	-.40987794	.32048248
	Expert	Novice	.081973033	.113880508	.755	-.21017113	.37411720
		AdvBeg	.044697728	.142350635	.947	-.32048248	.40987794
Client Thinking	Novice	AdvBeg	.32229636*	.104954677	.018	.05305014	.59154259
		Expert	.066616022	.091611953	.751	-.16840135	.30163339
	AdvBeg	Novice	-.3222964*	.104954677	.018	-.59154259	-.05305014
		Expert	-.25568034	.114514941	.094	-.54945205	.03809137
	Expert	Novice	-.06661602	.091611953	.751	-.30163339	.16840135
		AdvBeg	.255680341	.114514941	.094	-.03809137	.54945205
Suggestions for Improvement and Pressing	Novice	AdvBeg	-.05757985	.090331740	.802	-.28931302	.17415332
		Expert	-.4028048*	.078848007	.000	-.60507805	-.20053147
	AdvBeg	Novice	.057579850	.090331740	.802	-.17415332	.28931302
		Expert	-.3452249*	.098560008	.007	-.59806653	-.09238330
	Expert	Novice	.40280476*	.078848007	.000	.20053147	.60507805
		AdvBeg	.34522491*	.098560008	.007	.09238330	.59806653

\*. The mean difference is significant at the 0.05 level.

**Table 9:** The comparison of thought tool by level of expertise

These findings are summarized in **Table 10**, where the rows represent phases of the Novice/Expert continuum (Dreyfus and Dreyfus, 1986) and the columns represent the thought tools addressed in this study. In conceiving of these thought tools as markers of an individuals' ability to engage in deliberate professional practice, the study may now

identify the relevance of these behaviors to the real world. In the matching of the participants to phases in the continuum of expertise, I would cautiously assert that the consistent use of these tools becomes less frequent for each level of participant expertise as they increase in complexity from Literal to Critical thought tools.

	Actor Behavior	Client Thinking	Suggestions for Improvement
<b>Novice</b>		*	*
<b>Advanced Beginner</b>		*	*
<b>Expert</b>			

**Table 10:** Provisional Model of Tool Use Based on Frequencies

This provides us with further confirming evidence of the model of a Complete Noticing based on the Literal-Inferential-Critical themes introduced, in so far as researchers might now identify relational ‘plateaus’ between the frequencies of thought tool use and the levels of expertise of the participants. Implicit in this discovery is a real-life diagnostic tool for coaches to use in assessing the development of their learners’ capacity to notice features of practice and make comments that lead to double-loop learning. It is reasonable to hypothesize, and verify with future testing, that the guided and explicit use of these thought tools may help learners to push through their plateaus at key moments of reflection between cycles of practice. In some future time, I might imagine a coach observing a video and commenting to the novice saying “Use your Client Thinking Tool!” in order to prompt further thinking in particular ways. That is, coaches may induce learners to ‘think more like experts’ by having them use these thought tools at specific moments in the development of their expertise in a professional context. Further, it may be possible to use this model to stage and fade priming questions across the tools more deliberately between iterations of practice. However, the following

analysis will administer a deeper test of the applicability of this Grounded Theory by assessing its fit through an analysis of the *intersections* of the thought tools.

## 4.2 Fit

In the previous test, the frequency of thought tool use illustrates the relationship between the participant's place in the continuum of expertise and their frequency of use of progressively more critical thought tools. In this phase of the validity testing, I will investigate a more accurate way to model the relationship between the degree of a participant's expertise (as defined practically) and their ability to use these tools together effectively. In the Grounded Theory presented earlier, the optimal form of a comment does not focus solely on the frequency of thought tool use as much as it refers to the co-occurrence of these tools in the same comment. For this reason, the test of Fit of the theory to the data will require the use of a different form of calculation based on Boolean operators.

In the following section, I will create a composite percentile based on the unions of the Actor Behavior, Client Thinking, and Suggestions for Improvement and Pressing model to determine whether there are relationships between participants tendency to make Complete Noticings, their Content Team membership, and their levels of expertise as assigned by the program itself. I will then use a linear regression to model the possibility of using the theory to predict a participants' level of expertise based on thought tool use. First, however, I will define and investigate the construction of the Hit Rate Composite (HRC) percentage, as this value is crucial to the understanding of the fit of the theory to

the data.

#### 4.2.1 Overview of the Boolean Model of Code Co-Occurrences

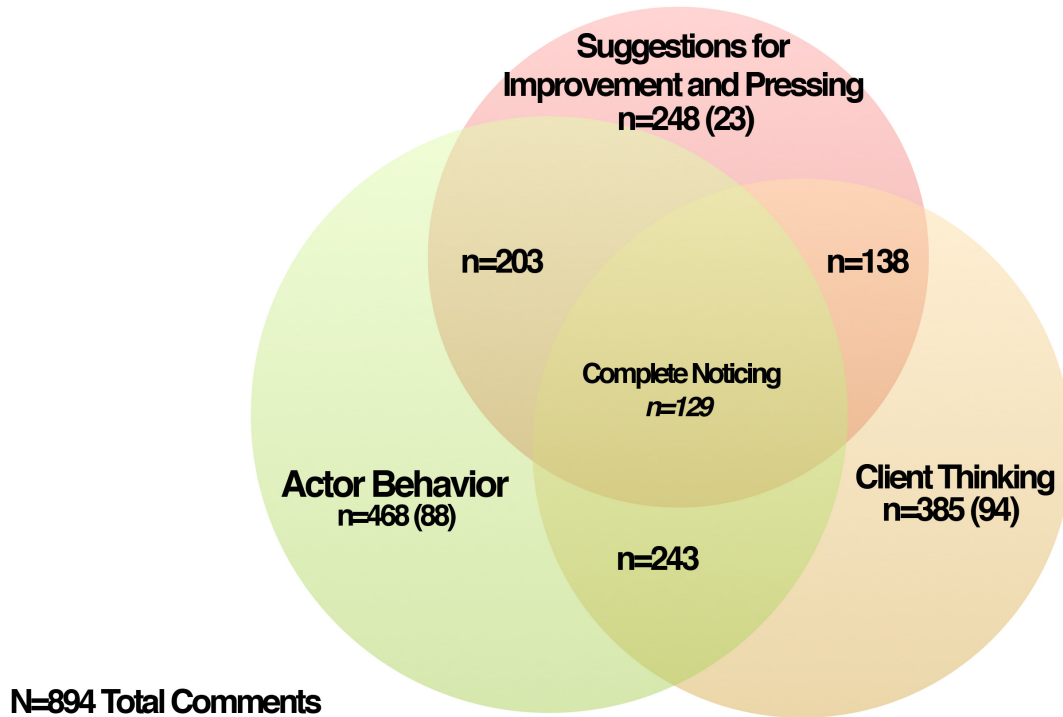
In order to accurately represent an individual participant's commenting activity over the course of the year, this study will need to adopt a different mathematical model. Since the Grounded Theory proposed in this study relies on a participant's ability to use all three thought tools in a given comment, I will shift our perspective from the discrete code counts to the analysis of code intersections in our dataset. To find the number of intersections of the thought tools under study, I used the CAQDAS program to manage the calculation of code co-occurrences by indexing all of the video comments and codes in the tool's online archive. Then, I used a set of Boolean parameters to filter and compare the occurrences of two or more tags in the dataset. This can be expressed symbolically as  $[AB \cup CT \cup SIP]$ , or the union of the three thought tools of the Grounded Theory of Professional Noticings. After applying the correct Boolean filters to each participant's body of codes, I was able to obtain the metrics below for the distribution of co-occurrence of tags across the 894 noticings (with any thought tool) of all participants within the system. **Table 11** shows the number of co-occurrences for each phenomenon in the system:

N=894	AB (n=468)	CT (n=385)	SIP (n=248)
AB	88		
CT	243	94	
SIP	203	138	23

**Table 11:** Co-occurrence of thought tools in the video comments, including Actor Behavior (AB), Client Thinking (CT), and Suggestions for Improvement and Pressings (SIP)

This table illustrates the two-factor co-occurrence in the data, but the two-dimensional representation of the data fails to illustrate the three-factor co-occurrence. While the previous investigations in the Relevance section were reliant on the participant's frequency of thought tool use as expressed as a percentage of their total commenting behaviors, that analysis only described the total percentage of occurrences per individual, and did not examine the interaction of the various thought tools. This is a direct result of the differences between tests of frequency of discrete thought tool use (with each tool as a discrete variable) and fit (describing the Grounded Theory's assertion that expertise is the underlying variable that aligns the three tools, and that this is visible through co-occurrence).

**Figure 15** provides a visualization of the co-occurrence of instances of all three of the Grounded Thought tools in the sample. In the magnified region in the center, a total of 129 Complete Noticings were identified in the dataset. The rest of the data is arrayed in appropriate intersecting regions:



**Figure 15:** The intersections of thought tool code counts  
(NB: figure not to scale)

As represented in the diagram, I was able to identify the 129 Complete Noticings, or approximately 14.43% of the total number of comments, that I had coded in the CAQDAS system. I was then able to use the system to determine how many of these Complete Noticings were attributable to each participant in the data. I then divided the number of Complete Noticings by the total number of comments made by the participant, and used this percentage as the basis for further investigation of the data.

The resultant *Hit Rate Composite* number in the right column of **Table 12** provides the rate of co-occurrence of all three thought tools in the same comment per hundred comments:

<b>Participant</b>	<b>Complete Noticings</b>	<b>N Comments</b>	<b>Hit Rate Composite</b>
<b>Team Lead Humanities 2</b>	4	10	40.00%
<b>Team Lead Elementary 1</b>	39	122	31.97%
<b>Team Lead Elementary 2</b>	7	24	29.17%
<b>Team Lead Science</b>	14	49	28.57%
<b>AmJe (Sci)</b>	4	14	28.57%
<b>Team Lead Math</b>	7	34	20.59%
<b>Team Lead Humanities 1</b>	6	32	18.75%
<b>BM (Math)</b>	2	11	18.18%
<b>MA (Elem)</b>	9	52	17.31%
<b>JL (Elem)</b>	15	105	14.29%
<b>EG (Elem)</b>	13	142	9.15%
<b>JB (HLA)</b>	2	23	8.70%
<b>LF (HLA)</b>	1	58	1.72%
<b>CB (Math)</b>	1	83	1.20%
<b>AJ (Elem)</b>	0	26	0.00%
<b>BT (Sci)</b>	0	17	0.00%
<b>EF (Sci)</b>	0	6	0.00%
<b>BL (Math)</b>	0	16	0.00%
<b>CR (HLA)</b>	0	13	0.00%
<b>MR (Math)</b>	0	53	0.00%
<b>Totals</b>	124	838	13.41%

**Table 12:** The Hit Rate Composite value for each participant

While percentages obscure the scale of the differences in commenting (e.g. 4/10 is very different than 39/122 in practical reality), the wide variations in commenting make the use of raw scores less than ideal for comparative purposes (as not all individuals chose to comment with the same frequency and regularity). Using these percentages as markers of thought tool use, statistical tests can now determine whether the intersection

of thought tool use is more predictive than those of the frequency percentages in understanding the development of expertise.

The assembly of the data in this way allows us to ask two new questions that will help to advance and challenge the Theory as I have described it so far. This is achieved by asking two new questions of the percentages as they are assembled here. The following questions will help us to clarify how this data informs the test of Fit:

- What might the participant HRCs reveal about the Fit of the Grounded Theory as compared to the results of the Relevance test, and how might these tests challenge or advance the theory further?
- Does the study's Grounded Theory map back onto the data in predictable ways?

In asking these questions, I will test whether the qualitative Theory adequately describes its own data when tested in full, before extending it further to the Modifiability phase. Further, the testing of tool co-occurrence (as opposed to frequency of tool use) will allow us to more accurately determine the robustness of the Theory's earlier assertion that all three Literal-Inferential-Critical tools are essential to the process of noticing as exhibited by experts in the community.

To answer the first question of Fit, it is essential to revisit some of the questions that I asked earlier about the potential confounding relationships between a participants' Content Team membership, their expertise, and their capacity to use the thought tools. To achieve this, I will again perform two ANOVA tests, this time using the HRC instead

of the discrete frequency percentages. Ideally, this will uncover any nesting effects in the HRC data caused by the real-world division of the teams in much the same way as seen earlier. Further, a post-hoc test should reveal whether there are any underlying similarities amongst the groups that explain the variances in novice and expert behavior illustrated in the Relevance analysis. The second ANOVA test will examine the differences between the National Service Organization Teacher Candidates, conventionally prepared first year TEP grads, and the Team Leads to see if the HRC reflects the participant's level of expertise in ways that are similar or different than our earlier assays with frequency.

#### **4.2.2 Hit Rate Composite by Group**

The HRCs were compared across teams to determine if divisions across teams accounted for the sources of the variance in the scores, as it would be natural to anticipate some potential nesting effects, or the existence of some magical practice employed by one group but not another. I might phrase our null hypothesis in this test in the following way: "Content Group membership has no effect on the HRC scores of the participants." In the case of this data, the ANOVA test (**Table 13**) of the HRC by group did not find any significant differences at the omnibus level [ $F(3,16)=.521, p=.674$ ] or amongst any of the groups in the Tukey HSD post-hoc test. This indicates that it is unlikely that the source of the variance between HRCs can be explained by any one particular group's activities or behaviors. Further this indicates that the variance in the Hit Rates between the novices and experts might again come from some other source.

ANOVA

Hit Rate Composite					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.034	3	.011	.521	.674
Within Groups	.346	16	.022		
Total	.380	19			

Multiple Comparisons

Dependent Variable: Hit Rate Composite

Tukey HSD

(I) Team Membership	(J) Team Membership	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Elementary	HLA	.006905672	.092195020	1.000	-.25686611	.27067745
	Science	-.02937313	.101503377	.991	-.31977630	.26103005
	Math	.081993556	.081834639	.750	-.15213697	.31612408
HLA	Elementary	-.00690567	.092195020	1.000	-.27067745	.25686611
	Science	-.03627880	.112343651	.988	-.35769621	.28513862
	Math	.075087884	.094947715	.858	-.19655941	.34673518
Science	Elementary	.029373125	.101503377	.991	-.26103005	.31977630
	HLA	.036278798	.112343651	.988	-.28513862	.35769621
	Math	.111366681	.104010010	.712	-.18620802	.40894138
Math	Elementary	-.08199356	.081834639	.750	-.31612408	.15213697
	HLA	-.07508788	.094947715	.858	-.34673518	.19655941
	Science	-.11136668	.104010010	.712	-.40894138	.18620802

**Table 13:** ANOVA comparing Hit Rate Composite by Team Membership

### 4.2.3 Hit Rate Composite by Level of Expertise

While no significant differences appeared in HRCxGroup comparisons, **Table 14** illustrates that level of expertise has a significant relationship with the HRC percentage. The omnibus test finds that the HRCs percentages are significantly different, indicating that differences exist between one or more levels of expertise [ $F(2,17)=13.61$ ,  $p<.001$ ]. In a new twist, the Tukey HSD Post-Hoc test illustrates significant differences between Novices and Expert groups ( $M=-.21$ ,  $SD=.05$ ,  $p=.001$ ) and Advanced Beginners and Experts ( $M=-.28$ ,  $SD=.05$ ,  $p=.001$ ), but the differences between Advanced Beginners and Novices seen in the test of frequency has disappeared ( $M=-.07$ ,  $SD=.05$ ). One explanation for the disappearance of the intermediary stage of expertise when switching

from Frequency to Boolean counts may come from the difficulty and experience associated with using all three types of thought tools in each comment. That is, the ability to make concurrent use of the three thought tools in one comment might require deliberate practice behaviors that occur between three and five years of teaching (the time-in-practice differences between most of the advanced beginners and the expert teachers).

*ANOVA*

Hit Rate Composite					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.234	2	.117	13.609	.000
Within Groups	.146	17	.009		
Total	.380	19			

*Multiple Comparisons*

Dependent Variable: Hit Rate Composite  
Tukey HSD

(I) ThreeLevelEx Nov	(J) ThreeLevelEx Nov	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Novice	AdvBeg	.068691410	.054842952	.440	-.07200034	.20938316
	Expert	-.2094586*	.047870853	.001	-.33226441	-.08665275
AdvBeg	Novice	-.06869141	.054842952	.440	-.20938316	.07200034
	Expert	-.2781500*	.059838566	.001	-.43165728	-.12464270
Expert	Novice	.20945858*	.047870853	.001	.08665275	.33226441
	AdvBeg	.27814999*	.059838566	.001	.12464270	.43165728

\*. The mean difference is significant at the 0.05 level.

**Table 14:** ANOVA comparing Hit Rate Composites x Expertise

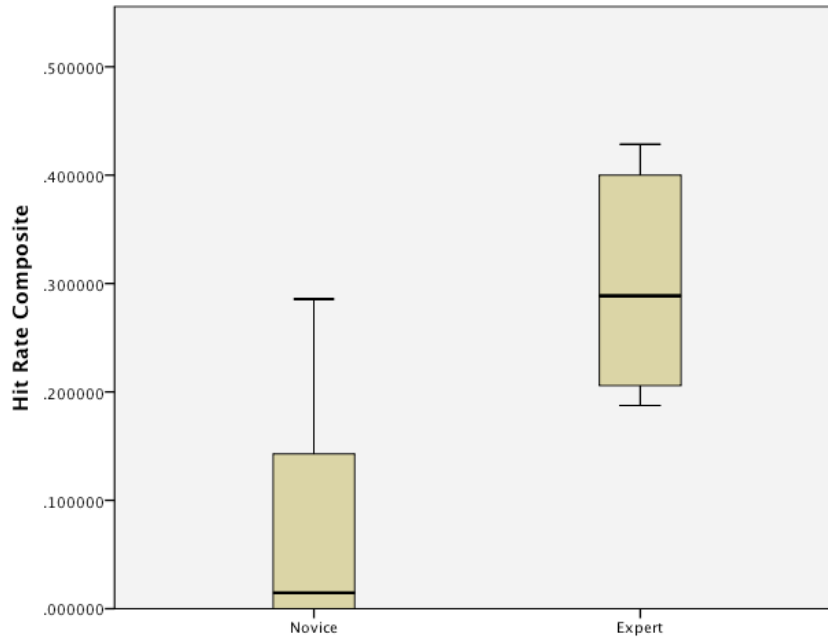
These differences allow us to collapse the novice and advanced beginner categories into one ‘novice’ category. This would provide a strong argument for a binary distinction between experts and novices in the context of the ATEP data, and the idea that HRCs are sensitive enough instruments to discern between the poles of the expertise spectrum. However, it is now possible to use more advanced statistics to further refine our

understanding of the relationship between Expertise and the HRC expression of the Grounded Theory.

#### **4.2.4 Deriving a Predictive Model for the Data**

Based on the lack of statistical differences between Novices and Advanced Beginners, I chose to collapse those groups into a single ‘novice’ group in relation to the production of Complete Noticings. This required the reclassification of all 4 Advanced Beginners as Novices, a move that makes sense in the realm of theory and in the Wild. No Novice or Advanced Beginner in the ATEP program had more than two full years of teaching practice, compared to the three or more years of teaching and coaching (and substantially greater number of years of research in teacher education) that attend the Expert group. In recoding participants this way, I realized that a new opportunity to establish the validity of this theory came into view. Because of the observed polarity of the novice/expert participant spectrum, I realized that the creation of a predictive model could provide a further layer of abductive proof. That is, a statistical model that can predict novice/expert assignment based on HRC scores may also serve as ‘necessary and sufficient’ evidence for the validity of the theoretical model represented by the HRC. For this reason, I chose to assemble a binary linear regression model, as this methodology produces a number of illuminating metrics based on the HRC percentages.

This decision was further supported by the Box and Whisker graph (**Figure 16**) below, where the data indicates substantial differences between the Hit Rate Composites of the Novice and Expert Groups:



**Figure 16:** Novice and Expert Hit Rate Composites

In this graph, the mean and range of the Novice candidates' Hit Rate Composite is much lower than that of the Expert group, with the exception of one outlier Novice (identified as AmJe) who approximates the mean of the Experts because of her small number of overall comments. Further, there are several 'low-performing' experts who interacted with students via email, in person, and in other non-VBOCS contexts for reasons that are still unclear. The differences between novices and experts are clearly visible from the Box-and-Whisker plot of the interquartile ranges.

In addition to simplifying our assessment of Fit, collapsing the three groups into two categories allowed me to consider the use of a logistic regression as a means of testing fit (Tabachnick and Fidell, 2007) to test whether it is possible to predict an individual's level of expertise based on the number of Complete Noticings that they made over the course of the year, as a percentage of their total commenting activities. In preparing the



Step number: 1  
Observed Groups and Predicted Probabilities

	8	+N	
+		IN	
I		IN	
I		IN	
F		IN	
I	6	+N	
R		IN	
+		IN	
E		IN	
I		IN	
Q		IN	
I		IN	
U		IN	
I	4	+N	
E		IN	
+		IN	
N		IN	
I		IN	
C		IN	
I		IN	
Y		IN	
I	2	+N	N

E

**Figure 18:** Cut Value of .3

In all cases of the model, the use of .3, .4, or .5 as a cut value compared favorably to the 30% predictive rate found when HRC is not compared against Novice/Experience status (as in the Entry Block test in **Table 15**, Tabachik & Fidell, 2007). That is, if expert-novice quality is unaccounted for in the regression, the model fails to make better-than-even odds projections for the person's actual classification. For this reason, I will use the full model to make further assertions about the nature of the HRC value as a means of predicting expert behavior.

Classification Table<sup>a,b</sup>

Observed	BinaryCoding	ExNov	Predicted		Percentage Correct
			Novice	Expert	
Step 0	Novice	Novice	0	14	.0
	ExNov	Expert	0	6	100.0
Overall Percentage					30.0

a. Constant is included in the model.

b. The cut value is .300

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0 Constant	-.847	.488	3.015	1	.082	.429

**Table 15:** Poorly-predictive entry block model (.3 cut value, no expert-novice predictors)

## Logistic Regression Model

A test of the full model (**Table 16**) with the set of predictors against the null model with predictors was significant,  $\chi^2(1) = 14.31, p < .001$ , and indicates that the set of predictors reliably distinguishes individuals who were categorized as experts from those who were not (as quantified by the log-odds). The non-significance ( $p > .05$ ) of the Hosmer and Lemeshow test indicates that the data was a good fit for the model, and Nagelkerke's R Square indicates that the model of the condition of being expert or novice and its effects on the HRC commenting values accounts for 72.5% (.725) of the variance in the data, an indication of strong fit. The model sensitivity was 92.9% and specificity was 100%, with an overall hit rate of 95%, or better than the null model's hit rate of 30%. Expertise, as a predictive variable, was significantly different from zero, indicating that the log-odds for experts making Complete Noticings (holding all predictors constant at zero) was  $1.22 \times 10^{10}$ ,  $b = 23.28$  (SE = 11.20),  $Wald(1) = 4.3, p < .05$ . As a result of these findings, it is possible to assert that the statistical model

generated by the logistic regression supports the hypothesis that the HRC (a value that represents each individual's tendency to make Complete Comments) accurately predicts expert/novice categorization.

*Omnibus Tests of Model Coefficients*

		Chi-square	df	Sig.
Step 1	Step	14.310	1	.000
	Block	14.310	1	.000
	Model	14.310	1	.000

*Model Summary*

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	10.125 <sup>a</sup>	.511	.725

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

*Hosmer and Lemeshow Test*

Step	Chi-square	df	Sig.
1	1.208	6	.976

*Classification Table<sup>a</sup>*

	Observed		Predicted		
			BinaryCoding Novice	ExNov Expert	Percentage Correct
Step 1	BinaryCoding	Novice	13	1	92.9
	ExNov	Expert	0	6	100.0
Overall Percentage					95.0

a. The cut value is .300

*Variables in the Equation*

Step		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1 <sup>a</sup>	HitRateCompo site	23.228	11.201	4.301	1	.038	1.224E+10	3.580	4.186E+19
	Constant	-5.129	2.421	4.491	1	.034	.006		

a. Variable(s) entered on step 1: HitRateComposite.

**Table 16:** Logistic Regression Results

Based on the results of this test, it is possible to say that the co-occurrence of the three tools identified in this Grounded Theory (known as the Complete Noticing) is indeed an accurate predictor of a participant's level of expertise when co-occurrence is used as a factor through the HRC value. This also provides further evidence for our central

questions about the relationship of expertise and metacognitive thought tools that inform the upcoming virtual learning environment design.

And so I close the statistical analysis portion of this study, having learned four lessons about the validity of the Grounded Theory from the previous quantitative tests:

- 1) Content Team membership (a controller variable) does not have a relationship with frequency of use of thought tools.
- 2) Level of expertise does have a relationship with frequency of thought tool use, indicating that novices, advanced beginners, and experts have different capacities for using Literal-Inferential-Critical thought tools when commenting on videos.
- 3) Content Team membership does not have a relationship with the Hit Rate Composite percentage that represents the intersecting occurrences of the thought tools.
- 4) Level of expertise does have a relationship with Hit Rate Composite, indicating that HRC is predictive of a participant's classification as expert or novice.

With these tests, it is possible to determine relationships between the kinds of comments that a person makes and their level of expertise. Based on these findings, I would make the cautious claim that technological systems designed to support the honing of these core thought tools can help novices become experts in a more focused and deliberate way by incorporating these findings into the software. However, this is not a claim that should be taken lightly, and this study will require a new epistemology to understand the ramifications of the use of these tools in practice-oriented contexts. Thus, this confirming evidence presents us with a new opportunity to ask how the process of

design as a research tool to might support the development of a space for participants to try out these thought tools in a natural and satisfying way.

### **4.3 Modifiability: A Research-Based Design**

In Grounded Theory, the test of Modifiability serves as a means of assessing the continued fit and relevance through the capacity of the Theory to change as it relates new data and new contexts. For this reason, I will attempt to integrate the findings from the Grounded Theory and my own observations of the ATEP activity system into a larger design that would hypothetically support the ATEP's video-based reflective activities as examined in the introduction (**Figure 7, Chapter 1**). That is, I will present a design for a flexible virtual learning environment (Curtis, 2009) that further supports the observed connections amongst actors and groups through their tools. This reusable set of activity environments may be recombined by local communities in ways that support the development of thought tools by reducing the transactional costs associated with the activities that invite the use of thought tools (as designed by the experts in the community). Further, the study will evaluate the claim that the design of a hypothetical persuasive technology platform (Fogg, 2003) will allow this study to engage in the process of reconciliation of the Grounded Theory of Noticings with the actual constraints of real-world implementation. The research-based design provides support for the embodiment of the conjectures (Sandoval, 2013) of the Grounded Theory by designing a place for participants to easily instantiate their thought tools, and an artifact to test in the future.

The test of Modifiability will create an opportunity to engage in a round of critical design as identified in Dunne (1999) and in Barab, Thomas, Dodge, Squire, Newell

(2004). Anthony Dunne, a media theorist first coined the phrase *critical design*, and identified the methodology as a means of provoking responses and thought from participants in response to novel problems of design. In transporting this idea to the world of education, Barab et al. note that it is possible to use designs to test, support, and develop theories about the development of tools for use across multiple contexts, but only through a deep understanding of how participants use their knowledge in local instances.

In the context of this study, the creation of a Critical Design for software to support this community is a novel way to examine the potential Modifiability of the Grounded Theory, and one that provides new light on the observations and data examined so far. This process of design represents the study's opportunity to posit a counterfactual of its own, to consider how a video-based online commenting system might support the program's endeavors, from the particulate level of the Grounded Theory of Complete Noticings to the holistic and integrative level of the participant experience. That is, the use of a critical design as a formative investigative tool (Burdick, 2003; Schrag, 2006) that examines its basic assumptions provides a way to instantiate the Grounded Theory into something tangible once more. The effect of this condensation from theory to a new learning environment will then be redistilled into a multi-domain theory in the workability section, where researchers might envision the use of the flexibly designed VBOCS software design in the context of other professional settings.

The inspiration for this redesign of the system came from seeing a presentation on work done in learning environment design at the University of Minnesota. The University of Minnesota LT Media Lab has created a set of technologies that support formative feedback and assessment to support language acquisition and learning (Doering, Miller, and Scharber, 2010; 2012). Two of the tools created there (AvenueASL for adult ASL learners and AvenueDHH for deaf and hard-of-hearing children) promote the fluid exchange of feedback and frequent assessment to enable learners to focus on their specific skill deficits. The software created by Doering et al. applies the principles of personalized feedback, authentic assessments, and simple interface design to provide learners with a rich and individualized learning experience of the kind that might best serve professionals.

The design for the software is also based on three bodies of data collected over the course of my involvement with the project that would support my specific design claims. First, the design itself originated as a result of discussions with participants in the field, including Team Leads and novice teachers. These discussions helped to identify some of the causes of transactional costs (non-learning interactions with software that require active user decisions, such as file management and video uploading) that designers might hope to avoid in the future. Second, I will draw from a consensus document of software requirements created by the Team Leads to clarify ‘deal breaking’ features of such a design. This feedback was created in response to the *Odin* system itself, and provides invaluable insights into the values and goals of the participants. Finally, I will extend these two sources of data through the introduction of a ‘paper prototype’ of the

software that I created and member-checked with the ATEP community. Because of its presentation in April of 2012, I named this iteration of the prototype *Aviva* (Hebrew: the Spring season), though it has been subject to several revisions since its inception. Each of the selected wireframes (or individual screen mockups) in the study provides an opportunity to envision a new form of the VBOCS technology that more ergonomically supports reflective learning activity.

#### **4.3.1 Technological Requirements from Candidates and Leads**

While the design presented here is based on authentic discussions with novice and expert teachers within and beyond the ATEP program, it contains three starting assumptions based on my own experiences with the participants, and member checked with several participants. These included:

- Tighter integration of software and learning process (as defined by Team Leads) will lead to more satisfying user experience and more consistent use of the learning process across teams
- The use of a single system that provides the structure for the learning process will reduce waste-time for Candidates and Leads
- The possibility of producing a high-quality representation of their practice will motivate Candidates to invest effort in their portfolio projects and commenting

Additionally, the Team Leads provided a set of requirements that expressed their concerns and interests in the design of a program that would support reflective practice:

- Workflow must be completely performed in-system
- Commenting must be done on the video's timeline, and comments should be aggregated into a list below the videos
- It should be possible to share and re-share videos across groups and assignment, maintaining privacy of commenting across groups
- No 'patchwork' solutions (e.g. storage in another platform that requires a second user-name or password)
  - Online video editing, cutting, and compressing would ideally be done in-system in straightforward and unobtrusive ways
  - Leads must be able to receive customizable notifications of comments, videos, and changes to the system

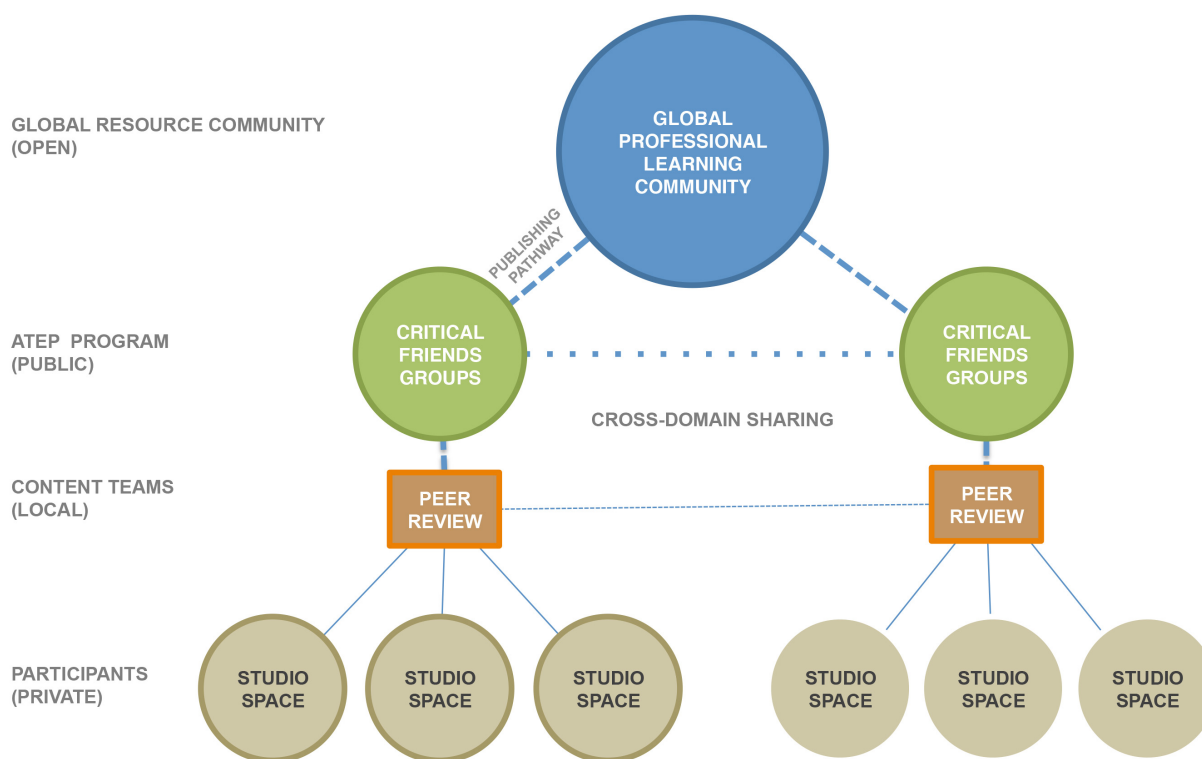
In providing this design, this space for participants to use and hone their skills with thought tools, I have attempted to integrate these assumptions and requirements gathered from the community into the make-up of the system. This process will produce a flexible platform that can be reconfigured in multiple ways to produce a more effective reflective practice experience.

#### **4.3.2 Proposed Redesign of the Software Architecture for Flexible Community**

##### **Building**

In considering an alternative VBOCS software platform to wrap around the ATEP program's social practices and thought tools, I decided to begin with an examination of the *Odin* platform's taxonomic structure. As noted in the introduction to the context, the *Odin* platform is structured around creating strong local communities of practice.

However, participants were unable to create spaces for public display of teaching because of the system’s ambiguous support for anything above or below the group level.



**Figure 19:** Proposed Community Structure

After many discussions with one of the principal investigators on the project, I began to see possibilities for the use of a VBOCS system to scaffold a global/local context through the use of the ‘studio space’ metaphor. In the model illustrated in **Figure 19**, this new ideal community for the support of video-based commenting is reoriented around a private space for each participant that may only be accessed by the participant and their coach. In these private spaces, the coach and participant may comment freely on the video in a safe and private way, coaches may assign further remediation or

feedback, and privately evaluate the submitted video. However, part of growing as a practitioner in any field is periodic feedback from peers, coaches, and colleagues on one's practice. This new system would support the promotion of high-quality videos from the studio space to local instances of Peer Review. In this system, Peer Reviews are events as opposed to spaces, and may be called whenever a formative or summative feedback cycle is ready to advance or conclude. It may also be called by coaches as well as by participants who would like help with a particular feature of their practice. When a Peer Review is called, candidates may choose to move materials (including videos, photos, and documents) from their Studio Spaces to the Peer Review for discussion and review. Further, Peer Reviews are 'permeable,' meaning that members of other higher-level groups (e.g. different teams) may be invited to discuss and share their work.

In addition to the Peer Review events, studio spaces are hierarchically oriented to the larger professional communities through Critical Friends Groups. Though there are numerous potential protocols for community-norming, I chose the Critical Friends Groups structure specifically because of its focus on the roles of feedback, collaboration, new solutions, and community in the context of coaching and practice (Bambino, 2002). Further, this selection for organizing the social space of the community comes from my observations of the use of the CFG protocols as a norming tool for synchronous video-based discussions of practice in a previous appointment at the university. During my time as a technology steward on a different project, I had the opportunity to support a blended online/in-person teacher induction program in their use of technology. One of the major features of this induction program was its use of a modified CFG protocol to

scaffold the use of time and maximize interaction in a synchronous online workspace. Candidates in the program (first year teachers from the university credentialing program who had accepted positions in Tokyo, Beijing, Mexico City, Madrid, and Cairo) met online four times during the year to discuss their practice and share their evolving capstone projects that fulfilled their graduation requirements. The candidates reported positive feedback regarding the use of the CFG protocol to structure their reviews. Extending from my past experience, this design would further test the adaptability of the CFG protocols to the support of asynchronous professional development support software by providing a structure for the process.

However, this past experience should by no means limit the imaginations of others who are constructing such systems; others may imagine a similar restructuring of the group-level unit using other kinds of protocols and strategies, depending upon the needs of the local context and coach preferences. In fact, it may be possible to provide coaches with back-end tools that facilitate the development of custom protocols that fit their own context. Further, these custom protocols (e.g. a specific constellation of assignments, timelines for completing assignments, and goals) might be made shareable to other members of the global and local community. For the time being, however, the CFG protocols may provide an adequate ‘default’ starting structure for the purposes of a community that does not have the necessary expertise to develop its own protocols.

Beyond the level of the Critical Friends Groups, the Global Professional Learning Community provides a space for professionals-in-practice to disseminate their written

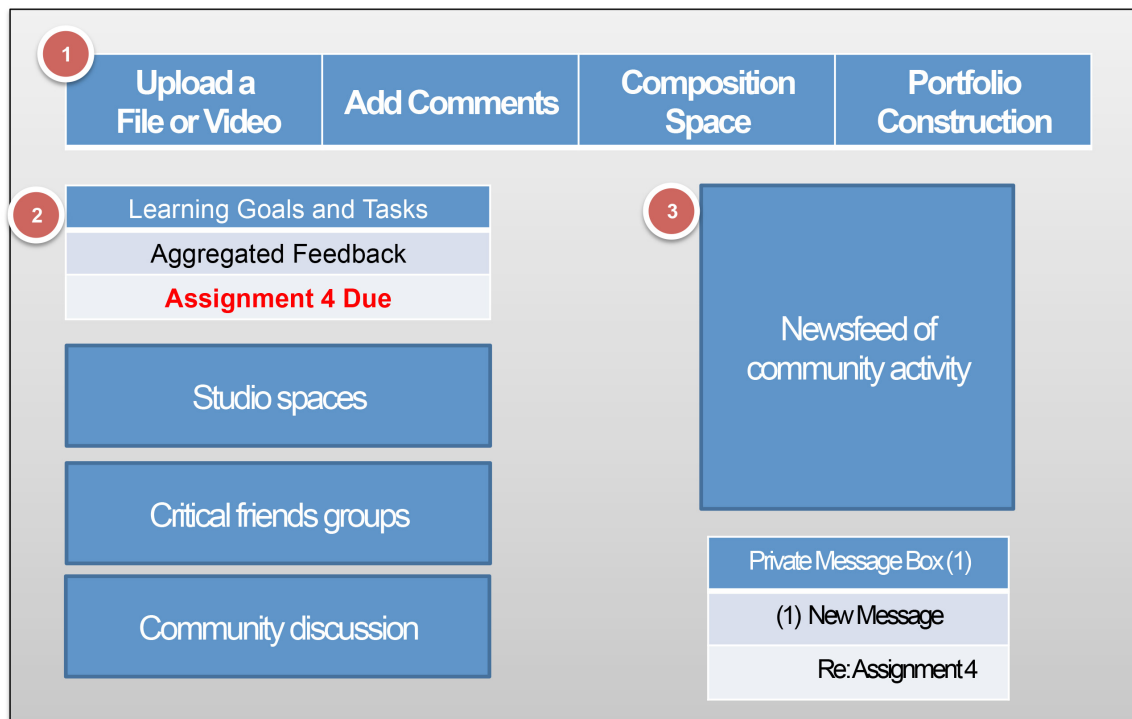
findings to other practitioners across the larger field. This ‘publishing’ activity would occur by nomination of the Critical Friends Group, and acts as a peer-reviewed dissemination apparatus that helps to provide a wealth of knowledge for participants and coaches. In addition to the benefits accrued by each individual professional in each event thus far, it might also serve as a curated space for coaches to share exemplar videos of teacher enactments for others to use. These twin features would also serve to solve a key problem articulated by both the Team Leads and Gainsburg (2009). In the ATEP context, the Team Leads found it difficult to find high quality videos of practice for their novices to observe and discuss, as many of the professionally produced videos in teacher education contain out-of-date practices and information. Further, many of these videos were not relevant to the needs of residency-based teachers. The use of publishing and practice sharing may provide experts with a broader number of options for representations of practice, as well as a way for all learners to disseminate their research-in-practice to others in the field.

The technology-supported community structure proposed in this section provides an opportunity to discuss many of the issues relevant to the development of the technology that would support a professional learning community like ATEP. As this study digs deeper into the function and user experience of this *Aviva* system, it will examine a selection of relevant wireframes that support participant activity in ways that cultivate the deliberate use of the thought tools described by the Grounded Theory. That is, now that I have shown some relevant examples of how participants in the PLC make meaning, the study may begin to imagine a place where that meaning can be achieved.

And so the study will present a critical design for a virtual learning environment that flexibly and seamlessly supports the local community's learning process.

Each space in *Aviva* provides an opportunity to consider how designers may provide participants with an environment to hone and refine their thought tools. In either case, this examination of the prototype will ideally open up further avenues of dialog for designers interested in the development of these kinds of spaces. To this end, the crucial spaces represented by the following wireframes will receive specific questions that future researchers in Learning Sciences and Human Centered Design Engineering may pursue. The inclusion of these questions emphasizes the contingent and emerging nature of the software, as opposed to a completed product. I invite future researchers to build this design, test it, improve upon it, or critique it, and thus continue to advance our collective knowledge about reflective practice in VBOCS platforms.

### 4.3.3 Aviva Space: Dashboard



**Figure 20:** The *Aviva* Dashboard

The Dashboard is the first space that the participant interacts with after logging into the system; it must reflect their needs and provide quick access to specific activities.

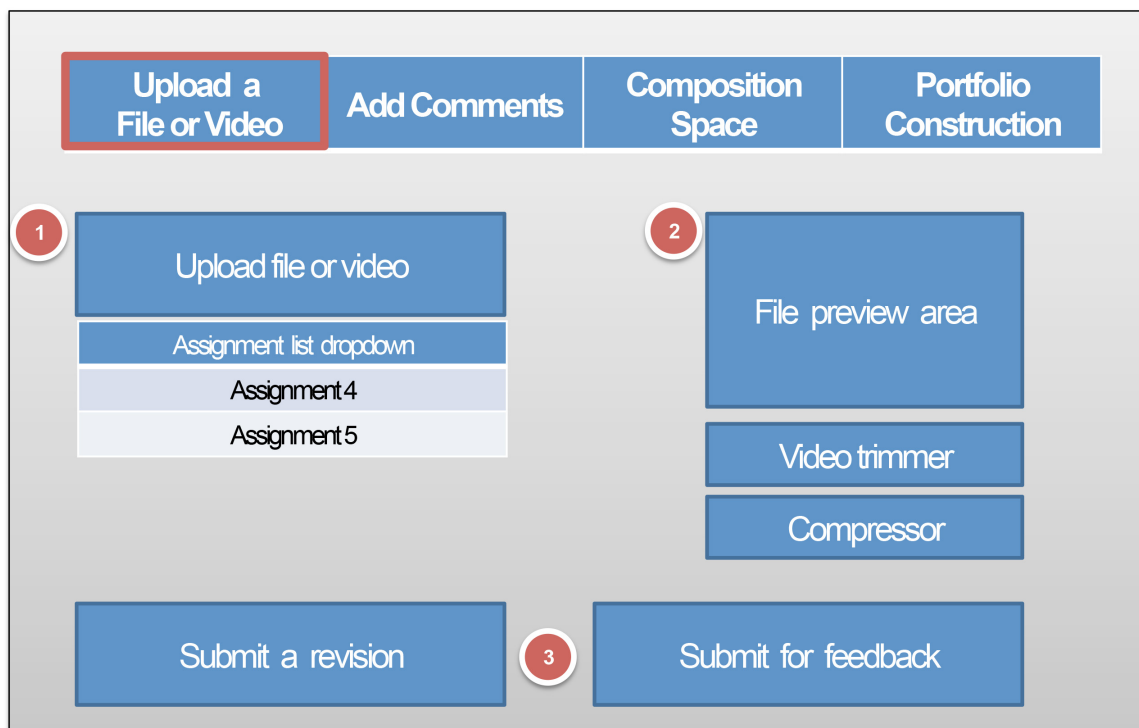
Therefore, the goal of the dashboard is to quickly present relevant information regarding their assignments and provide the smoothest possible journey to an activity space. In the case of this iteration of the prototype, the horizontal buttons (1) in the top row represent shortcuts to frequent activities, while the vertical array of dropdown menus (2) represent links to other spaces in the system, organized hierarchically from lowest (and most immediate, e.g. assignments) to highest (and more infrequent, e.g. publishing opportunities). Finally, the right side (3) of the screen contains a news feed of relevant

alerts (e.g. assignment changes, grades, etc.) and a display portal for incoming private messages, discussions, and responses.

**Questions for Further Investigation:**

- What are the most common activity spaces used by learners, and how might this inform the layout of the dashboard to reduce waste-space?
- Might we find other, more relevant ways to use the dashboard space?
- Might different workspaces call for different dashboard layouts and use cases, or is there a possible universal design for all domains?

#### 4.3.4 Aviva Space: Upload a File or Video



**Figure 21:** Uploading a File or Video

The Upload File or Video page would provide participants with an easy means of submitting their large video files to the commenting system. In the first action on the screen, candidates can choose an assignment to upload their video or a non-video file (e.g. a Word document containing a lesson plan, a PowerPoint for a proposed activity, or a photo of student work from the classroom) (1) using a dropdown that is automatically populated with their current local assignments (as assigned by the Team Leads). Then, candidates may choose to preview their video, or use the built-in video trimmer and compressor (2) to reduce the length and size of their video before upload. The addition of these features (not present in the *Odin* platform) would reduce two of the most common technical complaints from the users (that their videos are too long, and that the

file size is too large to easily upload). Finally, candidates may then choose to submit their video as a revision of a previous assignment, or send it to their studio space for feedback from their Team Leads (3).

**Questions for Further Investigation:**

- In what ways might this workflow increase or decrease learner participation in video uploads due to the simplified process?
- Does the inclusion of in-system compression and trimming tools decrease participant frustration with the process of moving large video files?
- Are there other ways to arrange the system submission buttons that are clearer to the participants, or is the pair illustrated here adequate?

### 4.3.5 Aviva Space: Add Comments Page

File Name	Assignment	Type	Date submitted
Round 1 Lesson Plan.pdf	Round 1	Lesson plan	10/14/2012
Round 1 enactment video.m4v	Round 1	Video Enactment	10/20/2012
Week 7 hot topics.doc	Week 7 class	Hot topics	10/31/12
Week 7 exit slip.doc	Week 7 class	Exit slips	10/31/12
Round 2 Student Work.pdf	Round 2	Student work	11/2/12

**Figure 22:** Adding comments to a file or video to the system

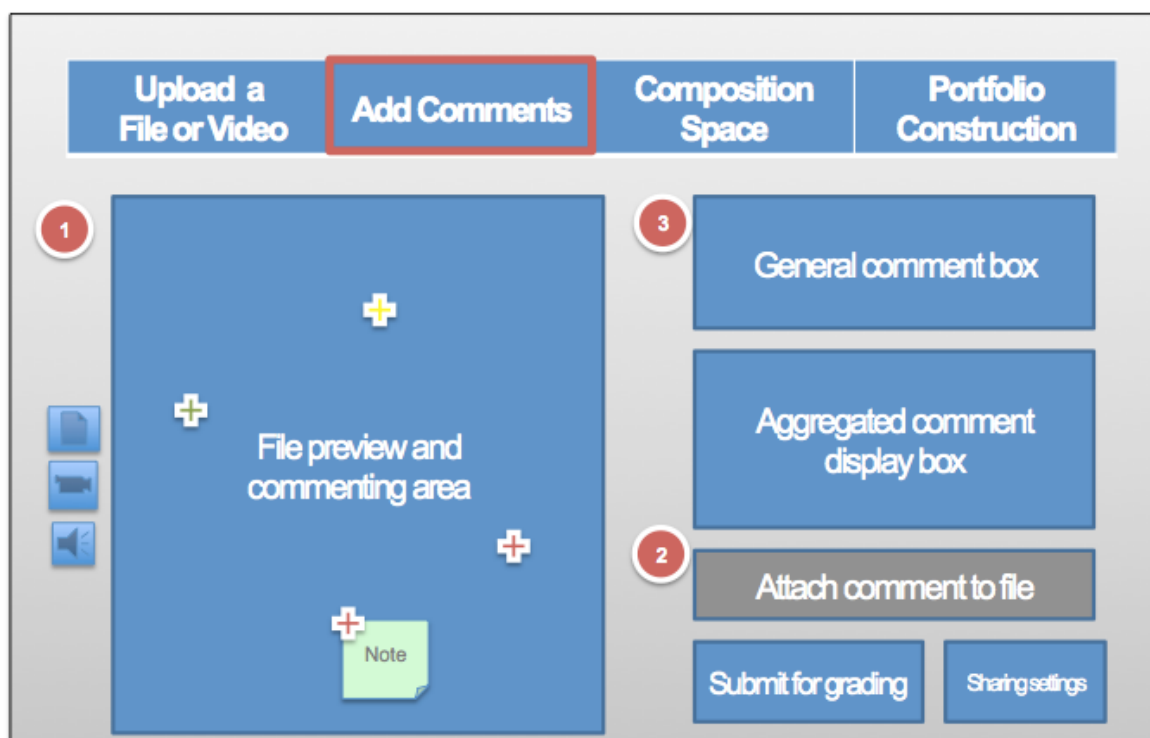
Once the participant has uploaded a video or document to the system, they may access their files at any time through the *Add Comments* option (1) at the top of the screen. This will present them with a list of files that they have uploaded to the system (2), including information about the file name, assignment name, assignment type, and the date submitted. (The system might also support the use of a ‘grade’ column in communities with a relevant need; the concept of ‘grading’ was left out of this screen, as it may agitate some users and discourage their free-commenting during this phase.) These lists are also sortable by column, allowing easy access to the most recent files. When a user

clicks on one of the file rows, they are automatically taken to the relevant commenting page (screens 4 or 5). In addition to this screen, there is a counter-part (not shown) for community administrators that would allow coaches to keep track of incoming videos, graded and ungraded assignments, and learning analytics for their novices.

**Questions for Further Investigation:**

- Do participants need immediate access to this page in the form of a quick-link (1), or are there other links that may prove more useful?
- Does this possible layout effectively facilitate the revisitation of past assignments for the purposes of revised commenting on candidate work?
- What kinds of data and metrics would help coaches to assign work for that builds and grows their novices in desirable and predictable ways?

### 4.3.6 Aviva Space: Adding Comments to a Non-Video File



**Figure 23:** Adding Comments to a Text File

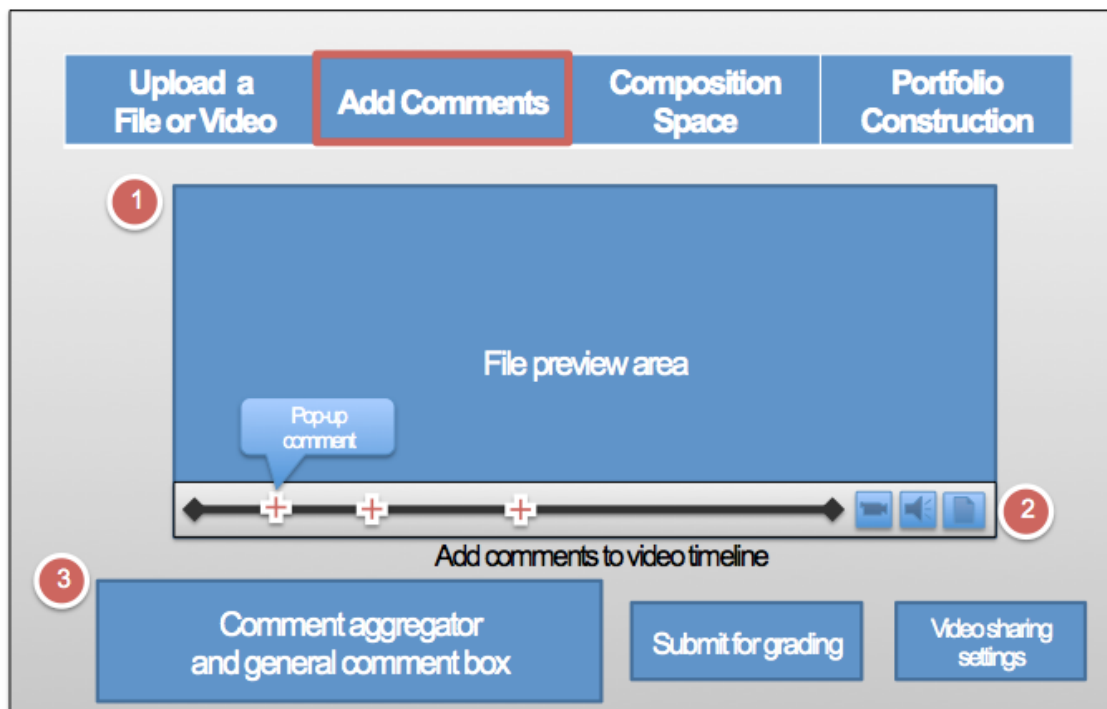
While the original *Odin* platform focused primarily on uploading and commenting on video, this platform would expand that commenting capability to text documents and photographs as well. Through this interface, Team Leads and peer reviewers would use the File Preview area (1) to identify areas of the document that need attention using virtual ‘pushpins’ that affix a comment (text, video, or audio) to the document in a particular place by dragging it from the icon on the far to left to the File preview and commenting area in the center-left. After placing a pushpin, the participant can use the Comment Composition and Review Space (2) to compose or edit the comments. Finally, the participant can click the Attach comment to file button (3) to add new comments, or submit the file for grading or sharing. The process supported by this screen would

ideally scaffold the three activities of professional vision (Coding, Highlighting, and Representation, Greeno 1994). Participants might offer feedback on lesson plans and other practical tools in ways that keep the comment pinned tightly to the evidence. At present, HTML5 tools provide the necessary technological functionality to support this document-commenting process, and the availability of these tools will expand in the years ahead.

**Questions for Further Investigation:**

- What kinds of interactive or video features might be integrated into the commenting process to facilitate user engagement and thought-tool use?
- Might a full-screen option increase users' focus on the document?
- Might a Microsoft Office or Google Docs plugin improve the workflow of users who are already familiar with those tools?

### 4.3.7 Aviva Space: Adding Comments to a Video File



**Figure 24:** Adding Comments to a Video File

When users upload a video, the system will automatically take them to a video-commenting page. On this page, the users will see their recently uploaded video file displayed in the center of the screen (1). Below the video, users will be able to enter their comments directly onto the video timeline (based on the position of the playhead) in text, video, and audio formats (2). In addition to these ways of adding comments, a third area supports the writing of longer, non-timeline comments that would be displayed in a separate activity stream aggregator. This way, users can see a running log of the comments and meta-discussions occurring beyond the location on the timeline.

#### **Questions for Further Investigation:**

- How might fast-forward/rewind system support students in finding moments in their clips?
- Are there other kinds of technological solutions that we might employ (e.g. pattern recognition software, volume comparison) to aid participants in the selection of important moments?
- How might learners use this space to recruit quick feedback from fellow teachers? Can the commenting platform be optimized for mobile devices?

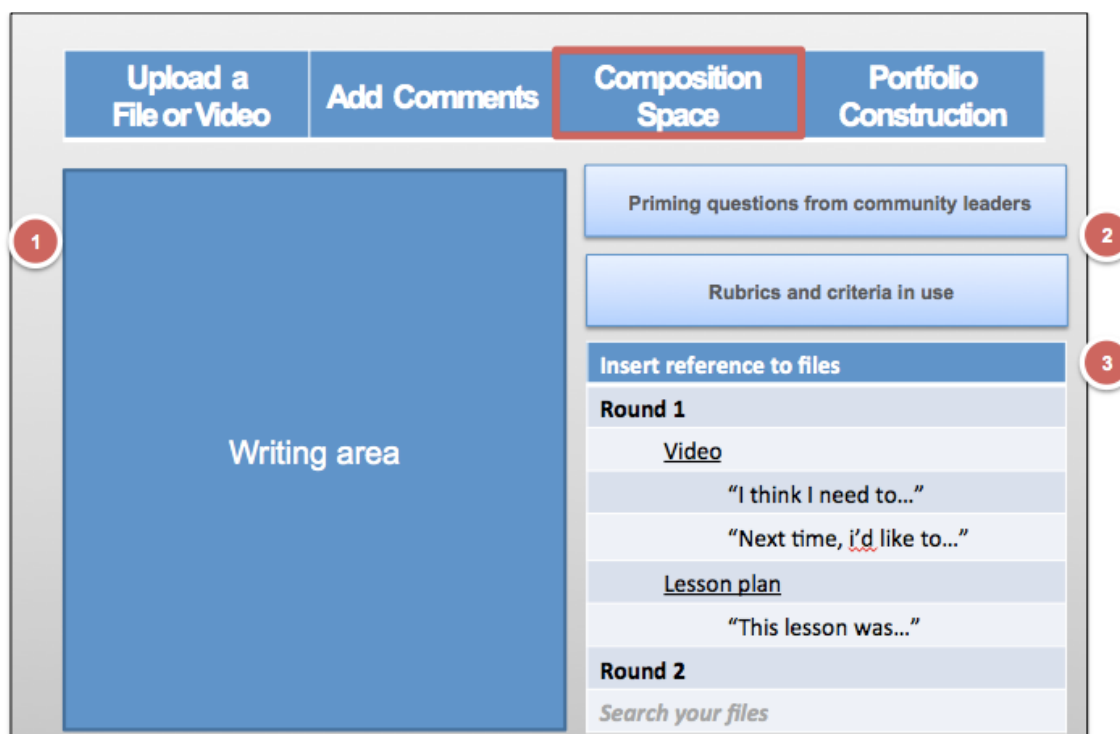
### 4.3.8 Aviva Space: Composition Spaces

1	Composition Name	Assignment	Type	Date submitted
	Round 1 Lesson Plan	Round 1	Lesson Plan	10/14/2012
	Round 1 Video	Round 1	Video Paper	10/21/2012
	Round 2 Video	Round 2	Video Paper	

**Figure 25:** Composition Spaces

As video commenting gives way to longer compositions in formalized professional development programs, this interface would support that transition through the ‘Composition Space.’ Here, users may access existing and assigned compositions (1) of various types (e.g. video paper, lesson plan, journals) that reflect the pedagogy of the coaches and instructional designers. These assignments may be started by the user and ‘attached’ to assignments using the ‘New Composition’ feature (2), or may be pushed to the user by a coach. In either case, these assignments may be duplicated (to reduce formatting time) or submitted for grading from this screen as well. Participants can also choose to duplicate their assignments (to reduce redundant work), submit the composition to a coach for grading (in programs where this is required), or call for a Peer Review of the composition when they are ready to share their ideas.

### 4.3.9 Aviva Space: Compositions



**Figure 26:** Compositions

In the Composition Space itself, users will find the safe, private ‘Studio Space’ presented in the discussion of the community redesign. Here they may try out new ideas and observations (and have them reviewed privately with a coach) before submitting them to the larger community for discussion. On the left side of the screen, students will use a multimedia writing area (1) to compose their reflections or create annotated photo galleries that represent their practice. The Priming Questions area (2) is placed directly to the right of the writing area, as the close proximity will encourage writers to refer to the question periodically (as in Clark and Mayer, 2010). The presence of the Priming Questions in a conspicuous spot near the writing area may be essential to focusing the participant’s observations. Below the priming questions, participants will see the rubrics and criteria that may have been attached to the composition assignment by the coach. In

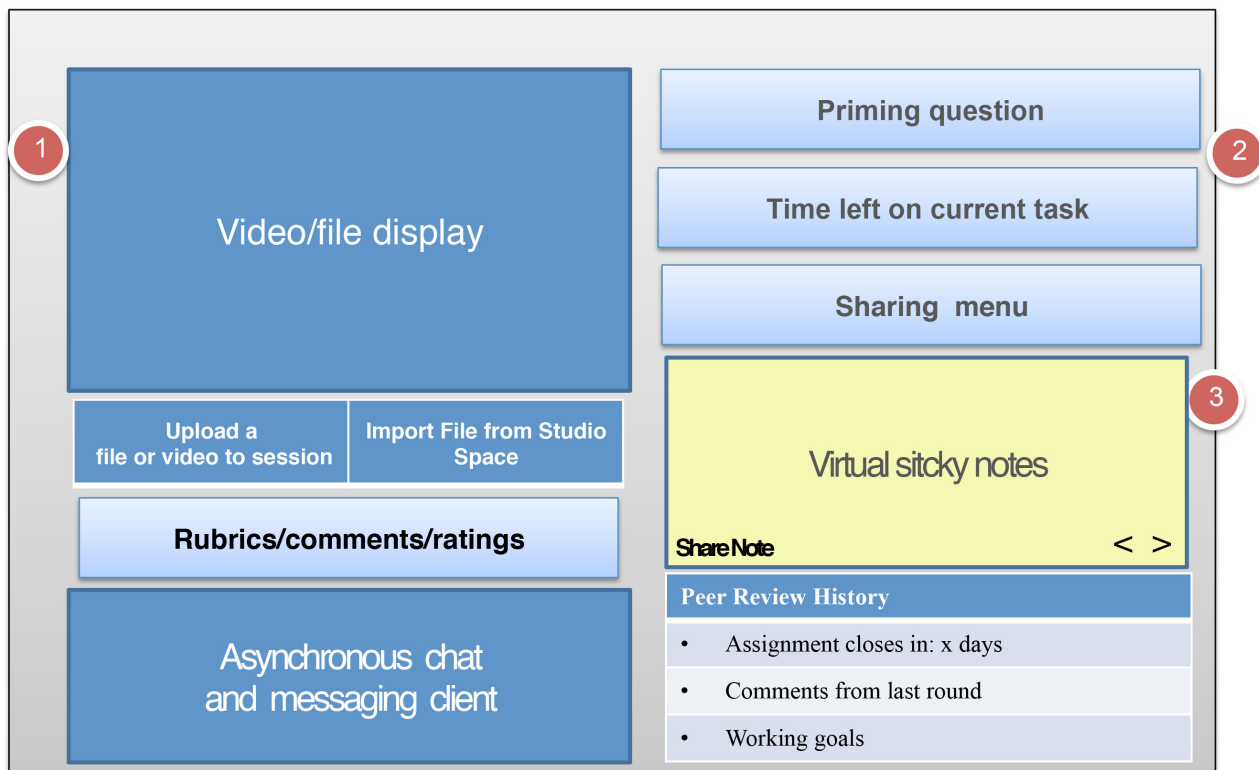
addition to the priming questions, these rubrics may give participants a clearer understanding of the coach's expectations for the videos.

Below the priming question, students will see an automatically populated list of their comments from past videos and lesson plans (3). The 'Insert References to Files' box would allow the writer to closely tie their thoughts to their past observations in their videos through the use of hyperlinks to those specific moments in the past. On mouse-over, the hyperlinks would provide immediate thumbnail views of the comment's position on the video timeline or document, and would open the video to that point upon mouse-click. Participants' efforts in video commenting are not left behind as they proceed to other, more complicated reflection assignments. Rather, they appear at a glance for learners to continue using as evidence throughout their reflective experiences. The addition of an advanced search function (including disaggregation by date, time, tags, and comment text) to this tab would also allow participants to dig into their past recordings, and help to reduce biases towards selecting data from newer artifacts. In making the video easier to work with through this space, the commenting features of the system may continue to scaffold the learner's observations over time, providing an indexed view of their observations and performance.

**Questions for Further Investigation:**

- Might we imagine ways to subtly cue the writer's attention to the priming question during the composition activity?

### 4.3.10 Aviva Space: Peer Review Sessions



**Figure 27:** Peer Review Sessions Screen

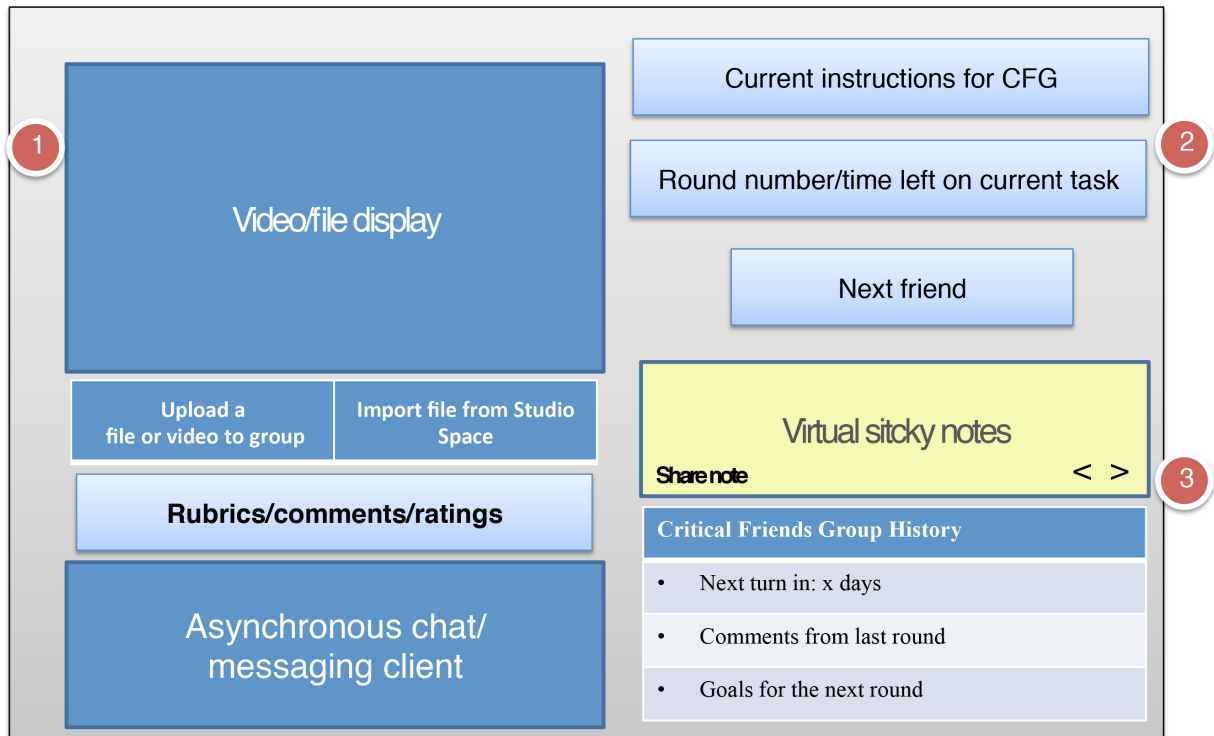
As noted earlier, actors or coaches may call Peer Review Sessions whenever they are ready for community feedback and discussion around a participant’s video. Research from Zhang, Lundeberg, Koehler, and Eberhardt (2012) indicates that teachers experienced the greatest growth when commenting on their own videos, and found that teachers also value privately delivered feedback from other peers or coaches. For this reason, peer review spaces in the system provide a private, asynchronous space for teachers to receive and provide feedback with participants of their own choosing.

On the left side of the screen (1), participants have the option to upload videos or files to the peer-review session, or import a file directly from an existing studio space. They may also choose grading rubrics from a drop-down menu below the video preview, so that their peer reviewers may make comments and assign scores related to specific qualities of the video or quality. At the bottom left, an asynchronous chat window provides participants with opportunities to discuss, ask probing questions, or make recommendations to the reviewer. On the upper-right side (2), participants see the current priming question from their team lead as a constant reminder of their current task, followed by a reminder of the number of days until the assignment ends, and a menu with options for adding or removing reviewers. At the bottom-right (3), a peer-review history box keeps track of past interactions, including a cumulative score based on the selected rubrics, a roster noting the participants who have submitted reviews and those who have yet to do so, comments from the previous round, and goals for continued learning.

**Questions for Further Investigation:**

- Is this space adequately configured to provide a satisfying user experience for online peer review?
- If not, what components might we test together and in isolation to provide a better model?

### 4.3.11 Aviva Space: Critical Friends Groups



**Figure 28:** Critical Friends Groups

Critical Friends Groups (Bambino, 2002) provide students with a safe, reflective environment for discussing relevant issues of practice, and have been successfully used to structure discourse in online environments (Collins, Cook-Cottone, Robinson, Sullivan, 2005). In addition to the smaller, more private peer-reviewed spaces in the system, all participants in a team would have access to the Critical Friends Group space, as a type of ‘lobby’ for structuring feedback. However, at present, there are few existing models for the use of asynchronous CFGs in online workspaces, and the regulation of time is a crucial part of the CFG process. For this reason, a technologically scaffolded CFG space may provide students with opportunities for rich discussion and feedback.

In this space, the left side of the screen (1) contains the same tools as in the peer-review. The right side of the screen (2) illustrates the differences between a peer-review and a CFG. In CFGs, learners progress through ‘rounds’ of discussion, providing each person with at least 5-10 minutes to discuss their current problems of practice, followed by feedback and ideas from other Critical Friends. While timing, transitions, and note taking are crucial for these activities, the effectiveness of the CFG is in some ways reliant on the skill of the moderator or coach. By scaffolding this process through the commenting system, CFGs may be able to function asynchronously, with instructions, notations about the round number/time available for commenting, and the option for the coach/leader to proceed to the ‘next friend.’ At the bottom-right of the screen, participants would also be able to take personal notes on the content and provide these to the participant under scrutiny (3), as well as see a summary history of recent discussions and interactions in the CFG. This is important, as learners must keep close track of the community’s current location in the sequence of the protocol, and to anticipate and plan for the next round.

While this system may be more explicitly designed to support CFG activity, it is also possible to use these same elements to support other kinds of communal commenting activities beyond that specific protocol. While CFGs have been shown to have positive results on teacher practice, other communities may identify different requirements of their protocols. Thus, the back-end of this system should provide customization options for coaches that allow them to alter the time to better fit their vision, different modes of

feedback and review, and easy access to community files. However, the question of how to more tightly wrap technology around users' needs will require continued research.

**Questions for Further Investigation:**

- Might future advances in online, asynchronous CFG protocols improve the quality of this experience for professionals?

### 4.3.12 Aviva Space: Portfolio Construction

Open Portfolios

Portfolio name	Assignment	Type	Date submitted
IIC 1	IIC 1, round 1 IIC 1, round 2 IIC 1, round 3	Video paper Lesson plan Student work	1/14/2013
IIC 2	IIC 2, round 1 IIC 2, round 2 IIC 2, round 3	Video paper Lesson plan Student work	1/14/2013
IIC 1-2	IIC 1, round 1 IIC 1, round 2 IIC 2, round 3	Video paper Lesson plan Student work	1/14/2013

Start a New Portfolio Export Portfolio

**Figure 29:** Portfolio Construction

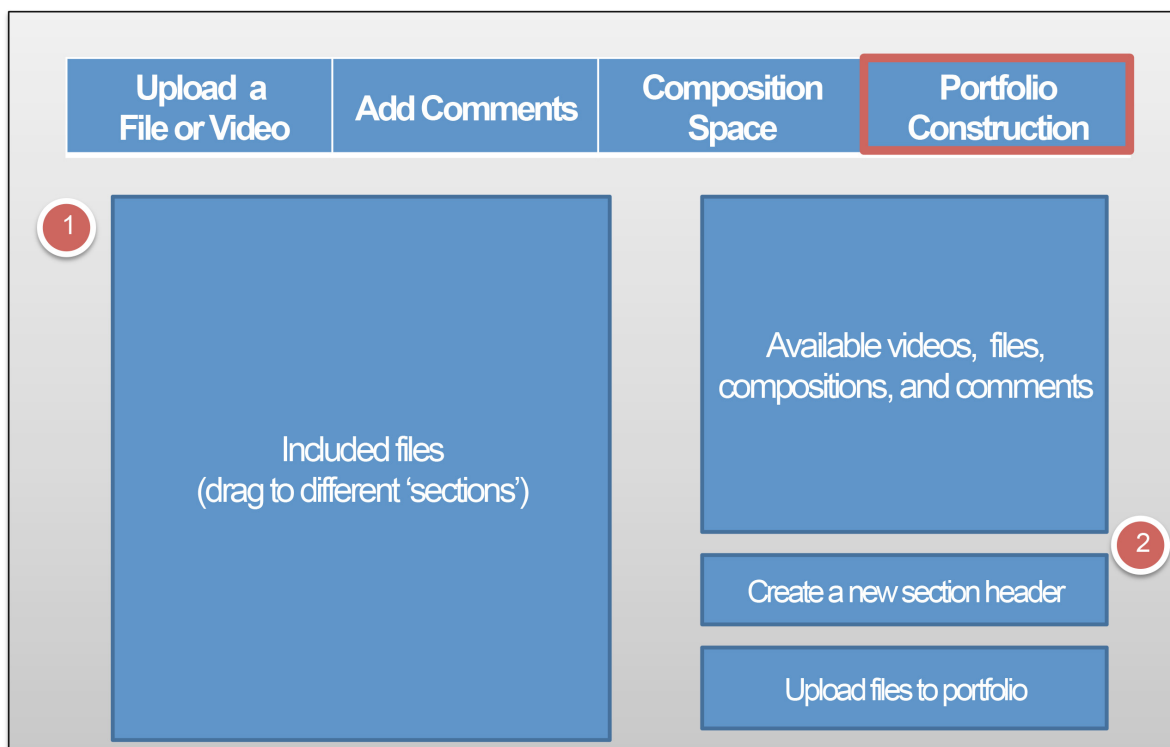
Beyond the formative assessment capability of video commenting process, ATEP team leads introduced the use of workfolios to their candidates during the second half of the year. These video-based portfolios would serve as an intermediary step between the long-form IIC assignments and the summative TPA portfolio examination. Apart from the literature associated with teacher portfolio assessment, this proposed software should include support for this process for three reasons. First, portfolio-based assessments have become a common feature of conventional teacher education programs; this wide acceptance would indicate that this is a practice of interest for the greater field. Second, the coming governmental pressure to adopt the TPA as a criterion for certification across all institutions in the region has prompted a need to provide scaffolding support to

teacher educators who are not familiar with the particularities of the assessment.

Building a portfolio structure into the video-based commenting system may help to reduce some of the technological stresses related to video-based portfolio development (including video editing and encoding), and ease the implementation of portfolio use in other contexts. Finally, providing students with the option to develop a portfolio within the system would provide them with a means to use and reuse their existing clips, comments, and video papers in a more formal context. That way, video and artifact commenting, video papers, and portfolio assignments are woven together into a tight structure, and no assignment goes to waste. I hypothesize that creating a program to manage this process will promote participant engagement by reducing the silos between learning, practice, and assessment and providing the participants with a valuable end product to use in their job searches.

In the context of the hypothetical software, the Portfolio Construction space allows users to create and monitor their existing portfolio tasks, so that they might build them over time and access them from a centralized location (1). Participants can also create a new portfolio or export an existing one into an HTML5 shell suitable for online or physical media distribution and submission (2). These buttons provide participants with links to the further layers of the portfolio construction process.

### 4.3.13 Aviva Space: Assembling a Portfolio



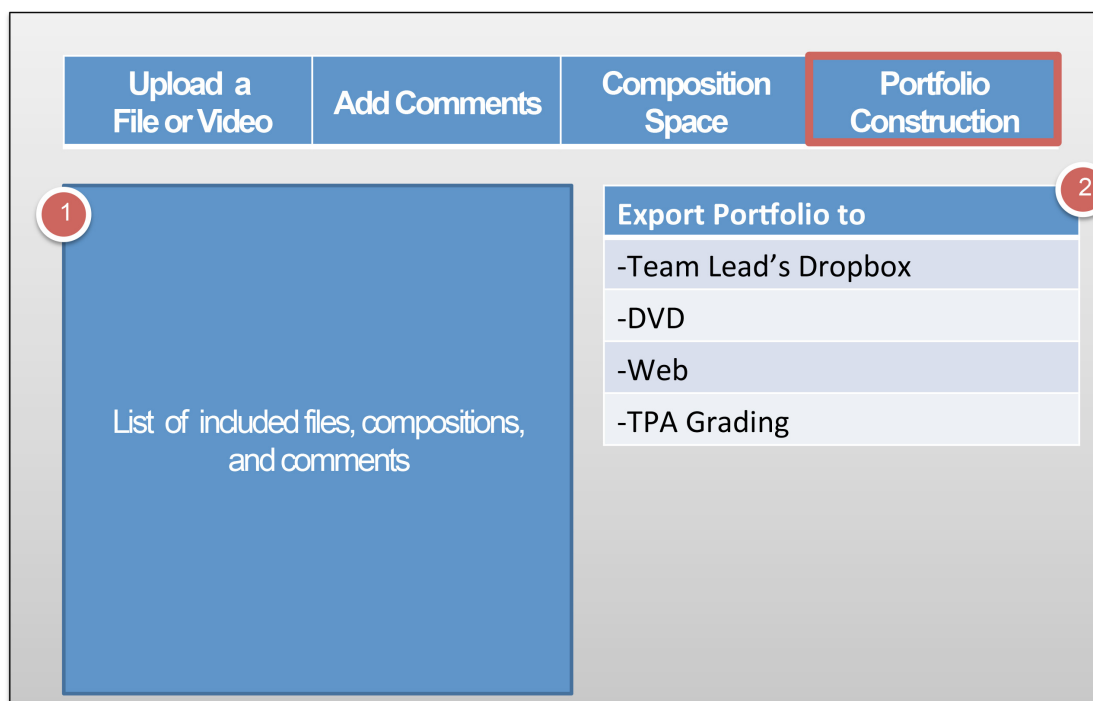
**Figure 30:** Assembling a Portfolio

The purpose of the 'Portfolio Construction' space is to help reduce the task complexity of the portfolio construction process. Ideally, this is achieved by providing students with direct access to their past videos and artifacts, video papers, and comments, and providing them with a simple way to represent this information to evaluators and employers. In essence, this process has three parts. First, the user would drag their portfolio components from the right menu into the left (1), or upload files directly from their computer into their portfolio. Quick access to their existing files will ideally reduce the cognitive load associated with file management in the portfolio development process, freeing up mental resources for higher-level processes and the use of

metacognitive thought tools. However, more specific user-centered studies are required to assess the veracity of this assertion.

Second, the user would create ‘Section Headers’ (2), or compositions that summarize the relationships of the artifacts and hyperlink them together into thematic statements. The goal of this feature is to provide participants with an easy space to curate their past videos, artifacts, and writings through the use of specific prompts. These prompts, provided by local coaches or drawn from the TPA, would help the student to reach deeper levels of reflective deliberate practice by asking them to locate features of their practice over time, and to identify recurring deficiencies and strengths. These hyperlinked documents would serve to peg specific instances of thought tool use to the moments in the data, thus supporting participants’ claims and ideas with supporting evidence produced by students in the past. Further, the process would link the evidence to the prompt itself, making explicit the relationship between the data and the question asked by the coach or assessor. The Section Header screen is not illustrated, but would look much like the artifact commenting screen, with support for hyperlinks to comments, video preview thumbnails, and the ability to link to specific passages in documents that have been added to the portfolio. In developing this interface, students would have an all-in-one space that supports a wide-array of variance in pedagogical models of portfolio development while supporting a number of practices observed in the ATEP context. Further testing is required to determine how this software-supported process will benefit participants and coaches in other kinds of professional contexts.

#### 4.3.14 Aviva Space: Exporting a Portfolio



**Figure 31:** Exporting a Portfolio

In the spirit of the open nature of the system, users should be able to construct and export their content to other formats in a variety of usable forms. After participants have constructed their portfolios, they might proceed to the Portfolio Export space, where they will see the portfolio's table of comments (1). On the right side of the screen (2), participants can choose to export the portfolio to their coach's in-system dropbox, to a DVD or webpage, or directly to the TPA portfolio submission system. In theory, these formats should cover most of the potential needs for portfolio use outside of the system.

### 4.3.15 Aviva Space: Assigning Compositions (Leads)

1	2	3	4	5
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

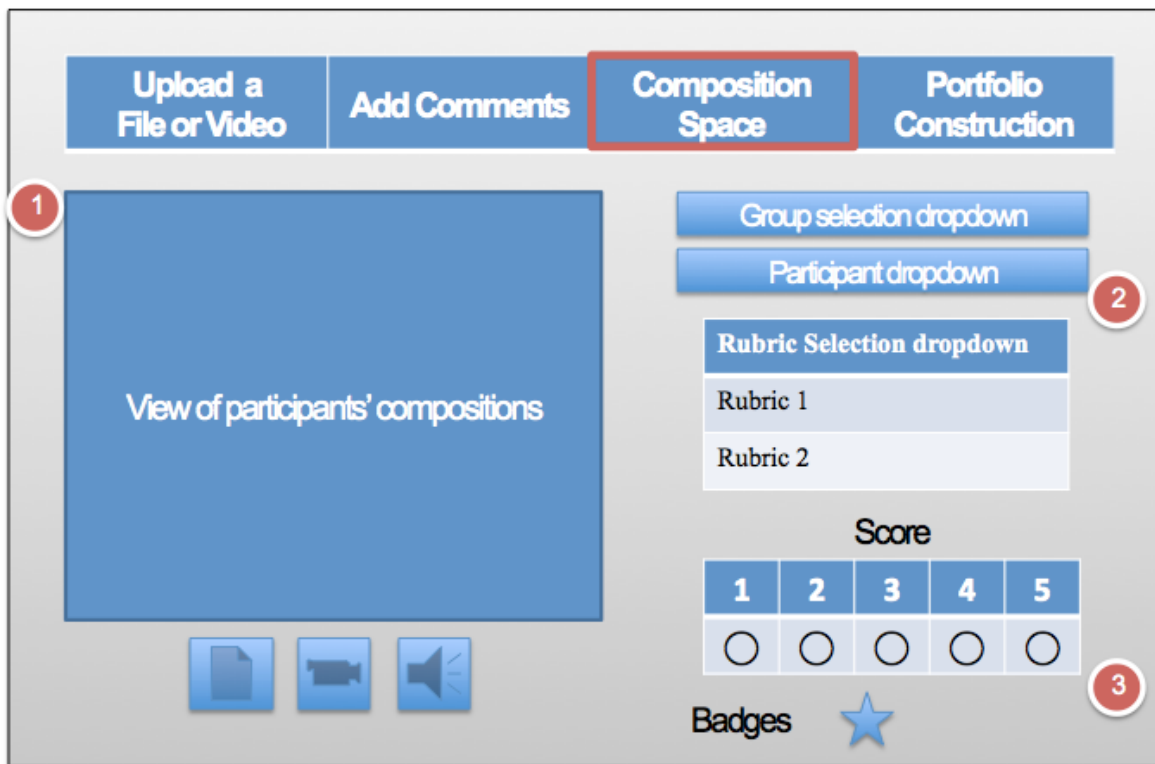
**Figure 32:** Assigning Compositions

In addition to the Composition Space for participants, Leads also require a space for creating and assigning composition and commenting prompts. From this screen, coaches may add due dates, assignees, and coach-defined tags to help manage and keep track of student videos (1). A supportive system would provide coaches with the ability to quickly access examples of past work from particular participants for later use, and the combination of dates, people, and tags would help to manage these videos. Below the descriptive components, coaches may use a multimedia input area to compose their priming questions (2). In this case, the prompt area might include a sample video, photos, and text that help to clarify the purpose of the assignment or provide foil-examples. These priming questions may also be selected from priming question ‘pools,’

or stored versions of each priming question. The creation of these pools of questions can help to create continuity in the community, as coaches may refer to these questions and modify them over time. This would ideally help to reduce community drift, as coaches join and leave the community over time, and their past priming questions and prompts are preserved for future coaches to examine.

Finally, this screen would also provide coaches with the ability to establish shareable rubrics for the formative and summative evaluation of participant work (3). These rubrics would contain bundles of criteria that might be used to consistently evaluate participant writings and videos. Team Leads in the ATEP program found these rubrics to be essential, and calibrated them to help the novice candidates achieve their practical goals throughout the program. Further, the application of rubrics in this way may provide easy ‘at-a-glance’ overviews of past participant performance. These overviews may serve as formative and summative records for the participants, but may also serve a role in helping coaches to work together to address specific participant needs collaboratively and over time. For example, if a coach leaves to pursue a new job or a participant enters a new group with a different coach, the coaches may use these records to continue developing the candidates in ways that build on past efforts.

#### 4.3.16 Aviva Space: Grading (Leads)



**Figure 33:** Grading Compositions (Leads)

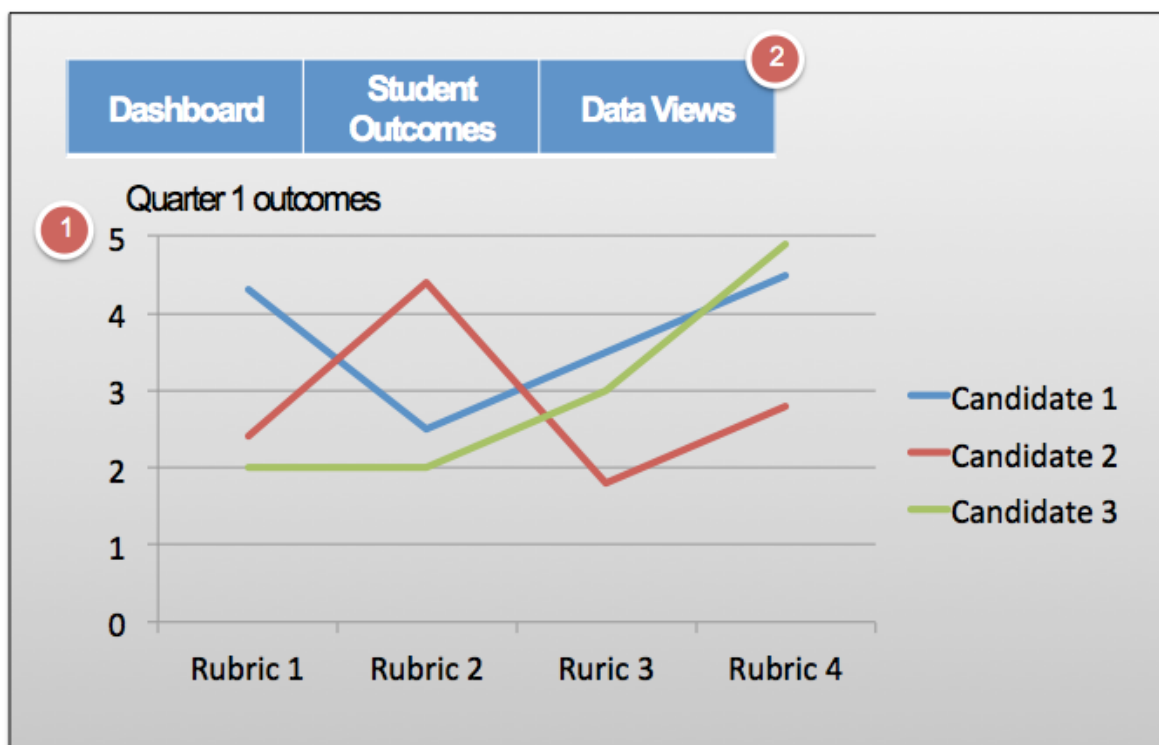
In the composition grading space, coaches are able to give feedback private to participants on their longer compositions. In the left area, teachers can make text, video, or audio comments and tag them to specific points in the text (1), as in other parts of the system. Coaches may access participant compositions through the dropdown menus in the upper right (2) of the screen, allowing them to quickly move through students in a group. Below, they can select rubrics and rubric clusters from the dropdown menu to allow for easy grading using the relevant criteria for activity. At the bottom right, coaches can give rubric scores (3) on an adjustable scale that has been tied to the specific rubric selected during the rubric creation process. Coaches can also assign

community derived badges to increase motivation and allow for public recognition once the participant chooses to share their video. As with badge-systems found in video games, teachers might assign the badges when participants have achieved particular milestones or have completed particular parts of the reflective cycle.

**Questions for Further Investigation:**

- In what ways might we alter the composition grading space to encourage richer and more interactive feedback within the system?
- How might the systematic implementation of badges improve motivation along specific lines of reflective practice?

#### 4.3.17 Aviva Space: Student Analytics (Leads)



**Figure 34:** Student Analytics

The use of rubrics for scoring may allow coaches to track specific outcomes related to the content that is taught in their professional development community. The Student Analytics space allows coaches to use that rubric-assessed data to create snapshots of participant skill growth along specific rubrics, or to create long-term studies of participant commenting performance over time. Further, the analytics engine would allow coaches to create custom ‘data cubes,’ or databases that allow flexible reconfiguration of data for visualization and reporting purposes. For example, these data cubes might allow coaches to create complex reports that trace participants’ improvement by year, group, or skillset. Coaches and programs might also use this data

to demonstrate the efficacy of their coaching, as well as gains in their participants' reflective abilities.

#### **Questions for Further Investigation:**

- How might coaches and teachers make use of this information to improve their habits of mind and thought tools?

#### **4.3.18 Conclusion of the Research-based Design**

In learning from the ATEP context and the development of the Grounded Theory, this study has presented a system that provides a place for these thought tools to be honed in a safe, active environment. In touring the hypothetical learning spaces of the *Aviva* system, this study has deepened our discussion of the qualities of reflective practice by envisioning a platform that flexibly supports reflective practice in a variety of ways through the use of a customizable toolkit of spaces. These spaces for reflection provide a broad and adaptable set of affordances for the reflective practitioners. However, the design of the system and wireframes represent a set of conjectures about directions for these investigations, but are by no means exhaustive. In concluding this review of the *Aviva* system, I will offer two principles for the use, construction, and implementation of the system. These may provide guidance to future instructional designers, software developers, professional development organizations, and coaches who might wish to construct some version of the *Aviva* system in their own context: Hijacking Technology and Process Hacking.

If a local community does not have the resources to produce the *Aviva* system on their own, they may consider the use of locally available technological resources. Even though they are not as ergonomic as the design presented here, learning management systems, blogging platforms, and online PLC networks may support many of the kinds of relevant reflective activity. If a community is sufficiently motivated, they may be able to patch together a functionally similar system using Instructure's *Canvas* LMS platform. Further, Instructure's open-source code may be mutated to more accurately follow these designs for a relatively low monetary cost. If the *Canvas* platform were combined with the *Viddler* video hosting service's ability to offer timeline commenting, then many of the necessary components for the *Aviva* system could be easily tied together and put to use without the creation of any new software. This is important, as software is expensive to code and test. The hijacking of several commercially available technologies for the purposes of supporting expert practice may better serve communities who do not have the necessary funds to build something from scratch. However, this strategy requires greater levels of Technological, Pedagogical, and Content Knowledge (TPACK; Doering, Veletsianos, Scharber, and Miller, 2009) from the local community, as well as a greater motivation to integrate technology into routine and reflective practice.

Any system built from these designs should also accommodate 'Process Hacking' by the local participants. For the purposes of this principle, hacking broadly refers to the use of any tool for a purpose other than its explicit and manufacturer-intended use for the purposes of customization, adaptation, necessity, or fun (as described by Erickson,

2008). In applying this definition to the *Aviva* system, I hope to encourage future software developers to create reflective learning systems that invite users to find new ways to combine, remix, remake, and reuse the spaces to serve their ever changing needs; to provide toolkits that support learning. Since a local community understands its own needs more accurately than an outside software developer ever could, a system that encourages users to ‘hack’ it by finding new, novel purposes for the technology is one that encourages innovation. As noted earlier, a local community might hack the CFG function of the system and use it for some other protocol or discursive practice. Or perhaps a community will use peer-review spaces as virtual white boards for shared norming. The software itself becomes an integrated and co-evolving part of the local activity system, one that conforms to the needs of the user in a constantly resolving and contingent way. To extend this line of thought, I will test the proposition that this design may be adapted to other professional contexts in the final test of validity.

## **4.4 Workability: Cross-Domain Compatibility**

In Grounded Theory, Workability is an essential component of the validity process, as it attempts to reconnect the growing Theory with the real-world organizations, constraints, and properties of the participants who are described by the theory. In concluding this test of validity, I will use this process to expand from our existing population under study (novice and expert teachers in a community of practice) to other possible professional contexts. In pursuing this goal, I will examine how the theory and technology described in this study may improve the broader worlds of professionals following the logic outlined earlier. The study will attempt to generalize the findings in this study to other contexts in anticipation of uncovering new possibilities in the Grounded Theory and the *Aviva* software. I have undertaken this task as the test of workability because, as Wenger (1998) notes, no community may ever completely design its own learning system (and no outsider may ever completely design a system for a community). Thus, in imaging use-cases for the software, I will attempt to identify and anticipate changes to the theory that will emerge in implementations in other fields. This will help future researchers to investigate the potential roles of reflective, deliberate practice as facilitated by software in other professional disciplines.

Reflective practice has become a prominent feature in the research in the professional field of Architecture (Schon, 1985). However, the crucial features of reflective practice are still weakly represented in professional fields such as Engineering and Medicine.

These fields, characterized by a technocratic bent, have not adopted the use of reflective

practice as a means of advancing the knowledge and capacities of novices and experts to the extent observed in the literature of fields like Education. For this reason, I will examine potential use-cases for this Grounded Theory of Noticing and the *Aviva* system that might improve the early and continuing professional development for engineers and other scientific professionals. Each use-case contains three core features. First, a use-case begins with the identification of the role of reflective practice in the professional domain, as articulated by a particular piece of literature from the field. Second, it will examine how these visions of reflective practice square against the theory and software that this study has illustrated thus far. Finally, each case will examine a brief hypothetical scenario where reflective deliberate practice is supported by the software and through localization into the activity systems of teaching and learning in the professions. The goal of these scenarios is to illustrate the possibilities for the syncretization of the system with the known demands of other communities. These use cases are hypothetical in nature and based on my own experience in the field, but are valuable in that they allow us to map potential avenues of design for future coaches, trainers, and Learning Scientists.

Further, fields such as Engineering and Medicine would be well served by a pivot towards the use of these software and thought tools in their broader teaching and professional development processes. At present, they are in danger of encountering Schon's 'crisis,' where the distance between the modes of professional training and necessities of practice are increased by the inherent instability in the social and economic ecology. It may be possible to judiciously apply the theory discussed here to

stabilize this crisis through the implementation of flexible support technologies.

However, the implementation of these technologies and practices will require further design and research to localize the software to a particular community in a particular professional discipline.

#### **4.4.1 Reflective Practice in the Engineering Domain**

As a field, engineering is not neatly identified with reflective practice as an explicit tradition. While experienced engineers are expert at iterative rounds of planning, design, and testing, the degree of explicitness of this process (and its qualification as metacognitive and deliberate) varies by teacher and institution during formative training and professional development. However, some scholars have begun to consider how reflective practice can improve and support their students in engineering professional development interventions. The need for a more flexible study conducted at The Boeing Company (a major aerospace engineering firm), O'Mahony, Vye, Bransford, Sanders, Stevens, Stephens, Richey and Soleman (2012) compared the use of challenge-based learning (an explicitly metacognitive practice) to restructure the ways that engineers learn in practice. In this study, researchers found greater levels of participants and interaction in engineer professionals when they used challenge-based instructional design methods over conventional lecture-based training. Further, the researchers identified higher post-test scores on synthesis and transfer assignments in the challenge-based group as compared to the lecture group. Trainers and teachers in engineering may benefit from the use of reflective and constructive learning experiences that involve complex problems of practice.

However, teachers in this field may require additional help to shift towards these co-constructive modes of learning. Nilsson (2012) conducted a study of six professors in an engineering masters program at a Swedish university who worked with a critical friend from the university's center for teaching and learning. She notes that the use of critical friends to support reflective teaching practices in the engineering masters programs can have a number of benefits for the teachers that yield positive experiences for their terminal degree students. The benefits can include the rethinking of values, uncovering reasons behind actions and decisions, framing and reframing of problems of practice and goals, and developing a sense of the scholarship of teaching (similar to the findings in engineering students in Adams, Turns, & Atman, 2003). These benefits of teacher coaching in engineering are similar to those in the ATEP context and at Boeing, particularly in the framing and reframing aspect seen in the Grounded Theory.

To understand how our Grounded Theory and hypothetical software might improve the practices of teachers and the experiences of learners in engineering, online environment developers might consider the professional development needs of a design team at an office in a major hardware and software engineering firm. In contemporary engineering firms, these teams are often organized around engineering functions, where each member has a specific area of expertise in the process (e.g. testing, coding, integration, technical skills). Engineering teams form a type of distributed cognitive system that achieves its goals through constantly resolving institutional processes and roles.

However, to maintain the quality of these teams, each member must take time away from their work to attend content and institutional trainings (on matters such as company policy). And if a team member leaves the organization or is taken ill, their loss from the

actor-network system might impede the team's success. These constraints create time pressures as engineers struggle to develop their skills and knowledge while attending to deadlines and deliverables, similar to the time pressures observable in the ATEP context.

Ostensibly, developments in eLearning were supposed to increase the availability of new knowledge and skills and reduce time away from the job. However, the cost of producing custom-made eLearning can make this avenue impractical for medium-sized firms, and relevance to a specific engineer's need is difficult to guarantee. For this reason, metacognitive approaches to learning from context may provide these engineers with an experience that increases their capacity for learning in practice. The *Aviva* system described in the modifiability test can achieve syncretization with the engineering domain through a modification that would support the professional community's adoption of Agile product development techniques. This fixture of engineering teams involves coordinated sprints towards shippable products, daily 'stand-up' meetings that allow for structured communication, and annual cycles of engineer performance reviews. The goal of this product development methodology is to provide a continually improving product to the end customer by working towards customer-facing goals.

The software design proposed in this study provides opportunities to support these Agile processes while engaging participants in knowledge construction and documentation activities. That is, the Agile process might be supplemented with the creation video-based records of the meetings that are annotated and assembled into 'sprint portfolios'

over time. These might contain video and written annotation of key decisions and discoveries from the previous sprint, and filed for later reference by management or performance reviewers. Further, the peer-review process may theoretically provide benefits in cross-domain learning and cooperative problem solving (though more evidence is needed to validate that idea). This would create durable, community-generated records that represent organizational intelligence for those who need to learn-in-practice and learn-from-practice.

It is possible to envision three ways that this system might further support the performance of engineers by focusing in on facilitating learning through situated tasks and goals instead of removing them from their context for training. First, managers and engineers may use the representations of practice (like the portfolio) to enable the team to identify problems of practice in their own meetings and create representations that illustrate the solution. These records may serve for future review through the Studio-Peer Review-CFG-PLC structure identified earlier. Second, engineers who use design process management software to control the packaging of plans and code will be familiar with the mode of portfolio creation detailed earlier, as both of these processes involve choosing particular slates of files to create meaning for the next entity in the development process. These portfolios (organized around Agile sprint periods) may provide crucial documentation of design decisions along the way, and necessary opportunities for lesson sharing and shop talk. Third, the *Aviva* software's ability to support community-oriented publishing could provide the larger organizational community with insights into the activities of individual groups, promoting

communication across the silos that naturally occur in these teams. The production of reflective records of practice might provide these communities with ways to trace larger challenges, as well as hold individual teams accountable for their performance.

In concluding this use case, I will identify three ways that providing engineers with a means for reflective practice through a technological scaffold might provide actual benefits for the actors who use the system. These possibilities may provide us with a way to understand how the Grounded Theory and *Aviva* may generalize to other populations, and do provide assertions that other researchers may test in the future. First, the syncretization of this Grounded Theory and technology system with native forms of social organization provides a way for instructional designers and coaches to provide a relevant experience to their learners-in-practice. Second, through the integration of these tools into their routine practice, and the communalization of knowledge that results, other researchers may use the lessons learned from this study to improve the long-term performance and practice of these stakeholders. Finally, the records generated by *Aviva* can help distributed systems of cognition (like an engineering firm) to create durable records that reduce the impact of the disconnection of an individual actor from the network. The routinized collection and organization of knowledge (integrated seamlessly into the existing daily workflow) might provide opportunities to improve. While the assertions derived from this use case require further testing, I hope that they provide a line of inquiry for future researchers to consider in their own studies of reflective practice in Engineering.

#### 4.4.2 Reflection in the Medical Domain

The Medical domain (including doctors, nurses, and associated paraprofessionals) provides a unique use-case due to two fundamental training constraints. First, medical professionals are bound by strict federal legal guidelines regarding the protection of patient data. Privacy protection statutes levy heavy penalties on the improper use and public sharing of patient details with actors outside of the direct chain of client service. Therefore, coaches and teachers in medicine may shy away from the use of problems drawn directly from practice for fear of breaching these ethics and rules. Second, unlike engineers, medical professionals generally have client-facing roles. That is, they must interact with clients on a routine basis, and attempt to assess their health through a variety of diagnostic tools, both physical (e.g. stethoscopes) and mental (e.g. analyzing a rash). This client interaction also has front-of-house and back-of-house features, with unique flavors of shoptalk and unique concerns emerging in local communities.

It is tempting to consider the application of the Grounded Theory and *Aviva* system to diagnostics in medicine, but a systematic review of reflective practice studies in the medical domain performed by Mann, Gordon, and MacLeod (2009) would indicate that this is not a proper application of the software. In their study, the authors reviewed 29 qualitative and quasi-experimental, experimental, and mixed methods studies for evidence of the effectiveness of reflective practice in nursing, medicine, and other medical domains. They found that reflective practice in these domains promoted the use of ‘deep studying’ in practice, but that few of the studies appear to provide evidence of changes to clinical behavior or patient outcomes based on that reflection. However,

Mann et al. note that while reflective and deliberate practices do not directly benefit clients, they may be useful in promoting reflective habits of mind for medical professionals. They posit that a tool that scaffolds the implicit reflective processes of the medical practitioner may help them in their attempts to learn from their own experience, and to integrate new perspectives from colleagues. Yet, how might Learning Scientists provide support for reflective activity in a way that promotes positive professional habits of mind and delivers tangible benefits to medical professionals and clients?

Part of the answer to this question comes from our first constraint: Due to the delicate nature of the maintenance of patient records, I would hesitate to advocate for the use of the *Aviva* system in handling actual case files. Rather, I imagine that the system can help medical professionals to practice and develop reflective practice through the sharpening of thought tools in a safe, fail-proof environment. The Grounded Theory and *Aviva* system may thus provide the necessary scaffolds for medical professionals through the use of reflective and deliberate simulations (as opposed to the real-life basis of the data in the engineering use case). These simulations would provide medical professionals with opportunities to practice and receive feedback on client-facing scenarios in a supportive, private environment before employing them in practice.

The use of simulations in medical training is not without precedent in the medical community. In their review of simulation-based medical education (SBME), McGahie, Issenberg, Petrusa, and Scalese (2010) note that deliberate practice, mastery, and transfer of context are three of the twelve key variables in medical simulation that have been

consistently studied since the 1960s. In the article's review of more contemporary literature, the researchers found that simulations have been put to a wide variety of purposes in recent years, especially with the integration of life-like, interactive, computer-controlled manikins and digital support tools. However, the article does discuss the role of reflective activities in so far as they support the other elements of deliberate practice, mastery, and transfer. This is where the opportunity to use metacognitive thought tools cultivated through the Grounded Theory and the *Aviva* system may occur. That is, our goal in applying these findings to medicine is to reconstruct practice in these simulations in ways that are not only deliberate, mastery-focused, and transfer-oriented, but also provides a reflective lens that cultivate the habits of mind that evolve from the sharpening of thought tools. Researchers might differentiate between skills simulations (already under the stewardship of the profession) and human simulations (extending these skills into simulated practice environments with sufficiently complex cases) that involve the use of reflection in action.

Researchers writing in Wilson and Rockstraw (2012) discuss the use of 'human simulation' as a way of learning in nursing and other health professions. Simulations in medicine may vary along the axes of technology integration, and anywhere along the spectrum of virtual to augmented reality (as described in Novak, Wang, Callahan, 2012). Among the ideas found in Wilson and Rockstraw, clinicians propose the use of 'standardized patients' in real-world clinical simulations; these are participants (including elderly volunteers and non-medical workers) who enact a script with the medical practitioner in ways that mimic the fidelity of a real consultation. Through this

process, practitioners can learn in a safe, fail-proof environment where they may receive feedback from other members of the professional community without danger to patients.

Following these ideas, I might imagine a group of instructional designers in a university hospital who have been asked to implement a new practice as mandated by the Center for Disease Control for grantees. This practice requires changes in habits of mind and activity from both doctors and nurses, and also requires the employ of professional judgment on their parts. In times past, these instructional designers might hold a workshop or professional development seminar to educate the faculty and professionals. In more recent times, eLearning might be created to serve as a job aid or reference for use in the context of practice. The application of the Grounded Theory and *Aviva* system may provide a more advanced learning solution by providing opportunities for deep study through simulations and problem-based learning (PBL).

The use of the *Aviva* system would not supplant or replace the skilled instructional designers and trainers in this context; rather, it would leverage their domain knowledge and training skills into a form that promotes deliberate practice through inquiry and guided exploration (Clark and Mayer, 2010). For example, the instructional designers in the hospital context may continue to produce eLearning modules for content training components in the system, and trainers may take on the role of coach to offer customized feedback and support to supplement periodic stand-up training. However, the *Aviva* system would ideally allow these actors to place coordinate their resources together into a meaningful knowledge-construction experience for their clients.

This knowledge construction process is achieved through the pre-population of the *Aviva* system with modules that fit together into cycles of anchored instruction (Schwartz, Brophy, Lin, Bransford, 1999; Clark, 2013). Schwartz et al. describe the use of a software-scaffolded metacognitive learning system that presents learners with a series of modules oriented around a reflective inquiry cycle, similar to the challenge-based learning cycles described by O'Mahony et al (2012). At the outset, learners are given a sufficiently realistic domain-based central challenge that provides motivation through intrinsic and extrinsic means. Following the challenge introduction, learners proceed through smaller rounds of capturing their initial thoughts on a sub-question that relates to one component of the larger challenge, and thus expose their cognitive scaffold for metacognitive manipulation. After initially exposing their mental framework, learners look at the resources necessary to construct knowledge related to specific facets of a central issue in the discipline. As learners encounter three to five different multimedia sources of information, they will see how a variety of stakeholders see the issue, ideally producing some form of cognitive dissonance with the learners' existing scaffold. When the learners' scaffolds are in this state of agitation, they revisit their initial thoughts and produce revised thoughts that reinforce the changes in thought through writing and response. As learning is fundamentally socially situated, a public sharing of discovery and new knowledge is a key concluding step, opening the possibility for new avenues of inquiry that may be taken up by the community in future learning endeavors. It is these kinds of learning cycles, operated with the Grounded

Theory and reified in the *Aviva* system that can help medical professionals to make sense of new findings in field.

How might designers embody this pedagogical process in a form that facilitates this complex activity? In proposing a sufficiently high-resolution simulation, any implementation would need to include all of the data that a medical practitioner might need to make a decision in the case, in forms that are similar to those that they might encounter in the real world. Or, conversely, the case may omit or obscure key data points in ways that complicate the problem to challenge the noticing abilities of more expert practitioners. In each round of inquiry, the professionals would find pre-loaded case information (such as mock patient interviews, histories, medical charts) that the professionals may annotate with the tools in the *Aviva* system. Following this encounter with the patient, the learner would have an opportunity to reflect on their diagnostic process before encountering the new perspectives from the local instructional designers and the CDC. They may observe the delta between their current practices and those advocated by the growing knowledge in the field. Following this process, the professional might refer back to their video and document coding to crystalize their observation of this delta in writing before sharing it with coaches for peer review, and escalation to discussion in the CFG portion of the system. Upon completion of the CFG process, they may share their findings up to the larger local community through the publishing function to provide their peers with vetted descriptions of how the new practices have integrated with their current ways of doing things. In continuing this process over time, the medical professional would have the opportunity to engage in

knowledge building, integration, and testing without fear of embarrassment or ethical breaches.

In facilitating this reflective and deliberate process through the *Aviva* system, instructional designers and Learning Scientists may provide these medical professionals with a way to engage in reflective practice without overly taxing their finite time for non-field practice. The reshaping the use of online learning and coaching in medical professions to promote inquiry practices through reflective practice simulations achieve the same ends without the risk of exposing patient data.

## **4.5 Conclusion of Validity Testing**

In this series of validity tests, I have subjected the Grounded Theory to a series of trials that have expanded our understanding of the role of reflective practice as it occurs in relationship to the contexts of practice. Further, I have advanced a design for the *Aviva* system and a plan for localizing the system to other professional contexts. The Grounded Theory grew to accommodate a variety of concerns that may inform instructional designers, Learning Scientists, and software developers in the years to come. Ideally, this study will help them to make wise choices and ask better questions as they construct their systems for local professional development communities.

## **Chapter 5: Implications, Limitations, Further**

### **Questions**

In this study, I have assembled a number of interrelated data sources, literatures, and methods into a rich view of the relationships between technology, metacognition, and professional expertise. First, study illustrated the activity system gave rise to the integration of a new tool into the ATEP program, and how this tool allowed for new ways of engaging in reflective practice. Then, it examined supporting literature to understand the phenomenon of reflective deliberate practice as it has been taken up in teacher education, in the area of metacognition, and in the professions. With that theoretical base, I created a Grounded Theory of Noticing to identify and describe this phenomenon, and the specific thought tools deliberate practice qualities that were observed in the VBOCS technology. Finally, I tested the validity of this theory using exploratory statistics, designed a hypothetical VBOCS space for participants to employ their thought tools, and offered three use cases for the technology in other disciplines. These findings will ideally provide value to a variety of stakeholders throughout the educational ecosystem, from teachers to instructional designers. In concluding this study, I will examine some of the implications, limitations, and further questions that remain unaddressed.

### **5.1 Implications**

In assessing the implications of this study for the broader field, I will briefly summarize the advances that this study has made towards the primary question and five goals

defined in Chapter 1. In the first chapter, the study's central question was articulated in the following way:

*How might we design virtual learning environments that scaffold expertise development through the training of specific kinds of metacognitive thought tools?*

In arranging the evidence gathered from the ATEP context, this study provided one avenue towards an answer through the analysis of the reflections of novice and expert teachers. The study generated and illustrated a theory that outlines a number of metacognitive tools that were employed by all of the teachers, and illustrated how expert and novice professionals used those tools differently. The data generated by this theory of reflection in video-based online commenting systems was then validated through statistical and design strategies. This resulted in a theoretical prototype of a reflective workspace that may be used in a variety of professional contexts. The process is summarized in the five goals achieved in this study:

***Goal 1: To understand how participants used the technological system to engage in deliberate practice, as exhibited through their use of thought tools in video commenting***

One way that participants engaged in deliberate practice is through reflection on artifacts drawn from their context of practice. The professional learning community's use of the VBOCS allowed practitioners to ready themselves for continued improvement when they employed particular thought tools. The Grounded Theory presented in this study illustrates potential opportunities for scaffolding professional noticing and reflective

practice. Further, it is a flexible theory that can apply to reflective practice in multiple domains, and is open to future reformulations and alterations.

***Goal 2: To identify features of the ways that thought tools were successfully implemented in the hopes of guiding future practice and design***

The strongest comments were those that contained Literal, Inferential, and Critical thought tools, specifically those that contained references to the actor behavior, client thinking, and suggestions for improvement and pressings. These are commenting patterns that may generalize across domains if they are used to scaffold reflective practice. In response to this goal, the study provided an eight-fold set of qualities that are associated with reflective practices in the ATEP professional learning community. These eight qualities may serve as markers for coaches and participants to use in formative assessments and practice periods.

***Goal 3: To observe specific markers of this process in action, and develop a socio-cognitive theory that explains the relationships of these expressions***

In observing these thought tools in action, I explored an array of the dialogic qualities of the comments. However, this study found strong evidence for the idea that the ability to engage in reflective practice is a skill that is strongly associated with expertise in the domain. This was illustrated by the tests of Relevance and Fit applied in Chapter 4, where the frequencies and co-occurrences of the observed the parts of Complete Noticings developed in the Grounded Theory were observed to be higher for experts than in novices. In this, the data conformed to a predictive statistical model that

illustrated with 95% accuracy that experts engage in Literal-Inferential-Critical patterns of thought tool use more frequently than novices.

***Goal 4: To produce a design for a flexible learning platform that more accurately conforms to the needs of professional learning communities in a variety of domain and practice contexts for future testing and critique***

Through the generalization of observations from the realm of the empirical to the realm of design, I have presented a set of design conjectures (embodied in software form) that may guide the development of future technologies. The *Aviva* system provides an object to consider and new angles to investigate in the ongoing evolution of the virtual learning environments. It is also a practical design, one that may be tested against actual end-user needs in a variety of domains, or freely manipulated and improved-upon. It is a suitably generative design, and one that I gift to future researchers and designers for improvement and adaptation to their own purposes and uses.

***Goal 5: To consider how other professions might adapt such a platform to support continued growth of learners in their signature pedagogies***

While I cannot claim to speak for the Engineering or Medical professions, I believe that this study has put forward a convincing set of potential use-cases for the implementation of the *Aviva* system in other professional development environments beyond education. In envisioning the usage of the *Aviva* system to provide a sufficient scaffold for reflective practice for these professionals, I have presented several ways of integrating

the system into some of the signature pedagogies and activities in these fields. However, further research on implementation will be required to validate the viability of this goal.

## **5.2 Limitations and Future Questions**

In talking with colleagues and presenting these results in informal settings, three strong limitations of this study have come to my attention. These limitations arise from fundamental contradictions in the domain relevance, methodology, and generalizability of this study. However, from each limitation arises a new question that may be investigated in future studies.

### **5.2.1 Limitations on Domain Relevance**

As Wenger (1998) notes, no outsider may ever completely design the learning of a community of practice, and no community of practice may ever fully design its own learning. This tension is one that I experienced first hand as a technology steward during my participant observation. As the outsider in the ATEP program, it took some time for me to appreciate the differences in perspective, preferences, values, and knowledge of instructional designers and classroom teachers. Because of their experience and depth of knowledge in classroom teaching, the Team Leads expressed a number of opinions related to technology, beginning teaching, and communication that I found often found surprising due to my lack of teaching experience in K-12 education. I realize that my design cannot completely conform to the needs of a community without some form of interactive user customization process. Thus, future iterations of this project (and similar endeavors) should consider the following question:

*In what ways might we design automated user-configuration wizards that can serve to customize the system to the professional learning community's specific reflective practice needs?*

In pursuing this question through further design and experimental research cycles, designers may develop tools that can help coaches and learners in multiple domains. For example, one future avenue of research may come from the use of drag-and-drop spaces to allow coaches to customize reflective assignments to more directly support their pedagogical intent. Further, the tool might help to guide and focus this pedagogical intent in novice VBOCS coaches by empowering them to construct assignments from various reflective practice 'toolkits.' However, further testing is required to find new answers to this question that are grounded in user needs and behavior.

### **5.2.2 Limitations of Methodology**

In this study, I have taken a non-positivist approach to the data in question. The goals and question in this study did not require comparison treatments or blind-control trials, and focused mainly on participants' co-constructed patterns of meaning and activity. However, this flexible methodology gives rise to two critiques. First, the non-positivist nature of the methodology makes it ponderously difficult to trace these findings to specific student outcomes in classrooms. This is a valid concern, but one that exists outside of the specific boundaries of the study. That is, my goal in this study has been to identify ways to use technology to support reflective practice in professional contexts because this is known to support improvements in non-routine domain task performance.

The claims of this study may not extend beyond the boundaries of that goal in ways that imply improved performance for teachers or students in classrooms.

I have used a phenomenological perspective to visualize and describe the nature of a self-organizing technology and activity system in the wild. However, to achieve the creation of the design ethnography, this study has required a number of methods (e.g. statistics, Grounded Theory, Critical Design Ethnography) that do not share common epistemological and ontological roots in the sciences. Further, it is entirely possible to criticize this study's eclecticism as a limitation, and I invite readers to consider the philosophical implications of the juxtaposition of the multiple methods contained in the study. However, I would hope to reframe this as a key methodological question:

*In what ways might we combine and reinforce epistemologically different research methodologies in ways that support the process of design ethnography?*

In investigating this question, I would hope that future researchers might find ways to reconcile the different ways of knowing about the world that are represented across the qualitative, quantitative, philosophical, and design-research traditions. This is a resolution that is at the heart of design-based research in the field of the Learning Sciences and one that holds substantial benefits for all stakeholders in Education.

### **5.2.3 Limitations on Generalizability**

In this study, the generalization of the findings has taken the form of a design that was applied across a number of professional domains through the creation of use-cases, or hypothetical enactments of the design. However, it is only when these designs are

implemented in the real world that researchers may truly assess their viability, and only in recursive cycles of action might designers produce enduring and generalizable theories and tools. Since this study has only proceeded through one round of investigation, all findings are formative in nature contingent on further testing. The methodologies and theories of reflection and design posited in this study must be tested in other contexts and with more advanced prototypes. For this reason, designers should use their judgment when comparing these designs and theories, and should critically evaluate the similarities and differences of the context described here and their own local environment. However, the limitation on generalization propagated by the cyclical nature of the research and design process leads to the final question of this study, and the first question of the next cycle of research:

*How might we generalize from these designs to future actions?*

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