# ONLINE DISCOURSE:

# AN ANALYSIS OF MULTIPLE PROBLEM-SOLVING EPISODES OVER TIME

By

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**ABSTRACT OF THE DISSERTATION**

Online Discourse: An Analysis of Multiple Problem-Solving Episodes Over Time

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Computer technology is used as a mediational tool to support collaborative instructional methods. Computer support offers a platform for collaboration with the goal of scaffolding students' understanding, providing increased agency to the student for their own learning, and motivating students, as participants in a PBL process. In online PBL, ideas are made visible in the online environment where students can create iterative processes over time to build problem solutions. Research on face-to-face collaborative discourse in education is fairly extensive. However, with the relatively new and growing use of online collaborative learning, collaborative learning in this context has been given only modest attention to date. The primary research question was: What are different patterns of knowledge construction as part of collaborative discourse?

This qualitative case study examined data from 34 students enrolled in an undergraduate course in an educational psychology. The course used a blended instructional structure of in class face to face time and asynchronous online problem-based learning (PBL). Students were assigned to collaborative working groups (n=6 groups). Four online PBL cases were presented and each group was assigned a facilitator (the course professor and a graduate assistant). The students had to collaborate to develop and present a problem solution to each of four problems – posting their dialogue online.

The online dialogue was analyzed for characteristics of participation, interaction, and student learning.

The goal of this case study was to illuminate and understand the characteristics of online knowledge construction. Examination of the collaborative problem-solving process revealed examples of discourse that showed evidence of both individual learning, social construction of knowledge, and the collaborative knowledge building of a group. Groups that demonstrated a more interactive style of interaction and worked to negotiate a shared understanding of the problem solution were able to integrate educational psychology at a more elaborated level. Through this descriptive process the findings add to a growing body of knowledge about computer supported collaborative learning and PBL and can help to support effective instructional designs and practices.

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## Table of Contents

## Tables and Figures

### Tables



### Figures

**Figures (continued)**

# Chapter 1 Introduction

This case study is a descriptive analysis of six small groups working online to solve four problem-based learning (PBL) modules as a part of a semester class in educational psychology. The use of online learning in higher education has increased in recent years (Hiltz & Golman, 2005) as well as a focus on using online technology as a mediating tool in supporting collaborative learning (Koschmann, 2001; Stahl & Hesse, 2006). How the student engages in these processes can shed light on important aspects of learning and the tools used to facilitate that learning as well as support theoretical frameworks in collaborative and technology mediated environments.

First, this paper introduces the important concepts, research questions, and literature of interest. The findings examine the dialogue among the small groups to understand the characteristics of the interaction, participation, and learning. The discussion relates the findings back to the current literature to draw attention to the issues raised in this case study in comparison and contrast with other research in this field.

## A Taxonomy of Learning

Theoretical perspectives that explain individual achievement, the integration of individual achievement into community participation, and the collective advancement of knowledge for creation and innovation are important focuses for educational research. A taxonomy, described by Paavola, Lipponen, and Hakkarainen (2004) uses metaphors to describe three theoretical perspectives on learning and learning communities. In the *acquisition* metaphor knowledge is understood as residing within the individual. Learning emphasizes the agency of the individual, even when the learning activity might take place in a social setting; knowledge is located in the individual. The second

metaphor is *participation* in which knowledge is viewed as existing within the community and linked to the environmental context; emphasizing the individual in a social context. This learning includes sharing knowledge within a community of learners (Lave & Wenger, 1991), but the individual continues to be the primary vessel. The third metaphor is *knowledge-creation* that emphasizes collective responsibility for the development of knowledge and creation of new knowledge (knowledge building). This emphasizes joint meaning making (Suthers, 2006) and intentional learning within the community and for the community in mutual construction (Bereiter & Scardamalia, 1989).

In each of these types of learning communities, instructional approaches are used that promote collaboration. Collaborative learning is a broad method of instruction in which a group of learners engage in a shared task with a shared purpose. Knowledge is constructed, through the interaction of the learners, facilitator/teacher, and environment and is the product of the collaboration. Groups range from dyads to large learning communities. Collaboration suggests intentional interaction between group members. A group member may participate by posting a proposal or comment, but not explicitly interact. Interaction is the explicit acknowledgement of another and/or the work that has been done by another group member. Suthers et al. (2007) suggest that information sharing alone is not sufficient evidence of collaboration.

**Collaborative Learning**

Research has confirmed the benefits of using structured group discussions to elaborate, revise, and clarify thinking (O'Donnell, 2006). Educational research has found that as students explain, elaborate, and teach ideas and concepts that their own level of

understanding increases (Brooks & Brooks, 1993; Lowery, 2002; Palinscar, 1998). Structuring classroom discussions can frame the discourse so that students have the opportunity to express their ideas, listen to others, and construct new ways of thinking (Chinn, Anderson, & Waggoner, 2001). The goal of structuring the learning environment to support collaborative discourse is often to promote critical thinking skills and reasoning in students (Chinn, Anderson, & Waggoner, 2001; Engle & Conant, 2002; Ennis, 1987; Gruber & Boreen, 2003; Hmelo-Silver & Barrows, 2006) and promote conceptual change and convergent understanding of a topic (Roschelle, 1996). Additionally, students are given increased agency over their own learning and the collaboration provides an opportunity for deeper inquiry, conceptual understanding, and continual improvement of ideas (Bereiter & Scardamalia, 1989). The knowledge-creation learning metaphor, based on the work of Bereiter & Scardamalia (2006), considers collaboration and collective responsibility a requirement to knowledge building. Recent research on knowledge-building (KB) classrooms demonstrate that, in this context, individual learning, collective learning, and community advancement of knowledge can be achieved (Bereiter & Scardamalia, 2006: Chan, Lam, & van Aalst, 2003; Lee, Chan, & van Aalst, 2006).

Social constructivist theories of learning are one way to explain the effects of collaborative discourse. Constructivist concepts of education propose that learners, working collaboratively with information, build on their prior knowledge and then construct new ways of thinking. Social constructivist theories of learning view language as the tool that individuals use to share social meaning, develop concepts, negotiate meaning, and deepen levels of understanding (Palinscar, 1998; Vygotsky, 1978). Social

constructivists theorize that learning takes place in a social context and that learners are active participants in the learning process (Lave & Wenger, 1991). Students engage collaboratively in order to construct and apply content knowledge, often in order to solve a domain specific problem. Vygotsky (1978) theorized that all knowledge is first social – interpersonal – and then appropriated or internalized into an intrapersonal way of knowing. Social collaboration and assistance from a more capable peer or teacher help the student to realize potential levels of knowledge. The goal is to help learners internalize and reshape or transform information (Brooks & Brooks, 1993).

The discourse that accompanies peer interaction has been examined to identify characteristics within these collaborative structures that account for learning. Peers as tutors (Kohler & Greenwood, 1990), peer scaffolding (Lai & Law, 2006), and peer interaction in models of cooperative learning (O'Donnell, 2006) point to social and cognitive theoretical perspectives to explain positive effects. Discourse between peers has the potential to lead to deeper conceptual understanding (O'Donnell, 2006). Most of this empirical work on collaboration has been conducted in face-to-face environments. More recently, with the use of computer mediated communication (CMC), technology has been used to support collaborative learning. This study sought to examine dialogue in an online environment in order to look for instances of collaboration and the effect of that collaboration on how educational psychology concepts are developed in problem solutions.

**Technology as a Mediating Tool**

The term computer supported collaborative learning (CSCL) was coined in 1989 (Stahl & Hesse, 2006). Since that time a vibrant, international community of researchers

has worked to explore the uses of computers to assist learners and the effect on learning outcomes (Kienle & Wessner, 2006). Additionally, as the number of online course offerings has increased in higher education (Hiltz & Goldman, 2005) terminology to describe online learning has been adopted. The term asynchronous learning networks (ALN) was conceived in 1994 by a small group of researchers to describe online classes that promoted collaborative learning (Hiltz & Goldman, 2005) and the term computer-mediated communication (CMC) describes software platforms that allow for anywhere, anytime communication launched via the internet (Hiltz, Kim, & Shea, 2007). The model for instruction in CSCL environments is collaborative teaching and learning.

Computer technology is used as a mediational tool to support collaborative instructional methods. Computer support offers a platform for collaboration with the goal of scaffolding students' understanding, providing increased agency to the student for their own learning, and motivating students, as participants in a knowledge building community, to create a communal database (Scardamalia, 2002; Suthers & Medina, 2011). The collaborative, online dialogue provides opportunities for deep inquiry, reflection, and greater conceptual understanding – individually, as a working group, and in a community of learners (Kreijns, Krischner, & Jochems, 2003; Paulus, 2005; Scardamalia & Bereiter, 2003). Ideas are made visible in the online environment where students can create iterative processes over time to build problem solutions.

Computers have been used in problem-based learning environments to present problems, resources, and as a platform for dialogic problem solving (Derry, 2006; Hmelo-Silver, 2003). Online problem-based course work is being developed that present cases that place the interaction in a virtual environment (online) and require student

collaboration in order to solve a specific problem (Chernobilsky, DaCosta, & Hmelo-Silver, 2004; Steinkuehler et al., 2002). The online interaction is usually asynchronous and may consist of contributions to a community or group knowledge base, on a server, and is accessible at anytime to everyone in the working group. The purpose is to provide a virtual environment in which data can be stored and then accessed for reference and revision – a continual building on of what is known within the community that is participating. The social construction of knowledge takes place in a virtual environment. This online discourse and its developing pattern over time as the students move to a solution can be illustrative of how knowledge integration, the complexity of the reasoning and the problem solving process evolves. Students generate ideas; reject, refine or appropriate these ideas; and then weave them into a coherent whole (a solution) to a video case problem (Derry, 2006).

Dillenbourg & Traum (2006) suggest that online collaborative dialogue can be examined from a variety of levels: the micro level examines small pieces of discourse (minutes) from a psycholinguistic level; the meso level examines conceptual change among small groups as they problem solve over hours or days; the macro level examines communities of learners over months or years as they construct a culture of working together. The analysis presented in this study seeks to view the dialogue at the meso level - looking for evidence of learning, and problem solving, and the characteristics or patterns of online collaboration associated with problem solving. Is it possible to characterize the *optimal collaborative effort* (Dillenbourg, Traum, & Schneider, 1996) where there is the “just right” level of communications that produce understanding and where misunderstandings are potential learning opportunities? Learning is not just about

knowing more, but about knowing with understanding and in different ways than before. Analysis of an online collaborative process can help to assess the learning process and conceptual change in this context; a context that has been given only modest attention to date.

**Research Question**

The purpose of this case study is to describe the dialogue that took place online within six small groups of undergraduate students during multiple problem solving tasks. The goal was to gain an understanding of the online dialogue processes; characteristics of the dialogue and what it suggested about student learning as they solved multiple online problems over time. Each video case problem is solved as the student groups post proposals and comments in response to the demands of the task – a problem solving process that becomes visible through the online dialogue. The findings describe this process and add to the body of knowledge about what interaction can tell us about learning in this PBL online context.

The primary research question was: What characteristics of an online problem solving discourse can be described and what do those characteristics suggest about interaction and student learning over time? Sub-questions include: What are the patterns of participation and interactivity within these small groups? How does the dialogue reflect student learning? What evidence, in this PBL and computer-mediated environment, is there to suggest collaboration, and the use and development of educational psychology concepts in shared problem solutions?

## Chapter 2 Review of Literature

Collaborative learning is an instructional methodology linked to several pedagogical perspectives. Cognitive theories of learning and sociocultural theories have utilized collaborative learning methods and linked learning outcomes to the effects of the collaboration, respectively, on internal mental processes of the individual learner or the collective (contextualized) knowledge that resides in a community of learners (Greeno, Collins, Resnick, 1996). A more recent theoretical perspective proposed by Bereiter & Scardamalia (2006), termed knowledge building, focuses on knowledge as an artifact – ideas treated as real things – to be created, manipulated, changed, and enhanced. The theoretical model of knowledge building frames the act of collaborative discourse as an indispensable act that places knowledge in a public space (including a virtual environment). Knowledge building goes beyond what is learned (the internalized knowledge that an individual takes away from the learning event) and examines knowledge as ideas and concepts that are advanced within the community (knowing something that was not known before) and these ideas and concepts become the unit of analysis in examining a knowledge building process. With these theoretical perspectives in mind, the literature review focuses on the use of computer supported collaborative learning (CSCL) in problem-based learning (PBL) environments, and literature on collaborative discourse (both online and face-to-face) which examines what happens within the social dialogue that may further explain student knowledge construction and features that support learning in this context. The assumption in examining this type of collaborative discourse is that it is possible to track student reasoning through their online activities (Grasser, Baggett, & Williams, 1996), knowledge construction (Hogan, Nastasi,

and Pressley, 2000), the appropriation of important concepts (Chernobilsky et al., 2004), shared conceptual change (Barron, 2000; Roschelle, 1996), and evidence of knowledge building (Chan et al., 2003).

**Problem-based Learning**

Problem-based learning (PBL) structures the learning environment to afford collaboration and problem-solving. Features of PBL include the use of ill-structured, real-world problems in a student directed learning environment with support from a facilitator (Hmelo-Silver & Eberbach, 2012). PBL has increasingly been used as an instructional method in elementary to professional education programs (Walker & Leary, 2009). Hmelo-Silver & Eberbach (2012) define PBL goals as integrating practical and theoretical knowledge of a domain, helping students acquire professional reasoning and effective collaborative skills, and finally, helping students to use processes that facilitate learning into future contexts (flexible knowledge). Learning is achieved by the students working through a problem collaboratively within a small group and with the assistance of a facilitator (Barron et al., 1998; Hmelo-Silver & Barrows, 2006). Social constructivist theories of learning suggest that what accounts for learning in the PBL model is that the problems are situated in real world contexts, there is facilitation and collaboration that helps move the students to increasing levels of knowledge construction (Barron et al., 1998; Bridges, Botelho, Green & Chau, 2012; Hmelo-Silver, 2004), the cognitive load of problem solving is distributed among the group members, and the use of reflection and metacognition by the students deepen the students' levels of understanding (Ertmer, Newby, & MacDougall,1996). As students investigate and seek

solutions to a problem they acquire an understanding of key principles and concepts (Blumenfeld, et al., 1991).

An important concept is Vygotsky's (1978) zone of proximal development (ZPD) which is the range of the student's capacity for learning, beyond what can be done individually, when assisted through verbal and social interaction from a more capable peer or teacher. Social collaboration and assistance from a more capable peer or teacher help the student to realize higher levels of knowledge. Educational research in constructivist methodologies has found that through social interaction learners have access to how other people reason and solve problems, allowing them to internalize more expert and effective ways of thinking (Stepeich, Ertmer, & Lane, 2000) and use multimodal texts and mediating tools to support learner cognition in a social context (Bridges et al., 2012)

Use of online problem solving in a PBL environment is often conducted over multiple course periods and the online discourse is examined for evidence of individual learning. Siegel et al. (2001) examined the role of online PBL activities for preservice teachers. The goals of the study were to determine if pre-service teachers learn to spontaneously activate course concepts in various instructional situations; to find out if the pre-service teachers use appropriate concepts; and to assess if there is evidence of improvement in such ability from pretest to posttest. The authors combined hypertext instructions and PBL in the design of the web site and taught a course using it. According to the authors of the study, problem-based, case-based approach to instruction was "effective in helping student teachers use the learning sciences concepts to analyze and redesign classroom environments" (p. 14).

Chernobilsky et al. (2004) studied a group of pre-service teachers over a semester course in an educational psychology that utilized PBL and incorporated online web-based instruction. The authors examined group and individual artifacts to study how students incorporated the conceptual language of educational psychology into their problem solving. As students progressed through an online problem solving process the authors found that, "within each stage and from one stage to another, social interaction would serve as a mediating vehicle through which vocabulary, ideas, and knowledge might flow from one individual to another by means of appropriation" (p. 348).

In this case study the use of PBL is the instructional tool used to help students work collaboratively to solve "real world" problems. The problem solution is negotiated and constructed through collaborative discourse within the group and displayed via an online dialogue that occurs over the course of nine weeks as they work through four specific problem solving episodes.

**Collaborative Discourse**

Problem-based learning embraces the think aloud; talk aloud nature of mutually and socially constructing meanings (Palinscar, 1998). Problem-based learning is one example of how collaborative group dialogue can be applied - this section examines literature that focuses on discourse outside the PBL format.

Collaborative discourse is the dialogue that is created within a group or dyad (i.e. in student and tutor relationships) as they work together. Research has confirmed the benefits of using group discussions to elaborate, revise, and clarify thinking (O'Donnell, 2006). Hatano and Inagaki (1991) identified the discourse categories of clarifying, disputing, and coordinating pieces of knowledge as important metacognitive practices

that help students develop understanding in a group discussion. Donath et al (2005) characterized discourse during a Research Communications Studio (RCS) project where a small group of undergraduate students (N=3) in engineering education meet with a faculty advisor and graduate assistants to discuss their research projects. The group was videotaped and the discourse was coded and analyzed. Seven categories of speech events were identified: elicitation of critique, critique, internalization, (direct and indirect) instruction, contextualization, explanation, and negotiation and consensus building. The authors found that the RCS format "encourages interaction that facilitates learner-, community-, and (self)-assessment-centered stances to learning in an authentic communicative project" (p. 411). Effective discourse can lead to mutual understanding of concepts.

Effective dialogue can be prompted through the use of instructional strategies that feature interactive arguments and respectful controversy with opposing ideas (Chinn, O'Donnell, & Jinks, 2000) and questions and queries that lead to alternative views (Graesser, Person, & Magliano, 1995). Research suggests that the "disagreement" that arises when alternate/diverse ideas are presented can act as a motivating factor for students (rallying around a controversy) and create an opportunity to reach convergence around an idea or solution (Chinn, Anderson, & Waggoner, 2001; Engle & Conant, 2002; Roschelle, 1996). Hogan, Nastasi, & Pressley (2000) examined collaborative discourse and suggest that group member's ability to elaborate on one another's ideas was associated with more sophisticated reasoning. Roschelle (1996) conducted a microanalysis of a single case where two students were engaged in a discovery learning task about velocity and acceleration using a computer simulation activity. The research

interest was in exploring the collaboration and convergence of meaning that the two students negotiated as they approached the task. "Convergent conceptual change is achieved incrementally, interactively, and socially through collaborative participation in joint activity" (p. 211). Convergence emphasizes the mutual construction of understanding.

Other instructional tools that aim at improving collaborative discourse have been studied in an attempt to identify key features that promote critical thinking and deeper understanding. Hogan, Nastasi, and Pressley (2000) examined discourse components of Grade 8 students as they engaged in scientific reasoning within peer or teacher-guided groups. They found in analyzing the videotaped dialogue that the important feature was persistence in both groups in working with weak or incomplete ideas until they improved. Teacher guided discourse often proved more efficient at building ideas; however the peer groups were coded higher on the complexity of their reasoning. The use of questioning strategies have been examined as a key in prompting students to engage in explanatory reasoning (Graesser, Baggett, & Williams, 1996; Graesser & Person, 1994; King, 1990; vanZee & Minstrell, 1997). These studies suggest that questioning guides human reasoning and the use of quality questions can help to promote a pattern of discourse that has a positive influence on student learning. Herrenkohl and Guerra (1998) used structured roles to promote more purposeful involvement within classroom discussions. Students assumed assigned roles that required them to engage socially and critically with the material. Those students who were assigned specific roles (i.e. to check others work, seek clarification) during discussions "created a classroom situation in which understanding, clarifying, and sharing meaning as a class was more central" (p. 466).

Each of these studies provides evidence that collaborative discourse can be an effective tool to assist students to reach greater levels of understanding, mutually constructed ideas, and convergence between collaborators. Features of the discourse, such as diversity of ideas or clarifying or critiquing, can be identified as effective in promoting reasoning. Additionally, learning environments can be structured to improve the probability that effective discourse features are present. The structures that support effective face-to-face discourse are presumed to support effective online collaborative discourse. The next section looks at current research in online learning and whether these assumptions are supported by evidence.

**Computer Supported Collaborative Learning (CSCL)**

Research on face-to-face discourse in education is fairly extensive and has examined many of the structures, contexts, and characteristics of learners and teachers that lead to effective collaboration (Chinn, Anderson, & Waggoner, 2001; Engle & Conant, 2002; Ennis, 1987; Gruber & Boreen, 2003). The growing use of technology in education has resulted in a growing body of research about collaboration, collaborative discourse, and online learning environments in education. In a review, Fjermestad & Hiltz (1999) found that 90% of the experimental studies on group decision support systems (GSS) have been published since 1990. Research evaluating the use of technology for group collaboration and decision making found that students in computer mediated collaboration (CMC) formats tended to outperform face-to-face groups in critical thinking, perspective taking, and task focused interaction (Luppicini, 2007). There have been a number of mixed results comparing face-to-face and online collaboration; however, in general, on outcome measures the online students did as well as their

traditional counterparts (Luppicini, 2007). Fjermestad & Hiltz (1999) noted that 73.5% of all the studies reviewed (n=200) involved the examination of group members in a single problem-solving session and the majority did not have a leader (94%) or a facilitator (70%). Research focusing on collaboration has suggested that online environments can create opportunities for deeper inquiry, domain understanding, and help to assess and advance knowledge (Lee, Chan, & van Aalst, 2006) and afford more opportunities for synthesis students engaged in more collaborative dialogue (Paulus, 2005).

Booth & Hulten (2003) conducted an analysis of collaborative groups engaging in online problem solving discussions. The analysis led the authors to suggest a taxonomy of contributions that appeared necessary conditions for learning. The taxonomy of categories was identified as participatory (i.e acknowledging another group member), factual (i.e. referring to the specific problem), reflective (i.e. questioning/comparing), and learning contributions (i.e. refining, improving). Paulus & Roberts (2006) used the Booth & Hulten taxonomy to analyze online dialogue from two groups involving preservice teachers, one successful and one less successful, as they completed an online case study analysis. Findings suggest that the successful group engaged in more supportive dialogue and used evidence to support their claims. Types of contributions from both groups, in order from most to least frequent, were factual, participatory, reflective, and learning. Neither group challenged ideas or posted many questions. The authors recommended that more structures may need to be in place to help students be more reflective and demonstrate evidence of learning in the discourse.

Knowledge building is a specific form of collaborative inquiry supported by

asynchronous computer support. The focus is on promoting collaboration and idea diversity, helping students learn how to learn, and idea improvement that leads to more sophisticated thinking (van Aalst, 2006). The Knowledge Forum (KF) is a tool specifically designed to support this collective, online community. The KF is educational software that supports an intentional learning environment as "an asynchronous discourse medium…it consists of contributions to a community knowledge base, which resides on a server and is accessible to everyone in the network" (Scardamalia, 2002, p. 72). Work with young learners (9- and 10-year olds) has demonstrated that computer support and the implementation of knowledge building principles can assist learners in gaining increased levels of collective responsibility for their learning and advancing knowledge within the individual and the students' learning community (Zhang et al., 2009; Zhang, et al., 2007).

Moss & Beatty (2006) investigated knowledge building using the KF over 4-months with 4$^{th}$ grade students (N=68) learning and generalizing algebraic functions. The purpose was to provide a virtual environment in which data can be stored and then accessed for reference and revision – a continual building on of what is known within the community that is participating. The authors found that students were able to sustain collaborative discourse over time and use the KF to develop an awareness of multiple rules, evidence and justification for problem solutions. Law & Wong (2003) found that students experienced in the use of knowledge building principles and the use of KF could effectively collaborate and scaffold learning with a less experienced group of students. Technology, as a platform for learning, can offer a safe way for students to present a diverse array of ideas that are visible and useable to all participants. A database can be a

forum where ideas are presented, discussed, revised or used to create something new (Kali, 2006).

**Features for Online Collaboration**

The literature on design features for online collaboration offered insight to compare the online environment that was studied with practices that have been recommended in prior literature. Some researchers who have examined online formats have found that, in practice, providing opportunities to collaborate online does not automatically lead to quality interactions (Kreijns et al., 2003). Maurino (2006), in a review of 37 studies looked at evidence for critical thinking in online *threaded* discussion and found that in the dialogue there was not evidence of critical inquiry and deep learning at a high level or to any great extent. The threaded discussions often do not offer features that are thought to be needed for effective collaboration in the online environment.

Gudzdial & Turns (2000) examined online discussions and proposed that for effective online discussions to take place students need to easily access and understand the flow of discussion through discussion management features, facilitation features that assist the students in directing posts and prompting interaction, and anchoring features (e.g. a case or problem to solve). In the online PBL environment being examined in this case study many of the structures considered necessary for effective collaboration are part of the instructional features. The students had a beginning tutorial; solving one problem face to face prior to having to problem solve online. Logistical support was provided to help students with the technology. Collaboration was a structured requirement of the problem solving task and supported by online design features. Discussion was managed through the use of directional prompts (i.e. a question to answer and where to post the

answer), the discussion is anchored in a problem, and the instructor acts as a facilitator to the working groups.

**Summary**

The CSCL community has begun to demonstrate that technology can be instrumental in promoting principles of knowledge building. Computer instructional designs can allow for collaboration, negotiation, and developmental growth of ideas for individuals and the participating learning community. This course, employing PBL instructional tools, situates the learning in an online instructional model that has many of the features thought to be necessary to effective collaborative problem solving. Research in PBL, combined with an asynchronous online format, continues to need examination.

The collaborative discourse within this research examined small group online dialogue, questions, and facilitation and spans multiple weeks and multiple problems. Prior research suggests that examining problem solving dialogue can provide detailed descriptions of characteristics, processes, and the developmental trajectory of the process. Continued research in this area can help point to effective features of instruction.

Dillenbourg & Traum (2006) studied the relationship between grounding and problem solving during an online dialogue. Grounding is a term used to describe the process in which individuals come to know the same thing - find and maintain a shared conception. Similar to other researchers, and in the tradition of social constructivist learning theories and knowledge building, learning takes place at the point of interaction. This research has the potential to lead to a deeper understanding of online dialogue and the process of coming to a solution and the role that negotiating the shared understanding has to that process.

# Chapter 3 Methodology

Online discourse in the problem-based learning environment and the student/instructor interactions that take place in such a learning environment are complex social phenomena that can best be understood using a naturalistic and descriptive method. Qualitative research, as an inquiry process, uses a naturalistic setting and data that originates from the participants point of view in order to build a descriptive picture (Bogdan & Biklen, 1998; Creswell, 2007; Marshall & Rossman, 2006). The descriptive nature of the inquiry assumes that from the parts and details of an experience a holistic picture can be constructed and then used to create an interpretive finding. A qualitative method provided the researcher the opportunity to study the social world of online discussion, viewing the case holistically within a natural context (a course) and to maximize what can be learned. Stake (1995) suggests that by employing qualitative case study methods, previously unknown relationships and variables can be expected to emerge and provide insights into how the phenomenon develops.

A case study is an exploration of a bounded system or case or particular event over time through detailed examination and analysis (Bogdan & Biklen, 1998; Creswell, 2007). Yin (2003) defines a case study as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context" (p. 13). The case study provides the opportunity for an in-depth analysis of a well defined phenomenon within a real-life context (Merriam, 1998). This case study represents a nested case study design (Patton, 2002). The overall case is the online learning in a specific undergraduate course; however there are smaller cases nested within the primary case represented by the six small groups. The case covered approximately eight weeks of a fifteen week course in

educational psychology and involved six groups as they solved four computer-mediated problem-based cases. Initially, the students met in a classroom setting and then spent approximately half of their time online during the second half of the semester. How learning occurred is reflected in the language of the learners, how they create a meaningful problem solving dialogue, and the evolution of that dialogue over time and in an authentic context can best be examined by a descriptive examination of the phenomena.

**Pilot Study**

A pilot study was conducted with a small subset of the data represented in this case study. Data were collected from the STELLAR site; accessed via a login and password. The pilot study examined one group of six students during one online problem solving episode. The problem being solved was the third of four online problems presented during the course. The online discourse took place over ten days and included a total of 43 online entries that included proposals (9) for a problem solution, comments and revisions (29), and comments by the facilitator (5).

The primary research question for the pilot study was: what does the discourse suggest about online student learning and the characteristics of the interactions during the course of building a solution to a video problem-based case?

This pilot study provided a glimpse at some issues worthy of continued attention and issues that helped focus my attention. These included how to examine the data – both by episode and chronologically, the possible developmental nature of the dialogue, the role of the facilitator, how misconceptions are addressed, and the negotiation of a shared understanding of concepts, ideas, and of the final problem solution. The pilot

study helped to inform the current data analysis plan. The unit of analysis is the problem solving episode - solution proposals, comments, revisions, and facilitation. Arranging the data by problem solving episodes allowed the researcher to examine the discourse both chronologically and as it developed related to specific proposals/solutions that were generated.

**Setting**

This case study details the online dialogue of undergraduate students enrolled in an educational psychology course for potential pre-service teachers at a large northeastern university. The class was scheduled twice a week for 80 minute periods over a 15 week semester. The course utilized a problem-based learning (PBL) model with a strong emphasis on interaction and collaboration among learners. Using the demographic information that had been collected the first day of the class, the instructor and graduate assistant sorted the students into heterogeneous collaborative working groups of five or six. The students remained in these groups for the duration of the semester and solved five PBL activities. Approximately half the course time, primarily during the later weeks of the semester, was spent online rather than in face-to-face class time. There was an instructor and graduate teaching assistant, both who had expertise in teaching and managing online collaborative problem solving course work. Students were introduced to the online environment in class through demonstration and discussion to support use of the online materials. During the weeks when students were working online, classroom support was available to the students, if needed. The goal of the course was to have potential pre-service teachers understand how educational psychology can be applied to a variety of classroom practices and learn practices that could later be applied in a

classroom. As the course description stated: "This course introduces students to the theory and research that form the foundation for learning and instruction. We will focus on five major themes that are important for you to be able to learn and apply to your future teaching practice. These themes are: the constructive nature of knowledge, the social nature of learning, transfer, motivation, feedback and revision" (Hmelo-Silver, personal communication, December 12, 2007).

The first problem was presented during the fourth class session and completed over three in-class sessions. This initial problem served the purpose of introducing the students to each other, to group work, the problem-based learning process, and course content. The remaining four problems were introduced and solved using a web based platform called STELLAR (Socio-technological educational learning and learning activities research). The conceptualization of STELLAR was developed from eSTEP (*Elementary and Secondary Teacher Education Project*). The purpose of the eSTEP Instructional Model project was to design innovative, experimental web-based approaches to teaching the learning sciences to pre-service teachers. The project site (http://www.wcer.wisc.edu/estep/) describes instructional approaches that integrate: Interactive study of classroom video and learning science text, supported by an online multimedia hypertext called the Knowledge Web (KW), and collaborative lesson designs, supported by an online environment for problem-based learning (see Figure 1) (University of Wisconsin, 1999).


Figure 1. Example video case with links to knowledge web.

Following the in class case problem, the next four problems were presented online. The student groups viewed video cases which presented classroom situations illustrating four different teaching and learning scenarios. They worked collaboratively to design or redesign the lessons presented in response to questions posed. Each case had a slightly different emphasis for the students to explore and online links were provided to the Knowledge Web hypertext (Derry, 2006) for students to research and learn about important educational psychology concepts. Problem 1, Knowing what Brandon Knows, shows a sixth-grade student solving a mathematical problem and explaining his solution to an investigator. (see Figure 2, the screen view for the first problem and Appendix A for views of all screens) In Problem 2, Learning by Design, the video shows middle school students engaged in a design project in a science class. The groups were asked to help the teacher develop assessments to gauge student understanding. Problem 3, Instructional Redesign of a High School Physics Unit, compared two teachers. One of the teachers was seeking assistance to incorporate the other teacher's methods of a more inquiry-oriented,

constructivist approach. Problem 4, Foreign Language Problem Statement, showed a French teacher interested in redesigning her curriculum to meet new teaching standards (Hmelo-Silver, Derry, Bitterman, & Hatrak, 2009). In each video case the small groups were asked to incorporate educational psychology concepts and provide rationales for using concepts as they solved the problem. There was a set sequence for students to follow, represented by footsteps, that was pictured at the top of each screen where the problem was presented.

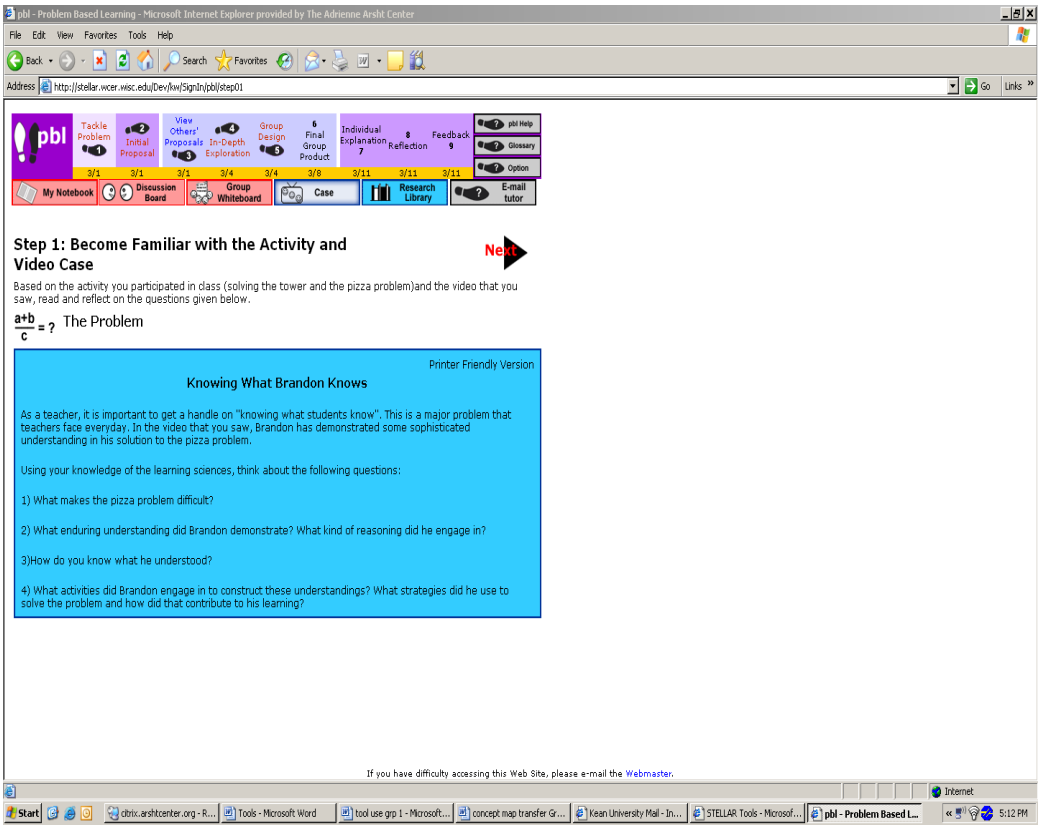



Figure 2. First Online Problem Case.

The actual problem solving involved nine steps (see Figure 3). In Step 1 the student would read the "problem statement", which presented a brief overview of the case and instructions on what the group had to produce to solve the problem. The problem

posed could take the form of specific questions to answer, products or artifacts to produce (e.g. a lesson plan), and what evidence would be expected to support their problem solution. The student then watched a brief online video that illustrated the situation or problem. The online group problem solving discussion (Steps 3-6) took place on the Group Whiteboard. A considerable portion of the grade for the class was for points earned completing the online video cases (48 points of 100) and an online participation grade (6 points of 100). The course syllabus suggested that students should post a minimum of 2-3 entries for each video case and respond (comment) to at least two other notes in the discussion.

| Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Step 8 | Step 9 |
|---|---|---|---|---|---|---|---|---|
| Review the problem | Develop an initial proposal | Post your proposal and view others | Establish goals for the project | As a group formu-late a problem solution | Post final problem solution | Post individual explanation of solution | Reflect on your learning | Give feedback on instructional issues |
| Individual | Individual | Group | Group | Group | Group | Individual | Individual | Individual |

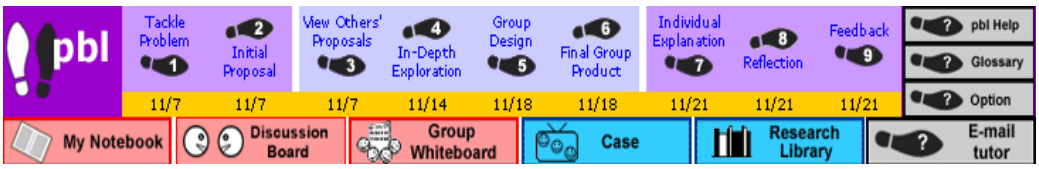


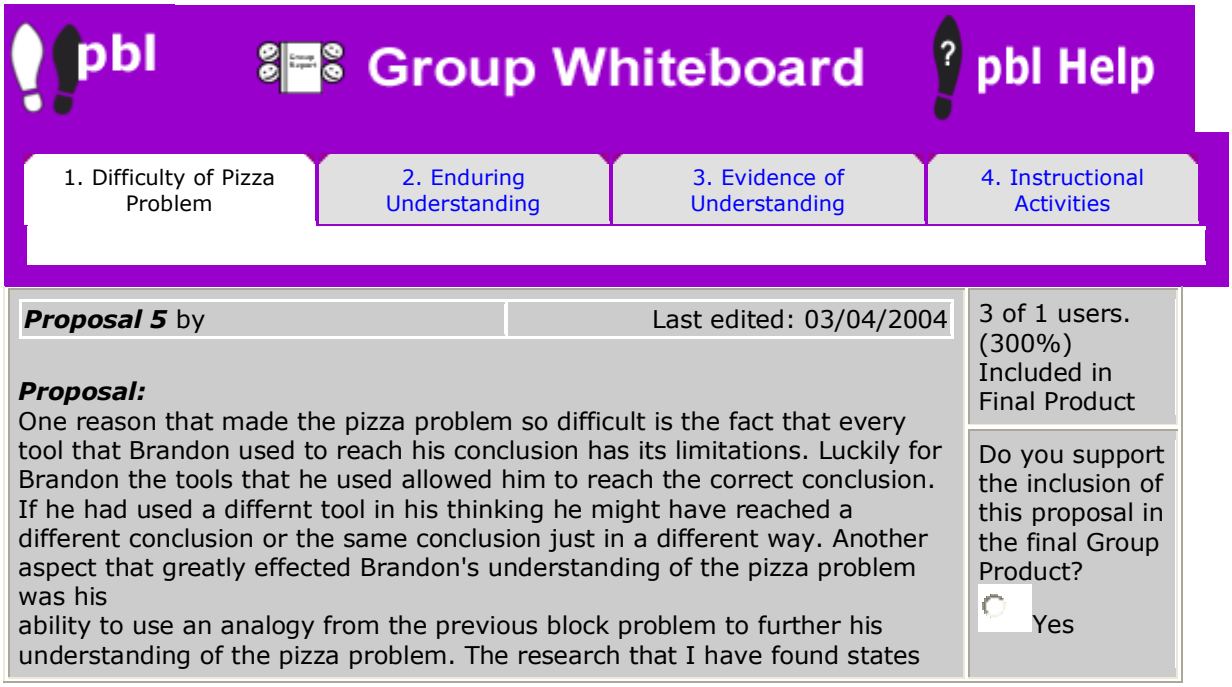

Figure 3. Nine problem solving steps and student screen view.

The Whiteboard (see Figure 4) was the place where members of the group posted problem solutions in the form of proposals and commented on other group member's

proposals. The students were to provide evidence and explanations that supported their proposed solutions. For example, in the first case, “Knowing what Brandon knows”, Brandon was shown solving a math problem. The problem case asked the students to respond to four questions.

> What makes the problem difficult?
> What kind of reasoning and evidence of enduring understanding did Brandon demonstrate?
> How do you know what he understood?
> What activities did Brandon engage in and strategies did he use to solve the problem?

Tabs on the whiteboard screen were labeled and corresponded with the questions: Difficulty of pizza problem; Enduring understanding; Evidence of understanding; and Instructional activities (see example in Figure 4). The students then presented answers, evidence, and comments that pertained to each question under the appropriate tab.



that, " research has shown that the use of appropriate instructional analogies can enhance students' understanding and memory for complex concepts." (knowledge web) Eventhough Brandon may have not consciously realized that his reasoning for solving the pizza problem in the way that he did was fueled by his understanding of the block problem he soon realized the correlation. The block problem created a schema or a template in Brandon's memory which he was able to access and apply to the pizza problem. This schema afforded him the opportunity to use high road transfer which involves the intentional search for connections between the differing problems.

***Research needed:***

No Vote

Comments by

Hey,. I think that maybe you can expand on the idea of schemas or schematas here. I found this link that has descent detail that can help with furter connection between Brandon and the actitity. Let us know if it helps any.
http://stellar.wcer.wisc.edu//step/theories/TheoreticalPerspectives/CognitiveTheory/KnowledgeConstruction/Comprehending

Figure 4. Student View of Group Whiteboard

The facilitators, the instructor and a graduate assistant, could also post comments. Each of the four case problems had two to four questions on individual tabs that allowed students to categorize responses according to a question or aspect of the problem solution. The virtual online site provided supplementary resources, materials, and links to assist students in researching problem solutions. Students could click on the link Knowledge Web (KW) to access these materials (see Figure 5).

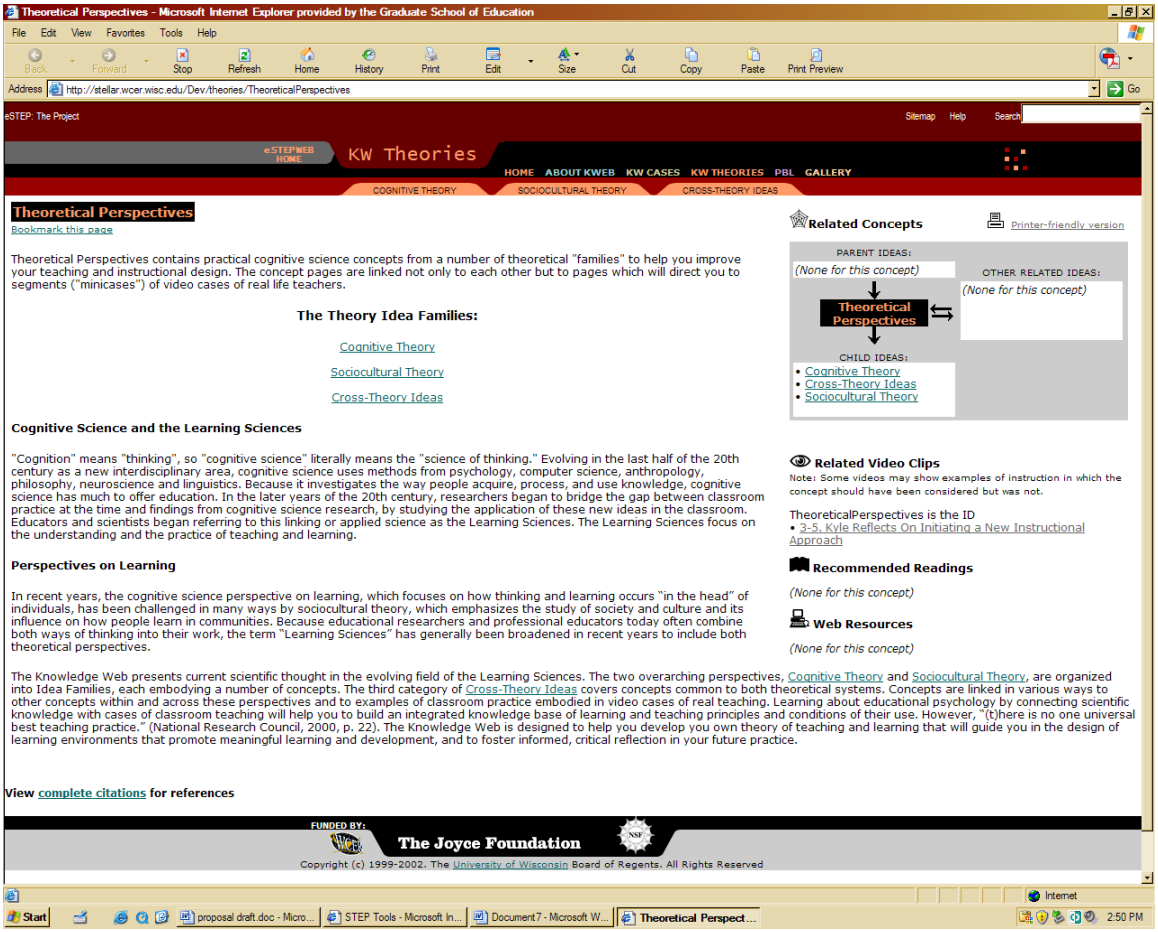



Figure 5. Student View of Knowledge Web (KW) Page

## Participants

The participants were 34 undergraduate students enrolled in an introduction to educational psychology course at a large northeastern university. The class was geared to individuals who were interested in K-12 teaching and self-identified as pre-service teachers (see Table 1for participant information). The students ranged from freshman to senior level and represented a variety of majors. Institutional Review Board (IRB) approval was granted and, after class discussion, students signed informed consent forms and provided demographic information at the beginning of the course.

Table 1. Participant Information.

| Participants* | Gender (F/M) | Age | Ethnicity | Year in College | Major |
|---|---|---|---|---|---|
| **Group 1** | | | | | |
| Nina | F | 21 | EuroAm | Junior | Psychology |
| Kim | F | 20 | EuroAm | Sophm | English |
| Nadia | F | 22 | Greek | Senior | Math |
| Kay | F | 21 | unknown | Junior | Foreign Language |
| Rose | F | 23 | Asian | Senior | Psychology |
| **Group 2** | | | | | |
| Robin | F | 20 | Hispanic | Sophm | Foreign Language |
| Geri | F | 21 | Hispanic | Junior | Psychology |
| Lynn | F | 21 | EuroAm | Junior | English |
| Rena | F | 21 | EuroAm | Junior | Sociology |
| Fay | F | 21 | EuroAm | Junior | Psychology |
| **Group 3** | | | | | |
| Dana | F | 21 | Hispanic | Sophm | Criminal justice |
| Ken | M | 21 | EuroAm | Junior | Special Ed |
| Julie | F | 22 | EuroAm | Junior | Social Studies |
| Vicki | F | 21 | EuroAm | Junior | Psych/Linguistics |
| Ernest | M | 21 | EuroAm | Junior | Math |
| Ina | F | 22 | EuroAm | Senior | English |
| **Group 4** | | | | | |
| Monica | F | 23 | EuroAm | Senior | Sociology |
| Rachel | F | 21 | EuroAm | Junior | Social Studies |
| Holly | F | 28 | EuroAm | Junior | English Ed |
| Mara | F | 21 | EuroAm | Junior | Math |
| Caitlin | F | 22 | EuroAm | Senior | Psychology |
| Amber | F | 20 | EuroAm | Sophm | English |
| **Group 5** | | | | | |
| Juan | M | 45 | Hispanic | Senior | Foreign Language |
| Fran | F | 20 | EuroAm | Freshman | Sociology |
| Steven | M | unknown | unknown | Sophm | Math |
| Karen | F | 22 | unknown | Junior | Social Studies |
| Lois | F | 23 | EuroAm | Senior | English/Psychology |
| Tina | F | 21 | Asian | Junior | Psych/Education |
| **Group 6** | | | | | |
| Vince | M | 20 | African-Am | Sophm | Social Studies |
| Ellie | F | unknown | EuroAm | Sophm | English |
| Bryan | M | 22 | unknown | Senior | Visual Arts |
| Anna | F | unknown | unknown | Junior | Foreign L/Psych |
| Emily | F | 21 | EuroAm | Junior | Evolutionary Anthropology |

* All participants are identified by pseudonyms

There was an instructor and graduate assistant who participated in the online dialogue as facilitators. They posted comments to student proposals. These comments were examined as a part of the dialogue.

**Data Collection**

Yin (1994) identified six sources of data as potential evidence in a case study. One of those sources is archival records. The online dialogue for this course was stored on the STELLAR platform for the purpose of review during the course as the problem solving was occurring and for prospective research. The archived data was made available to this researcher. After logging onto the STELLAR site the data could be accessed under a dropdown tab labeled "Workgroup". There were twenty-four selections representing each of the six group and their responses to the four cases. After selecting a group and one of the four cases, there were two options to view the data; click on the "Activity Window" to view the data from the student perspective, or click on "View Group Whiteboard History" for the researcher view. The student view provided a look at the finished proposals and comments in the context of the problem; organized by responses to questions posed for each problem. The facilitators used this view as they posted comments to the site. The researcher view was the primary source of the data (which was essentially the same content of the student view, but organized chronologically) and resembling a word document. The group white board history was copied into a word document data file; single spacing for each entry and then multiple spacing to distinguish between entries. All entries included the date, time, participant's name, and what type of entry it was (either a proposal or a comment). Headings were established for each document that was labeled and saved and indicated the group,

problem, and the “tab” under which the entry was made. Each group was filed by group name and divided into the four problem solving episodes. Students would occasionally enter the proposal several times or in an unfinished form or delete incomplete entries. The data files were reduced to eliminate redundancy and to reflect what postings under the student view. The total number of posts on the Whiteboard for students and facilitators across all problems is 881.

The online data is the written dialogue that students engaged in as they solved problems and consisted of developing a proposal that integrated learned concepts into a final solution for the four problems presented. The dialogue included posted comments from the two facilitators. Each individual member of a group had asynchronous access to the site, could view and review any posting, and post or respond any time during the problem solving session - typically two weeks in duration. Individuals could revise postings after they were put on the whiteboard (or delete them), and could continually add to or update any prior posting - one of their own or in comment to another members post.

Students could post a proposal and/or comments under several tabs, as mentioned above. Labeling of three of the four video problems included the “tabs”: instructional objectives, evidence of understanding, and instructional activities. These tabs reflected the work that had to be produced in response to the problem statement (e.g. lesson plans with specific objectives, explanations of how the students would demonstrate understanding and classroom activities to meet the objectives).

**Data Analysis**

Spradley (1979) defines data analysis in qualitative research as a "systematic examination of something to determine its parts, the relationship among parts, and their relationship to the whole" (p.92). In a case study the assumption is that "each case is special and unique: the first level of analysis is being true to, respecting, and capturing the details of the individual case being studied" (Patton, 2002, p. 41). In this case, the unit of analysis is online dialogue entries during multiple problem solving exercises for each of the six student groups. The analysis in this study sought to view the dialogue at the small group level (the meso-level); looking for evidence of learning, and problem solving, and the characteristics or patterns of interaction within the small groups and over time.

Merriam (1998) suggests starting with a reading of the data and making notes in the margin that might begin to label the data for later categorization. "Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled [and are] usually applied to 'chunks' of varying size" (Miles & Huberman, 1994, p. 56). Codes are frequently tentative until consistencies begin to emerge. The coded data was then grouped into categories. The categories were a conceptual grouping indicated by the data and informed by the study's purpose, orientation, and related knowledge domain. Codes and categories were tentative and flexible. Using an iterative process, the data was repeatedly analyzed - looking for meaningful patterns - and the categories reorganized until they seemed to fit the data. Attention to negative cases, those that did not fit or contradicted emergent categories, lead to re-examination of the data and helped to refine or revise the analytic framework (Ely et al., 1991). Looking

for patterns in the data reduced the data into smaller units, established a cognitive map for understanding the problem solving processes, and laid the groundwork for cross-group analysis (Miles & Huberman, 1994). Bogdan and Biklen (1992) suggest writing observer comments and memos that help the researcher organize his/her own thoughts and reactions to the data, explore related literature, the use of metaphors and analogies, and the use of visual devices. Miles and Huberman (1994) additionally suggest displaying the data and categories in different arrays, building a matrix of categories, and putting the information into chronological order.

With these suggestions in mind, and after all the data had been converted into word documents as described above, data analysis followed several steps.

First, the data was read and reread until I was intimately familiar with the text. I then began to reread the data with the interest in looking at the online dialogue for each problem, and across multiple problem solving episodes. As a student generated an idea about how to solve the problem, they labeled it as a “proposal” that was then commented on, questioned, revised, etc. Having the data arranged in this manner allowed the researcher to examine the dialogue as it developed related to specific proposals/solutions that were generated - corresponding to that meso level of analysis suggested by Dillenbourg and Traum (2006). Initial impressions were noted in the margins (i.e. identifying when an educational psychology concept was used or an interactional pattern observed). Interaction tables were created for each group and each problem that represented the participant, the posting of proposals, and the sequence of comments from peers or a facilitator. An analytic memo was generated after the reading of each set of

data from each group to record initial thoughts and potential codes as well as impressions about the interaction tables.

Second, while reading the online dialogue, I continued the coding process by identifying each instance when an educational psychology concept was introduced and used as part of the problem solution. Educational psychology concepts were identified as a concept, for example, when the dialogue included references to student learning or understanding (knowledge), learning processes, instructional strategies, or assessment. Many of the concepts that students included a problem solution could be traced back to the course textbook or the hypertext (KW). The dialogue about the concept was aggregated into a word document for each group. This was initially done sequentially from the student whiteboard postings and each entry was identified in the document by date, time, person, group, problem, tab, and type of post. For example, this post by Nina about assessment, "The teacher would also be able to assess their understanding from the classroom discussion". (C on P3 Nina 1:4:2), is a comment (C) on Proposal 3 by Nina who is in Group 1, on Problem 4, Tab 2. This arrangement helped me track the dialogue and organize it for further analysis. Initially, an educational psychology concept was identified by looking at each question (or tab) sequentially for instances of concept use. By examining the sequence of posts under each question, I could determine how the group was responding to each question and analyze the development of concepts and interaction that were presented. Data about concepts, such as assessment, were organized sequentially from the beginning of the postings on Tab 1 to the last postings on Tab 4.

Students could respond to any or all of the questions at any time during the assigned period. In order to follow any one concept the data was then arranged

chronologically. Examining the data chronologically allowed for a clearer picture of when a concept was introduced and its development over time across all question tabs by each member of the group. During data analysis each concept was identified as it was used within the group, how the group incorporated and interacted about the concept, and the interactive processes that the group used as concepts were incorporated into final solutions for each video case. This allowed me to identify how the concept was used, or not used, over time as the group worked with each successive video case sequentially from Problem 1 to Problem 4. At this point in the analysis there were interaction tables of each group and problem and files for each of the identified educational psychology concepts that contained dialogue from each group as they used the concept (see Appendix B for a list of all educational psychology concepts).

Third, prior research on collaborative online dialogue has identified several models for examining the social construction of knowledge and knowledge building and was discussed in the review of literature (Booth & Hulten, 2003; Campos, 2004; Gerbic & Stacey, 2005; Gunawardena et al., 1998; Law & Wong, 2003; Meier et al., 2007; Puntambekar, 2006; Zhu, 2006). These models were reviewed as presenting possible categories to consider a priori as well as categories that emerged from the analysis process. For example, Booth and Hulten (2003) coded contributions as participatory, factual, reflective, or a learning contribution. Inductive analysis that was informed from the pilot study included looking for evidence of collaborative problem solving; the use of dialogue maps that track interactivity; mapping ideas and concepts as they are presented and developed over time within groups.

After the reading and coding for the instances of the use of educational

psychology concepts I reexamined the data for patterns of interaction. I began to label the interaction dialogue and coded these interactions; grouping them in like categories that illustrated the types of interactions that were occurring. For example the dialogue was coded by type of interaction (e.g. statement categories of agreement, disagreement, scaffolding, metacognitive, etc.; see Table 2 for categories definitions and illustrative examples). The purpose was to look for the types of interactions and their characteristics as group members worked toward a problem solution. Dialogue was examined for indications of how participants presented, examined, manipulated, revised, and negotiated final solutions.

Table 2. Statement categories, definitions, and examples of dialogue

| | |
|---|---|
| Agree: A statement by one group member of agreement to another group member about a posting. | |
| Examples: | I completely agree with the statement "...our knowledge representation is built up when we can observe the differences and similarities in different events." It is important to recognize that previous activities or events can affect future events. |
| | I agree that analogy is a useful strategy to use |
| Disagree: A statement by one group member of disagreement to another group member about a posting. | |
| Examples: | I don't think you can "pass" your zone of proximal development |
| | Not necessarily true, sometimes it is found among novices |
| | I don't agree that confidence is really evidence of understanding |
| Analytical (yes, but…or an alternative view) or evaluative: A statement that offers evaluation or judgmental opinion of a posting by another group member. | |
| Examples: | But in the spirit of questioning and learning...wouldn't you say that his abilities as a flexible thinker along with his prior knowledge are what enabled him to make sense of it? |
| | The above proposals provide excellent details to this |

account; however, I think that Ms. B's aim may have gotten a bit sidetracked

Encourage: A statement of support or a prompt to continue to work on the problem solving effort

Examples: Interesting idea-- what do the rest of you think?

There are some very good points here—

Again, GREAT JOB!!

Logistical: A statement related specifically to the task and is about working in the problem space

Examples: Be sure to revise the proposal to reflect the discussion

I just wanted to let everyone know that I updated my proposal to include the ideas that Monica and Amber suggested.

Metacognitive: A statement about planning, monitoring, understanding, or evaluating the way the individual or the group is thinking about the problem solving.

Examples: I don't know if I'm looking at this correctly, but I see that not only did he possess the knowledge needed to execute the problem, but he also had the cognitive creativity to create his own tool...in this case the table of possible combinations.

I think it is important what Mara said about some students being left behind when the group is moving too quickly. We haven't talked about that before, and I never thought about it...

Request a response: A question that seeks a direct response.

Examples: what do the rest of you think?

Okay I hope that made sense please let me know what you all think about this idea...

Did I explain what I was trying to say well enough???

Seek clarification / question: A question that seeks more information or verification.

Examples Do you think there were any other instructional objectives that we didn't elaborate on in class though?

How can these ideas be developed into more specific instructional activities?

Is this one of the objectives that we agreed on in class?

Scaffolding: A statement or question that guides another group member to discuss ideas

or concepts in the material by offering suggestions of a next step.

Examples: Hey, Nina, I think that maybe you can expand on the idea of schemas or schemata here. I found this link that has descent detail that can help with further connection between Brandon and the activity

Can you elaborate on what the evidence would look like?

What does it mean to exhibit high road transfer?

Personal reference / Self-disclosure: A statement that offers a thought, feeling, experience of a personal nature and specific to the individual making the statement.

Examples: I am sorry that I didn't post my part of this last night girls! I had a MAJOR family emergency and had to leave school

For me personally, I was always shy in speaking up and the only time I did speak up was when I was very confident that I knew the answer

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Fourth, this step involved repeating the steps 1-3 with the purpose of developing, revising and assigning codes and categories for educational psychology concepts and for interaction patterns. I examined each group individually and then compared across groups. This involved noting which groups worked with the educational psychology concepts and at what level (i.e. how elaborative the language was around a concept – was it simply named, or used in an integrative fashion that elaborated on the concept and its use in the context of the problem). I also examined the pattern of interactivity among group members and between members and the facilitator. Using an iterative process the data was reexamined looking for fit of codes and fit of codes into categories. This allowed potential patterns to emerge, negative cases to be examined, and reduction of data into meaningful units. The negative and/or unique cases assisted me in identifying incomplete categories and lead to further re-examination and revision of my codes and categories.

I continually reviewed the data, to make sure that concepts were not missed or for instances when a group member may be describing the conceptual aspect of a concept without actually using the term or miss identifying a term. For example, in one group a member used the term “transference”, however it was apparent in the posting that she was referring to transfer or when group members thought that “small group discussions” would be a useful instructional strategy I placed that in the concept category of discourse.

Fifth: After reading and rereading the data and examining the coding and categories, I began to group together similar categories and search for repeated patterns within the data. This ongoing analysis involved successive rounds of coding, categorizing, chunking data, guided by the initial research questions, and identifying themes in the data. Concept maps that arranged dialogue as it occurred around an educational psychology concept were constructed and a descriptive narrative written to help to examine and understand what was going on in the dialogue.

Analytic memos at each point in this process established the needed audit trail to track the analytic process. Lincoln and Guba (1985) describe this on-going coding as procedures where codes are filled-in, extended, bridged, or new categories surface. This was a recursive process of data analysis until redundancy appeared (data fitting into the categories, repeated patterns, and saturation of a category) and themes can be interpreted (Lincoln & Guba, 1985). In addition to examining the data for each group, I then looked for similarities, differences and patterns across groups.

Sixth: Development of themes. Themes are defined as “a statement of meaning that runs through all or most of the pertinent data, or one in the minority that carries heavy emotional or factual impact” (Ely, 1991, p. 150). Themes represent the descriptive

and interpretive findings established by the researcher. In a case study, the findings represent an in-depth understanding of the phenomena (collaborative online problem solving) and can illustrate complexities, suggest what to do and not to do as "lessons learned" (Creswell, 2007). The analysis sought to reveal characteristics of the online dialogue, what it suggests about online student learning as it relates to educational psychology, collaborative problem solving, and the impact of multiple problem solving episodes over time.

At each of these steps an iterative process was used to examine the fit between data and coding; coded data to categories; and categories to theme statements. Repeated examination and use of the validity procedures – triangulation, peer debriefing, the audit trail – helped to ensure the trustworthiness of the findings.

**Trustworthiness**

Trustworthiness is a conceptual frame in qualitative research that aims to substantiate the quality of the research (Merriam, 1998). Qualitative research is naturalistic and interpretive in nature and it is important that the reader can be confident in the findings. This confidence is often defined by the degree of rigor, quality, and trustworthiness that can be identified in the methodology (Lincoln & Guba, 1985).

Trustworthiness of the findings involved the use of three methods.

First, prolonged engagement is a "validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000, p. 126). In this study the data was examined over multiple groups and over time. The multiple groups and problem solving

episodes provided an opportunity for examination and a search for convergence of the findings across the groups and over time.

The second method I used was peer debriefing: This is a process of involving an experienced peer or peers in an on-going analytic dialogue exploring most aspects of the inquiry (Creswell & Miller, 2000). The process of seeking feedback and perspective helps prevent researcher bias and ensures that alternate plausible explanations are considered; adding to the credibility of the findings. Colleagues offered support, opinions, and viewpoints that helped me consider fresh perspectives (Ely et al., 1991). The peer debriefers for this study were Dr. Laurie Knis-Matthews, an associate professor and colleague who has supported many aspects of my doctoral work and Dr. Sonna Opstad, faculty member at Touro College. Both individuals completed a qualitative dissertation – providing expertise in this method of research. Drs. Knis-Matthews and Opstad read select sections during analysis for the purpose of discussing coding; to critically review aspects of the analysis and formulation of themes. This process took the form of providing text for discussion and receiving feedback via email, telephone contact, and face-to-face meetings. We met several times during the course of the study. At these face-to-face meetings we reviewed the research work, discussed next steps, and thoughts and feelings about the research process. I conferred with Dr. Knis-Matthews and Opstad specifically following each steps four, five, and six of the analysis process and as needed until the findings were complete.

The third method was to ensure that I documented an audit trail of the study. An audit trail is a process in which the researcher details all aspects of the analytic method. The goal of an audit trail is to provide documentation from which the process and product

of the inquiry can be examined to determine the trustworthiness of the findings (Creswell & Miller, 2000). This allows potential readers to understand the development of the process and all the steps that led to the findings (Miles & Huberman, 1984). This includes detailed notes on thoughts, impressions, feelings, decisions, and revisions. Analytic memos are brief conceptual looks at the analysis and interpretation process for the purpose of clarifying and elucidating issues in the study (Miles & Huberman, 1984). All audit trail documentation, including memos, was dated and timed to ensure that the process could be traced from early ideas and inquiry to the final interpretations. Memos were written at anytime during the analysis and process of writing up the findings – at the end of a day, when a decision was made about a category, code or theme statement, or a possible theme to be developed was conceptualized. The purpose at the time of writing the memos was to detail where I was in the data analysis process, what the issue was at hand and how and why I decided to approach the analysis in a particular manner (e.g., decisions about codes, categories, and themes).

The next chapter will present the primary findings of this case study. Patterns of interaction within the groups are examined as well as what those patterns suggest about student learning in this online environment and learning over time. The first section will discuss the types of interaction patterns that were found followed by a discussion of what those patterns suggest about student learning. The second section will examine how groups incorporated select educational psychology concepts into the problems solution. This section will also include examples of interaction around the concept to understand how the group defined, incorporated, and used a concept in the problem solution.

# Chapter 4 Findings

This chapter will begin by describing characteristics of interaction within the groups. The dialogue was examined for evidence of interaction, collaboration, and appropriation of concepts to promote student learning and group problem solving. Additionally, I look at the effects of multiple problem solving episodes over time on the interactional patterns.

Second, I will introduce educational psychology concepts. It includes which concepts were chosen and the rationale for focusing on these specifically (See Appendix B for all concepts identified in the online dialogue). I then examine how these concepts were incorporated into each group dialogue – looking at evidence of how concepts were introduced, defined, and built upon as students negotiated a solution to the problem as evidence of student learning. The interactional patterns are deeply entwined with concept development and the relationship of the two will be described.

## Online Interaction Processes

Online posts fell into one of three types: a student proposal, a student comment, or a facilitator comment (See Table 2 below). In examining the characteristics of the online dialogue, interaction processes seemed to fall into three main categories. First, the processes could be identified as a parallel dialogue which consisted of the students working individually within the online structures. Second, the processes could be identified as cooperative dialogue where students shared responsibility by taking on different aspects of the work. The third is identified as collaborative where students, working together, negotiated and built on shared ideas in an iterative process of refinement and elaboration.

The difference between cooperative and collaborative processes was defined as:

> Collaboration is a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and contributions of their peers.
> Cooperation is a structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups. Panitz (1999)

Collaborative group work involves working on a planned task and includes positive interdependence, social support, and a shared negotiation and evaluation of the group product. Collaboration implies that the group is working in an effortful way to maintain a joint conception (Dillenbourg, 1999).

Table 3. Number of posts by type, group, and case.

| Group | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Case 1 | | | | | | |
| Proposals | 17 | 11 | 10 | 8 | 21 | 13 |
| Student comments | 13 | 19 | 1 | 22 | 6 | 21 |
| Facilitator comments | 5 | 13 | 5 | 6 | 14 | 8 |
| Case 2 | | | | | | |
| Proposals | 10 | 14 | 10 | 13 | 15 | 7 |
| Student comments | 19 | 11 | 11 | 27 | 4 | 11 |
| Facilitator comments | 12 | 12 | 5 | 13 | 14 | 7 |
| Case 3 | | | | | | |
| Proposals | 15 | 10 | 12 | 8 | 19 | 8 |
| Student comments | 8 | 13 | 12 | 29 | 15 | 24 |
| Facilitator comments | 8 | 8 | 2 | 5 | 9 | 9 |
| Case 4 | | | | | | |
| Proposals | 14 | 12 | 11 | 7 | 18 | 5 |
| Student comments | 12 | 9 | 18 | 23 | 8 | 22 |
| Facilitator comments | 14 | 14 | 14 | 10 | 17 | 6 |
| Total | | | | | | |
| Proposals | 56 | 47 | 43 | 36 | 73 | 33 |
| Student comments | 52 | 52 | 42 | 101 | 34 | 78 |
| Facilitator comments | 39 | 47 | 30 | 34 | 54 | 30 |

During the course of solving the four problems the groups demonstrated varying degrees of each type of process as evidenced in the dialogue. However, the number of problems solved did not seem to significantly alter an overall pattern of group communication that had been established in the first problem solving case with two exceptions. For example, in the first video case problem three of the six groups had more student comments than proposals – evidence that the students were reading and responding to the work of others from the beginning case. This pattern of interaction continued for these three groups. Group 5 had the fewest student comments – consistently fewer comments than proposals – and this pattern persisted across all four problem cases. Two groups, Group 1 and Group 3, had a slow starts in Problem 1with a low level of interaction and low participation, but developed higher levels of interactivity in subsequent problem cases. The findings and examples of these patterns of interaction are discussed below.

Additionally, these processes affect how educational psychology concepts and ideas were developed and applied in the video case solutions within the groups. The subsequent section will present the findings on how educational psychology concepts were introduced and used during the course of building a solution to the multiple problem-based cases.

**Parallel processes: *I'm in the group, but working on my own solution*.**

Groups engaging in parallel group processes work side by side doing their work individually, but with little evidence of interaction. The focus is on individual learning and the teacher as the authority. The posting of proposals and comments represents the work of an individual within the context of the group, but with little or no

acknowledgement of others. In parallel processes, the interaction tables, which illustrate the pattern and number of posting of a group, show a proliferation of proposals and few student comments. (See Table 2 above for a summary of all groups.) Student comments in this pattern of interaction are often commenting on their own proposal or in response to the facilitator (authority), but seldom in interaction with peers in the group.

***Group 5.***

Group 5 illustrates this pattern of interaction within the group. In Problem 1, Group 5 generated 21 proposals and six student comments; fifteen of the proposals received no responses from other students. Of the six student comments, three were by the same student, Juan, in response to a facilitator comment about his own proposal (i.e. the discourse pattern showed student proposal-facilitator comment-student comment) (See Table 3). Group 5 had more posted proposals than any other group across all four problems and the total number of student comments was lower than all other groups. Group 5 interacted more in response to the facilitator than to other members of the group.

Table 4. Interaction table Group 5: Problem 1.

| Student | Juan | Fran | Steven | Karen | Lois | Tina | Facil |
|---|---|---|---|---|---|---|---|
| Tab 1 | | | | Pr | | | C |
| Difficulty | | | Pr | | | | C |
| of pizza | Pr $C_2$ | | | | | | $C_1$ |
| problem | Pr $C_2$ | | | | | | $C_1$ |
| | Pr $C_2$ | | | | | | $C_1$ |
| | | Pr | | | | | C |
| | | | Pr | | C | | |
| Tab 2 | | Pr | | | | | |
| | | Pr | | | | | C |
| Enduring | | | Pr | | | | C |
| Under- | | Pr | | | | | |
| standing | | | $C_1$ | | Pr | | $C_2$ |
| | Pr | | | | | | |
| Tab 3 | | | | Pr | | | C |
| | | | | | Pr | | |
| Evidence of | | Pr | | | | | C |
| Under- | Pr | | | | | | |
| standing | | | C | | | Pr | |
| Tab 4 | | | | | Pr | | C |
| Instructional | Pr | | | | | | C |
| activities | | | Pr | | | | C |

Pr = Proposal
$C_1$ = Comment and chronological order

This pattern persisted through all four cases. In Problem 4, there were eight student comments and six were a reply to the facilitator about their own proposal – usually to clarify their proposal in response to a direct question from the facilitator. The interaction is between the student and the facilitator, with most of the first comments, and on multiple occasions the only comment, coming from the facilitator. The facilitator

comments across the problems ask students to focus the discussion, interact between each other, and provide psychological rationales for their proposals. The last facilitator comment under evidence of understanding in Problem 4 was, “How does this pertain to the unit we are designing? Also, how do these connect to psychology of learning and to the objectives of the unit we are re-designing?” This seems to indicate that even at the end of successive problems the group was not working together to contextualize solutions.

In Group 5 there was evidence of uneven participation across all four video cases. One individual group member posted 30% of all proposals and accounted for 35% of all the student comments. The comments he posted were directed to his own proposal and were part of an interaction with the facilitator. This might be compared to a group member who monopolizes the conversation as well as responding primarily to the facilitator in back and forth pattern of interaction. Figure 6, shows the number of times a student or the facilitator made a type of statement across all of the four problem cases. In this group there were very few specific interactional comments in the categories of agree (1), encouragement (2), seeking clarification/questioning, (2) personal references (0).

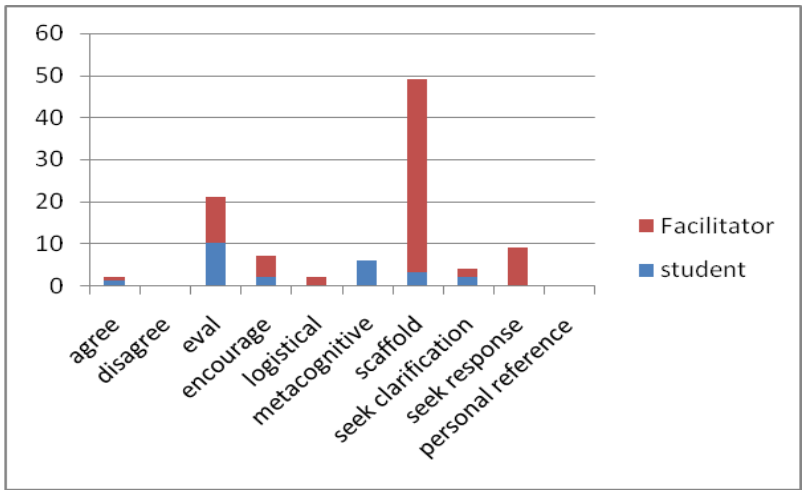



Figure 6. Group 5 student and facilitator postings by statement category.

***Group 3.***

Group 3 also provided an example of a parallel pattern of interaction. In Problem 1, there were 10 posted proposals and only one student comment. There was an uneven level of participation, with a few members posting with some frequency and two group members not posting at all. For example, Table 4 illustrates how Group 3 responded to Problem 1.

Table 5. Interaction table Group 3: Problem 1.

| Student | Dana | Ken | Julie | Vickie | Ernest | Ina | Facil |
|---|---|---|---|---|---|---|---|
| Tab 1 | Pr | Pr | | $C_1$ | | Pr | $C_2$<br>C |
| Tab 2 | | | | Pr | | Pr | C |
| Tab 3 | Pr | | | Pr | | Pr | C |
| Tab 4 | | | | Pr | | Pr | C |

Pr = Proposal
$C_1$ = Comment and chronological order

In this example, two of the five group members did not participate online (Julie and Earnest). Two of the students did most of the posting about the problem solution, Vickie and Ina. The facilitator seemed to be modeling the desired behavior of posting comments and prompting the group to participate, but with little effect. For example the facilitator encourages a group member (Dana) and prompts others to participate by stating: “These are all good questions that you posted. Meanwhile, what do you think the answers to these questions would be? This question is not just for Dana, but for the whole group to consider”.

The one student comment was not interactional, but was Vickie’s answer to the problem question. The facilitator comment, under Tab 1, was to Vickie about her comment; suggesting that it should be a proposal and not a comment. Vickie did not respond or alter her entry in response to the facilitator’s comment. Under Tab 4,

Instructional Activities, Vickie had posted a proposal and the facilitator asked, “what other activities did he [Brandon] engage in? Can you come up with a psychological account of how this lead to learning?” The next proposal by Ina is more detailed than Vickie’s and seems to respond to the facilitator’s questions, without specifically acknowledging or making reference to the comment. Ina listed most of the activities and provided an explanation of how Brandon solved the problem using an analogy, explained why analogies help with learning, and provided a reference from the online resources. This seemed to indicate that Ina would have read Vickie’s proposal, understood from the facilitator’s comment what was missing, and then contributed her own entry.

Each of Ina’s proposals is after another group member has posted a proposal and after a facilitator has made a comment. This seems to allow Ina to build on what has been done and respond to the facilitator prompts. Ina seems to be pursuing a more “precise” individual answer and benefiting from peer information and facilitator feedback. However, specific acknowledgement or interaction with the peer is not made. In the first problem there are few interactional statements. Two students posted comments of agreement in the first problem; however statements in other categories were absent in the first problem.

Group 3, despite this slow start, did demonstrate increased interactivity and participation across the next three problems (see Figure 7). In subsequent cases all members participate (although participation was uneven with two members taking on most of the work) and they had about an equal number of proposals to student comments and, overall, one of the lowest number of facilitator comments. Statements of encouragement (13) and additional statements of agreement (5) and evaluative statement

of others' work (13) were all posted subsequent to Problem 1. The group was able to move from an individualistic pattern to a more cooperative pattern of interaction over time. This may have been an instance of a group needing time to develop some interactive processes.

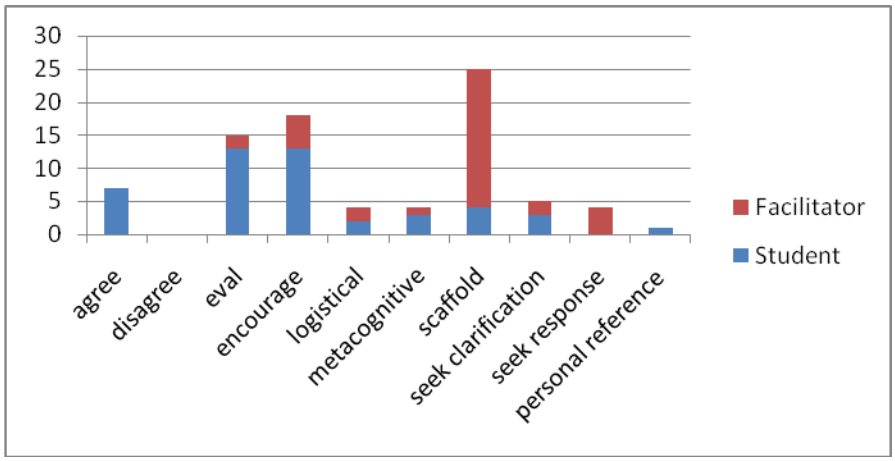



Figure 7. Group 3 Student and facilitator postings by statement category

***Group 1.***

In Group 1 there is a slightly different pattern of individualistic participation. There is an individualistic pattern when examining participation as it applies to the use of the educational psychology concept of transfer in Problem 1. Additionally, this pattern persisted throughout the problem solving as the group members seem to develop an interactional pattern between themselves and the facilitator rather than in collaboration with each other.

In the example of using the concept of "transfer" (Problem 1), it appeared as if each group member posted their ideas and then were done (see Table 5). This group seemed to build on the work of each other in a linear process. A group member posts a

proposal about how the concept of transfer applies to the problem, then another member and so forth. However, individual members do not come back and reconsider the concept once they present their idea. There is some evidence of appropriation and elaboration; however, there is not specific evidence of interactivity. This supports the idea that individuals within the group are working on their individual solutions; benefiting from prior postings, but not going back and forth to offer a *shared* solution. This will be examined more closely in the next section focusing on the concepts.

Table 6. Group 1: Problem 1, chronological posts on the concept transfer.

| Tab 1 | Tab 2 | Tab 3 | Tab 4 |
|---|---|---|---|
| Difficulty of pizza problem | Enduring understanding | Evidence of understanding | Instructional activities |
| Nina | | | |
| Rose | | | |
| | Rose | | |
| Kay | | | |
| | | Kay | |
| | | | Kay |
| | Kay | | |
| | Kim | | |
| | Kim | | |
| Nadia | | | |
| | Nadia | | |
| | | | Nadia |

Postings by individual in chronological order as it relates to the concept of transfer

The postings that refer to the concept of transfer start on March 4, however ten of the twelve references are on March 7 and March 8 (the day that the case was to be finished and presented in class) not leaving time for interaction among group members. There is some evidence that students, in their sequential postings have added to, or built onto a prior post. However, there is not the back and forth exchange of ideas, as if taking sequential turns, rather than engaging in an interactive discussion. Above you can see

that Kay has looked at the problem and posted her ideas in response to the questions across three of the tabs. She does not specifically acknowledge prior postings by others and does not come back to the concept after her posting. As evidenced by a time stamp, these postings were done by Kay on one day over the course of an hour. Other group members followed the same pattern, logging on and posting a response across several tabs in the course of a narrow time frame on one day. This may suggest that members of this group were interested in fulfilling the requirements of the course for posting and commenting, but were not invested in a collaborative effort to build a shared understanding of the concept. When examining chronologically for integration of the concept into the solution it seemed that, at least in this case, it is an example of an individualistic approach rather than cooperative or collaborative.

Postings across all of the problems show a moderate level of participation – approximately the same number of comments to proposals and slightly less reliance on the facilitator (see Figure 8). The high number of agree (17), evaluative (19), and metacognitive (14) statements seem counterintuitive to a group that is functioning at a relatively low level of interactivity. In examining the statements more closely, they reflect participation and not necessarily interaction. For example, the "agree" statements are frequently just that…"I agree with your proposal" without elaboration. Half of all the agree statements are made in the first case about Brandon and taper off in frequency until Problem 4 where there is only one statement in the agree category. One student – Rose, made nine of the nineteen evaluative statements. Five of the evaluative comments were repetitive suggestion, "I think you should mention formative and summative assessments", "I think you need to be more specific about the type of summative

assessment". Several of the evaluative and metacognitive statements are in response to a facilitator comment; not a peer. One student – Nadia, made nine of the 14 metacognitive statements. There is a fairly even level of participation across this group, but interactivity is limited to a few students (Rose and Nadia) and is primarily focused between the student and facilitator. The facilitator made thirteen statements of encouragement (e.g. "some good thoughts here, lots of good comments, good ideas, good job on evidence of understanding") which may have helped to reinforce participation; even in a group that was not interactive.

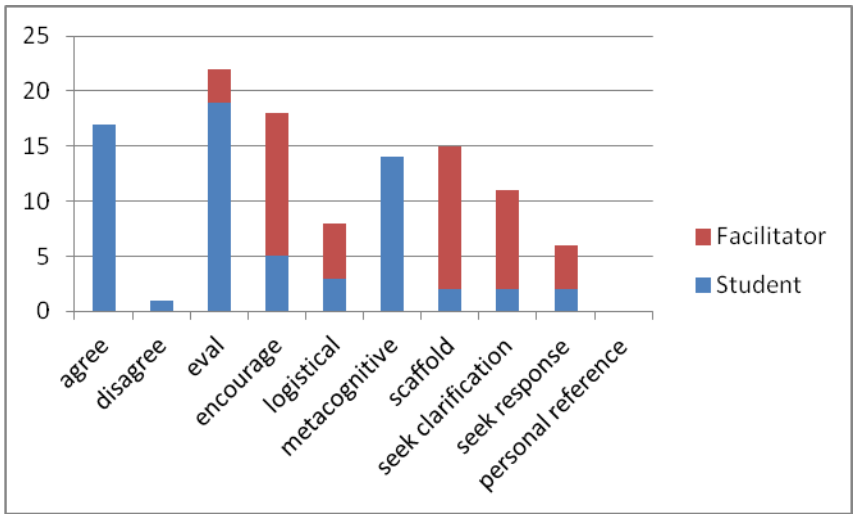



Figure 8. Group 1 Student and facilitator postings by statement category.

The parallel pattern persists through each of the four PBL cases and seemed to take on a back and forth pattern with the facilitator (see Table 6).

Table 7. Group 1: Problem 4 (P)roposals and (C)omments

| Tab 1<br>Instructional Objectives | Tab 2<br>Evidence of understanding | Tab 3<br>Instructional activities |
|---|---|---|
| Nina - P | Nina – P | Nina - P |
| Nadia – P | Facilitator - C | Facilitator - C |
| Kim - P | Nina - C | Nadia - C |
| Facilitator - C | Kim - P | Kim - P |
| Kay – P | Facilitator - C | Facilitator - C |
| Rose - P | Rose - C | Rose - C |
| Rose - P | Facilitator – C | Nadia - C |
| Rose - P | Kim - C | Facilitator - C |
| Facilitator - C | Kay - P | Kim – C |
| | Facilitator - C | Kay - P |
| | Nadia – P | Facilitator - C |
| | Rose -C | Rose -C |
| | Facilitator – C | Nadia - C |
| | Rose – P | Facilitator - C |
| | Facilitator – C | Rose – P |
| | | Facilitator – C |
| | | Nadia – P |
| | | Rose – C |
| | | Nadia – C |

Postings by individual sequentially listed under tabs 1, 2 and 3.

In all but one example after a proposal is posted, the facilitator is the first person to respond. This set up a pattern of back and forth between the student posting and the facilitator, such as in this example:

> Nina: Proposal: The evidence of understanding for this problem can be in the form of summative as well as formative assessment. Also discourse and the open participation structure can also be helpful indicators of understanding. This coincides with the six facets of understanding where the students can show explanation, application, interpretation and self knowledge
> Facilitator comment: Can you give some examples? How might you use the discourse and participation structure in formative assessment? What do those tell you about student thinking?
> Comment by Nina: Through discourse and the open participation structure the students have the opportunity to explain and apply what they have learned. The teacher then has the opportunity to correct any incorrect ideas that they bring up and praise them for correct responses. The teacher would also be able to assess their understanding from the classroom discussion. Also the complexity of the students discourse would be a good indicator of the students level of thinking and comprehension

In summary, parallel patterns of interaction are dominated by a focus on individual participation. Members responded to the facilitator rather than peers, refined individual work, and seemed to focus on requirements of the task. There was little evidence of engagement in a process that would suggest creation of a shared understanding of the problem and solution.

**Cooperative Dialogue:** ***I am working on my piece of the solution.***

The cooperative processes that are illustrated here are defined as processes where group members work together by assuming responsibility for parts of the whole. The focus tended to be on the task –generating a problem solution – and less on the processes of creating community knowledge within the group. In these groups the sub-dividing of a problem seemed to happen without explicit discussion. Responsibility of a member might be to take on a specific role within the group or specific areas of knowledge. Some students seemed to latch onto certain concepts, become the "expert" on the concept, and then took responsibility for inserting them into problem solutions. For example, Juan, in Group 5 Problem 1 included this statement in a proposal:

> Their [student's] cultural knowledge can sometimes support and sometimes conflict with children's learning in schools" [reference]. In this case, the lack of knowledge or familiarity with pizza due to their cultural background may conflict with children's learning in schools. "School failure may be partly explained by the mismatch between what students have learned in their home cultures and what is required of them in school.

Juan goes on to post multiple times across Problem 1 and Problem 4 about influences of culture and learning. Juan, a non-traditional (older) student and Hispanic, may be sensitive to the issue of culture and take responsibility to incorporate this part into the

group solution. No other member of his group posted on this topic – allowing Juan to "own" this part of the solution.

Several illustrative examples follow from the groups.

***Group 2.***

In this group, there is a cooperative effort to include the concept of transfer into problem solutions. Group 2 struggles to create a clear definition of the concept of transfer in Problem 1, Knowing what Brandon Knows, and two members use the wrong word – calling the concept "transference". The facilitator corrects the mistake: "I just want to point out that the correct term is "transfer" not transference. You need to explain in your own terms how this illustrates making connection to prior knowledge". The group seemed to have difficulty establishing a definition of the term and focused on describing what Brandon was doing. "Brandon used knowledge construction and transfer to solve the pizza problem because he was able to take the knowledge that he gained from the initial block problem and could transfer what he learned to apply the same techniques to solve the pizza problem"(Rena). The members named the concept or labeled Brandon's actions, but do not explicitly post a definition of transfer for the group to consider.

Two group members do most of the work of refining and integrating the concept of transfer across each of the problem solutions. There are 40 separate references to transfer as an educational concept in the four cases and two students (Geri and Rena) account for 22 of the postings by this group of five members. Their postings are more numerous and the descriptions are more detailed. This seemed to be an instance where two students work with the concept, clarifying their understanding of it, and then

integrate it into problem solutions. Geri is the first group member to include the concept of transfer in a proposal. She asked "Is transference (sic) a good predictor of enduring understanding?" The facilitator comments on this post by asking, "how does transfer occur (and how do you know it when you see it)?" This initial interaction and question by the facilitator may have prompted Geri to look more closely at the concept and attention from the facilitator (the course instructor in this case) may have reinforced her to do more with the concept. The posting, a proposal, was then revised in multiple postings over the course of several days to include a clearer statement of what Brandon was doing, how it demonstrated enduring understanding, and why it is can be considered "high road transfer" This same student continued to promote this concept in each of the next three problems. Rena appropriates some of this language in a subsequent post stating: "students would exhibit high road transfer if they were able to use the concepts being discussed within the lesson to make connections to unrelated concept or idea with being provoked by the teacher".

Geri posts the following quotes about transfer across multiple problems:

1) We see high road transfer in Brandon's case because he is able to reflect upon abstract principles like implementing numerical value to pizza topping.
2) The interviewer's instructional activities promote learning by scaffolding understanding and helping bring about 'high road transfer' in Brandon.
3) Students need to be guided within a lesson to promote transfer
4) The overall goal of the instructor is to have the students apply their acquired knowledge of static electricity to real world situations. Ultimately, the students should be able to exhibit high road transfer and thereby demonstrate competence of the subject matter.
5) Ultimately, Mr. Johnson should be able to recognize the students who are exhibiting high road transfer and thereby have acquired a deep understanding of the physics lesson. High road transfer is recognized by reflection to abstract deep principles as opposed to a transfer to similar situations that would be characteristic of low road transfer.
6) They [instructional strategies] will ultimately assist in high road transfer and the applicability of static electricity to real world problems.

7) Madame B. emphasizes the importance of French culture throughout her lessons. Ultimately, the French language is applied to various subjects by having students transfer their knowledge to other fields like geography.

These posts took place across all four video cases. There is similarity in the wording and in the theme of the postings. This student is focused on the idea of high road transfer and its applicability to the cases. Other students participate; however, their posts are not as elaborate or as frequent. The focus seemed to be on what a student will do in a learning environment, use “high road transfer”, and less about what specific instructional tools are used or the rationales about the psychology of how transfer works.

Unlike Group 1, an example of parallel interaction, this group interacts back and forth over the course of several days in solving Problem 1 (see Table 7).

Table 8. Group 2: Problem 1, chronological posting on concept of transfer:

| Tab 1 | Tab 2 | Tab 3 | Tab 4 | |
|---|---|---|---|---|
| Difficulty of pizza problem | Evidence of understanding | | | |
| | Enduring understanding | | Instructional activities | |
| | Geri | | | Postings by individual in chronological order as it relates to the concept of transfer |
| | | | Lynn | |
| | Facilitator | | | |
| | Geri | | | |
| | | | Facilitator | |
| | Robin | | | |
| | Geri | | | |
| | Rena | | | |
| | Fay | | | |
| | | | Lynn | |
| | | | Geri | |
| | Geri | | | |
| | Facilitator | | | |
| | Rena | | | |
| | | Rena | | |
| | Robin | | | |
| | | | Robin | |

This seemed to be a more focused dialogue than Group 1. It was focused on two of the tabs: What enduring understanding did Brandon demonstrate? and What activities did he engage in to construct these understandings? The level of focus and some interactivity suggested cooperation among the group; allowing two members to do most of the work on this concept (see Figure 9).

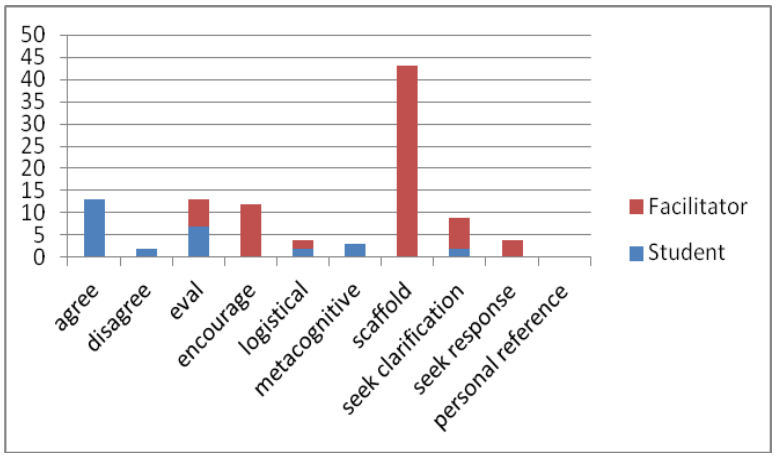



Figure 9. Group 2 Student and facilitator postings by statement category

It seems interesting that in this group, across the problems, they did use statements of agreement with some regularity (13); however, no statements of encouragement (0). Group members are rewarded with agreement; confirming command of their part of the task, but no explicit encouragement to do more or something different (few analytical/evaluative statements). The facilitator was encouraging (12) and frequently used scaffolding statements (43). The scaffolding statements by the facilitator repeatedly asked the students to think more deeply about the ideas they were presenting and for interactive participation. For example some of the scaffolding comments:

> What will you be looking for in Brandon's language to see if he understood?
> Are there any other factors that contribute to cognitive difficulty?
> How does this provide evidence of understanding – either formative or summative level?
> Can you talk more about the assessments? What is the psychology behind this assessment? How does this work?
> What is the psychological evidence for your claim? What do the rest of you think?

and even into the fourth problem the facilitator continued to ask: "what is the psychological rationale for these ideas?"

Interactions between the facilitator and some of the students indicates that

individuals in the group were working on their solutions or part of the solution to the problem. Low interactivity may have led to an environment where there was sharing of information and some explanatory processes, but a lack of negotiation that could have led to more elaborated knowledge in the group.

***Group 6.***

Group 6, in contrast to any of the other groups, seemed to explicitly look to divide and conquer the tasks presented. This is a group with the lowest number of proposals across all the problems (33) and the second highest number of student comments (78). The members make frequent statements of agreement (14), evaluative (14) and considerably more metacognitive statements (44) (see Figure 10). The students are more often the first to comment in response to a proposal; leaving the facilitator to come in later.

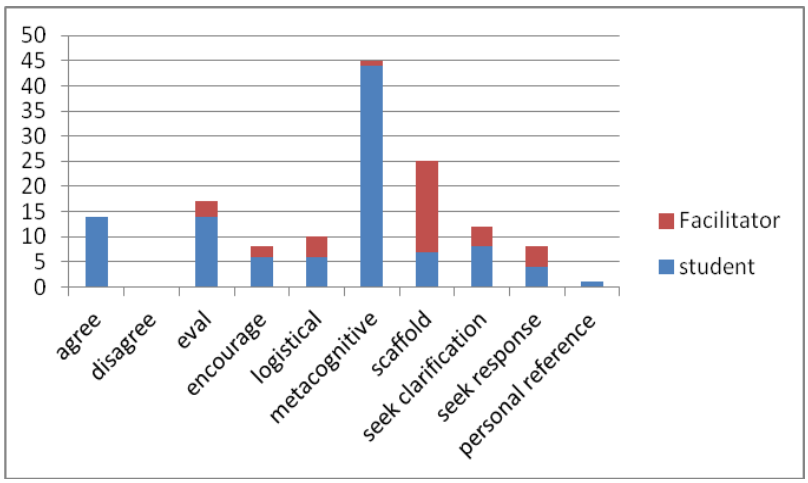



Figure 10. Group 6 Student and facilitator postings by statement category.

Student comments included:

> I found your proposal very thorough. I was attempting a proposal, but you have already covered all the points I was going to make. GREAT JOB, ANNA!
>
> I think that Ellie is right about her evidence about the proof.

> I'm going to add an additional proposal about collaborative learning, so we can have it in our final product.
>
> I think you did a great job taking the psychology of Bryan's argument and applying it to assessment. Great job!
>
> I was just typing the same information, but I like your detailed explanation better.
>
> Anna, I thought the agreement was that everyone was going to write a proposal based upon one of the objectives, then we would combine ideas in the end.
>
> Emily, perhaps you and Anna can combine ideas into one…I included Vince's portion into my proposal above. *[Student had actually cut and pasted his work into hers to complete a proposal]*

This group, rather than posting their own proposals, seemed to look at what was posted first, add their research, or confirm that the work is complete. There were few revisions and more of the, *I'll add on the work that I did*. This is the only group that explicitly divided up the work and combined it to form the final solution. This group had the highest number of metacognitive statements. These statements reflected individuals in the group negotiating task processes that involved monitoring and planning for how the problem solution would be completed more than negotiating about the content of the solution.

In Problem 1 (see Table 8 below) as the group incorporated the concept of transfer into the solution, three members seemed to take the lead in each tab. Anna, Bryan, and Ellie each took responsibility to include the concept under tabs 1,2, and 4 respectively.

Table 9. Group 6: Problem 1 posts on the concept of transfer

| Tab 1 | Tab 2 | Tab 3 | Tab 4 | |
|---|---|---|---|---|
| Difficulty of pizza problem | | Evidence of understanding | | |
| | Enduring understanding | | Instructional activities | |
| | | | Emily | Postings by individual in chronological order as it relates to the concept of transfer |
| | | Emily | | |
| | | | Ellie | |
| | | | Ellie | |
| Anna | | | | |
| Anna | | | | |
| | | Anna | | |
| | | | Ellie | |
| | Bryan | | | |
| | Bryan | | | |
| Anna | | | | |
| | | | Ellie | |

It is mostly linear (this time by tab) as the student locked into a "tab" and focused on answering that question – rather than posting across the tabs about this concept. The repeat posts by Anna and Ellie are additions to their own initial proposals – extending the idea of transfer as being the ability to transfer conceptual knowledge to new situations and bridge the gap between school knowledge and real world problems and adding references to support their ideas. This seemed to fit into a cooperative process – where different members take responsibility for a part of the whole.

In the next three video problems, this group continued to focus on a few proposals that members contributed to in an additive fashion. Anna stated,

> I thought that we were going to do the same thing we did in the last problem where we had one proposal that included all our comments for the final product.

On the last tab of the last problem, there is only one proposal and 13 student comments. This was a highly unusual pattern among all the groups. Emily started the proposal by stating: "As discussed in class on Thursday," suggesting that they had worked out at least

part of the solution in face-to-face time. The comments seemed to serve as add-ons to the proposal, additional research that members had found, or words of encouragement.

Group 6 seemed to be working together in a cooperative manner – dividing the work and individually taking responsibility for posting and then revising the work. There was a commitment from peers to comment on each other's work and an understanding that these comments, which included additional information, would result in revisions of proposals. This resulted in a shared understanding of the task and the solution. Each member was attentive to what the other members were doing and this allowed individual members to understand what was missing and fill it in or add their ideas. This resulted in sharing and negotiation of the task, but not negotiation or elaboration in a collaborative process.

***Group 3***

.

This group, in Problem 1, had a parallel pattern of posting. The first online problem for this group seemed to act as a jumping off place – where they could start and develop a more interactive pattern with more experience. In examining how the group approached integrating the concept of assessment into the subsequent problem solutions a pattern of cooperation emerged. All of the six group members participate in the assessment discussion across Problems 2, 3, and 4. Julie started in Problem 2 with the first proposal that included the concept of assessment and stated, "formative assessment such as feedback is most valuable, not through tests and grades, but rather when students can use feedback to revise their thinking". Ken noted that the use of the scientific method during this discovery activity provides "stepping points all along the way for assessment and evaluation". Ina thinks that the teacher is using both formative and

summative assessment – feedback during the activity and the actual product and explanation in a summative way. There is interaction as students acknowledge and support peer proposals with comments like, “I agree” or “our group decided”. Dana put it all together in a proposal under another tab, which started with, “our group decided”. She created a list of the formative and summative assessments to be used and a lengthy explanation of the rationales for using these assessments. This prompts a response first from the facilitator and then four of the other group members all in support of her work. A typical response was, “I completely agree with the proposal above!! Well done!”

The interaction around these proposals is supportive. In this problem, the first people who post under the two tabs start with strong proposals that do not seem to call for revision. However, this also does not limit participation. Other group members go on to post additional proposals with additional ideas. Each member offers a part of the whole, which Dana then pulls together.

Dana, who posted the comprehensive assessment strategy in Problem 2, started the discussion on assessment in Problem 3. This may be an indication that she had become the designated “expert” on this issue in the group (a cooperative process where she took responsibility for issues about assessment) and took on the role of “initiator” (posting the first proposal in five of the eight tabs in Problems 2, 3, and 4). The proposal in Problem 2 was a lengthy proposal that listed from the course textbook a “continuum of assessment strategies”. The first comment is from the facilitator that there is a lot of good information, but it needs to be tied to the problem objectives (contextualized). Several other group members provided supportive comments and asked for elaboration. Dana commented on her own proposal – responding to the comments of others – to

clarify a few points. Vickie took up the work in a subsequent proposal. Vickie adds to the ideas that were started by Dana, but reorganizes it into a list of three ways to assess that can provide evidence of understanding – discourse, the ability to transfer what was learned, and students as self-regulated learners. The facilitator was the first to respond and asked, "how does discourse provide evidence of understanding?" Vickie responded to the facilitator with an explanation and there is a positive response from two peers with a "way to go", and "nice response, I completely agree". Ken added a proposal that provided another piece to what had been started. He brought forward the ideas of formative and summative assessment and connected them to the learning objectives that the group had posted. His proposal seemed to respond to the facilitator's request, making a direct connection with the learning objectives and contextualized it to the problem – a factor that was missing in the previous proposals. Ernest then described an instance of formative assessment from the video. Ina posted the last three proposals under each tab that included strategies on assessment. These proposals were added at the end of the allowed time frame for working on the problem and did not elicit any comments (possibly a tactic to meet course requirements and did not allow for interaction with her peers).

Across the last three problems, this group seemed to work cooperatively around identifying assessment tools as a part of the problem solution. Each member provided their idea – strategies that they tended to promote – and then the group incorporated the pieces into the whole. The group used statements of agreement and encouragement to indicate acceptance and inclusion of individual ideas.

In summary, cooperative processes came in several varieties. Some groups and group members seemed to implicitly delegate (or relinquish) pieces of the task to others, some members assume responsibility for a piece (lay claim to an idea or role), and, in the case of Group 6, they explicitly divided the work. The interactional process is different in each of these examples. Group 2 used few statements of encouragement and acknowledgement or metacognitive statements that might suggest they discussed the process together. There is little evidence that this process resulted in a negotiated understanding of concepts or the problems solution rather more like a compilation of ideas. Individual learning was the focus (individuals extending their understanding of the piece that they contributed) and the facilitator as the authority and arbiter of the discussion. In contrast, Group 6 relied less on the facilitator, had many more student comments that included acknowledgement, encouragement and evidence that they worked on the solution together, as connected (versus disconnected) pieces of the whole. This demonstrated a dynamic student directed sharing rather than rather than an individualistic approach.

**Collaborative Processes:** ***We are working together to build our solution.***

At this level of interaction is it possible to find instances of knowledge building within the group – idea diversity, improving ideas, and shared responsibility and shared meaning-making for contributing and refining the problem solution. These processes are situated in the group and reflect the epistemological view of *knowledge-creation* that emphasizes collective responsibility for the development of knowledge and creation of new knowledge (knowledge building) (Bereiter & Scardamalia, 2006).

***Group 4.***

Group 4 was the most interactive and had the most student comments across all problems. By Problem 4 they had far more student comments than student proposals, indicating that students were building on one another's ideas instead of focusing on their own independent solutions or simply a part of the solution. This group was the only group that explicitly focused on working together to revise proposals rather than simply post new ones or create additive solutions. As Mara comments, "I just wanted to say that having one proposal and just amending it is GREAT. This is so much better-we rock." (Group 4; Problem 4)

Problem 3, redesigning a science lesson on static electricity, is an example of how the group worked collaboratively toward a problem solution. The initial response of the group to solving the problem involved a scatter shot approach. The first six proposals were generated within the first four days of the process (see Table 9 for postings of Group 4, Problem 3). The initial four proposals were all concept-oriented around educational psychology terminology and somewhat decontexualized from the video case (only two of the four made direct reference to video). The proposals provided information about concepts that might be relevant to solving the problem, but demonstrated little integration toward that end.

Table 10. Interaction table Group 4: Problem 3

| Student | Monica | Rachel | Holly | Mara | Caitlin | Amber | Facil |
|---|---|---|---|---|---|---|---|
| Tab 1 | | | | | | Pr | |
| | Pr $C_2$ | | | | $C_1$ | $C_3$ | $C_4$ |
| Tab 2 | $C_4$ $C_5$ | | Pr | $C_3$ | $C_1$ | $C_2$ | $C_6$ |
| | $C_1$ | | Pr | | $C_2$ | | |
| | $C_5$ | Pr $C_4$ | | $C_6$ | $C_3$ | $C_2$ | $C_1$ |
| Tab 3 | $C_1$ | | | Pr $C_3$ | | | $C_2$ |
| | $C_3$ | $C_7$ | Pr $C_2$ | $C_4$ | $C_5$ | $C_1$ | $C_6$ |
| | $C_2$ | | $C_3$ | | $C_4$ | Pr $C_1$ | |
| | Pr | | | | $C_2$ | $C_1$ | |

Pr = Proposal
C = Comment: subscript number represents chronological order of the comments

A change in this pattern occurred with some guidance from the facilitator when the facilitator made the first comment (under tab 3, Instructional Activities). The facilitator stated: “Can you give some concrete examples? How does Etkina [the demonstration teacher] do this in her classroom? What are the implications for Blair’s classroom?” This generated five individual comments – all but one group member responded. In the next proposal the facilitator came in as the second comment and asked, “What do you mean by disequilibrium?” Each of the facilitator questions seemed to effectively change the discourse from the general listing and defining of concepts to a discussion of how they become integrated into the specifics of the video case problem. Participation is distributed across the group as examples are generated, explanations are

provided, clarification of concepts is offered, negotiations regarding concepts to use are made, participants appropriate ideas of others into revisions of the proposal, and there are requests for involvement and validation. For example, in another proposal a line of discourse follows: the concept of Vygotsky's zone of proximal development is offered (defined inaccurately) and two more facets of understanding are added to the four that were previously proposed. The facilitator provides a nonspecific request to the others in the group, "what do the rest of you think?" This generates responses from four of the six group members. Monica was concerned that there are now too many facets of understanding, "I'm not sure we should use all of them" (negotiation). Mara clarified one facet (clarification) and compared it to another that was offered in a different proposal (explanation) and tries to involve others, "what are everyone's thoughts?" Rachel offered clarification about the facets of understanding and explicitly agreed with the ideas of another group member. Holly agreed that the number of facets should be limited (negotiation), then clarified and gave a more accurate example of the zone of proximal development, "I don't think you can 'pass' your zone of proximal development, maybe advance it" (clarification). Monica agreed with the new definition and stated, "I didn't even think about that until you said it" (appropriation of new knowledge, metacognitive). Each of these postings seemed to serve the purpose within the group of a way to negotiate concepts and terms. Prompted by the facilitator, the discourse becomes more contextualized, triggering the participants to create examples that relate specifically to the video case. However, each of these initial proposals ends without a problem solution.

The next two proposals are a combined proposal by Monica and added onto by Rachel. This is the first proposal that offers a specific instructional activity that is aimed

at solving the video case. It is also the longest discussion with 15 entries. This proposal, like the previous ones, relied on listing of educational psychology concepts within the initial proposal. For example, Monica writes,

> We need to facilitate or even initiate a discussion that would help the students to interact and create scaffolding. Once the teacher observes the students displaying the evidence of enduring understanding, she can then implement fading and allow the student to act as the facilitators.

This discussion starts with an approach that is similar to the previous proposals; however it quickly evolves into something more. The first difference is that the facilitator comments only toward the end of the discussion. The students have a concrete instructional activity proposed and they interact to refine the proposal. The other difference is that when there is some confusion about the instructional activity that is proposed, and its application, a student is prompted to go back and review the video of the demonstration teacher. Caitlin describes what happens in the video clips and offers a quote from the video to help clarify. She takes on a particular task, but with the goal of sharing and promoting the *process* that will lead to a shared solution. The discourse has become more focused and all group members post entries. Rather than clarifying concepts and terms the students are now clarifying the proposed instructional activity that integrates concepts into the solution. The group is negotiating how the instructional activity will be structured. All but one group member participated.

> Mara: An experiment could be designed for the groups and a prediction sheet should be handed out.
> Amber: I never thought of a prediction sheet, but now that she mentions it, it seems like a great idea.
> Caitlin: You wrote that an experiment could be designed for the groups to do…I was wondering if she [Etkina, the demonstration teacher] had designed the tape experiment…or did they have to think of it themselves?
> Monica: I went back to the [video] clips and watched. So what I'm wondering is

are we saying we want Blair to have students develop their OWN experiments or use an experiment he assigns to them as Etkina did???

Holly: I think that maybe we should give the students an experiment to complete with the prediction sheet.

The primary discussion within the next proposal is whether students in Blair's class should design and implement their own experiments or use an experiment that is structured by the teacher as a learning tool. Rachel added to Monica's initial proposal by proposing specific activities: "I think them actually doing the experiment would be much more beneficial" and providing learning rationales: "Hands on experiments helps them really learn the concepts and helps them make connections to things they might not by just thinking about it". Several rationales were offered that showed an integration of concepts into the specific context of this solution. There are several entries of agreement and then negotiation about how students would engage in a hands-on experiment to provide the best learning opportunity. The facilitator made an entry to encourage the students: "Great discussion" and to prompt a continued discussion on rationales for the proposed instructional activity: "What is the psychological rationale for having students work on experiments?" There are four more entries after the question. These comments are elaborated rationales and it prompted one student to enter the discussion that had not yet been involved.

The last posted proposal represented the final solution – an instructional activity that Blair could use that will integrate some of the demonstration teacher's teaching techniques and rationales about why it would help the students learn. Monica stated, "Okay, let's put this all together". There were three more comments on the previous proposal, but most of the attention was now focused on refining the instructional activity.

The comments provided encouragement; Caitlin "Nice job, you chose the ones [facets of understanding] that were most important". The entries provided clarifying examples such as Caitlin "an example of perspective, I thought that perspective would be best illustrated when students are working in groups and discussing their viewpoints". Additionally, there was still some negotiation about what to include, such as; (Mara) "I'm still not absolutely sold on the 'perspective' facet'". Ideas were incorporated from one student entry to another. Rachel suggested noting the benefits of "peer learning" and Mara suggested, "it may be good to mention that misconceptions can be uncovered by the teacher". In the last entry, Monica integrated these ideas into the instructional activity/problem solution. The solution demonstrated understanding of concepts by integrating them into the suggested activities. In contract to a cooperative approach, this solution was not simply a cut and paste compilation of several members' work; it was integrative – respecting the contributions of the group to negotiate and build a shared solution.

In summary, the interactional tone in this group was different from groups that showed parallel or cooperative patterns of interaction (see Figure 11).

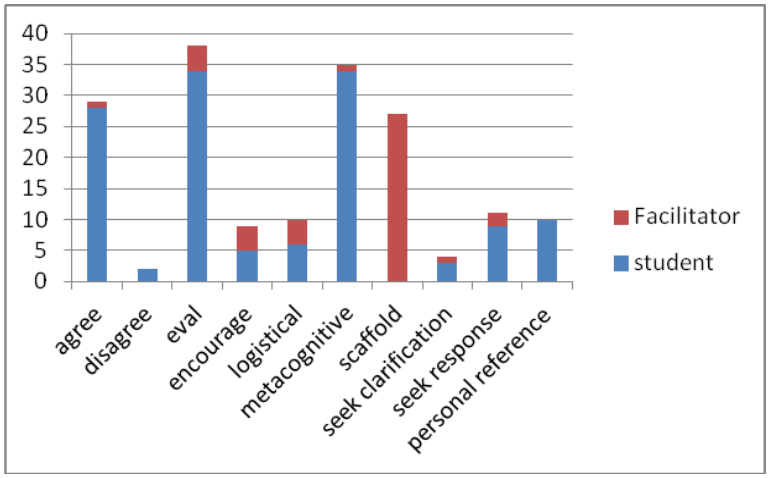



Figure 11. Group 4 Student and facilitator postings by statement category.

This group had, by far, the most comments of personal reference (10), and a high number of agree (28), evaluative (34), and metacognitive (34). There were not many statements of encouragement (5), but it seemed as though the agreement statements served that purpose. In other groups, members encouraged the work of others. In Group 4, there was a high level of participation and interactivity, so encouragement was not as necessary to the process. However, evaluative, metacognitive, and evaluative statements were important for the negotiation of a shared meaning.

This next section will focus on student learning and the application of select educational psychology concepts (one of the objectives of the course) within the dialogic patterns. First, there is an explanation about which educational psychology concepts were used to illustrate the case and then how those concepts were applied in problem solutions over time.

## Student Learning: Educational Psychology Concepts

During data analysis, I began to focus on several educational psychology concepts that I thought were important in the context of the course, online dialogue, and problem solutions. The findings in this section will focus on three concepts: transfer, assessment, and scaffolding. The rationale for choosing these concepts is that each was central to the course focus. One of the central themes cited in the course was the concept of transfer, and scaffolding and assessment were related to the theme of feedback and revision. Additionally, all of the four video cases had a tab labeled “Evidence of Understanding” where groups were asked to develop and describe a plan of assessment that would provide the teacher with evidence that students understood the material being taught and

had met the learning objectives. The groups were also asked to identify instructional objectives and strategies for each video case and transfer of learning was a frequently cited objective and the use of scaffolding was an instructional strategy that was highlighted in course materials and resources and adopted for use by the student groups. Course materials and the video cases included each educational psychology concept. The following introduces each concept and its definition in the context of the course.

**Transfer**

In *Knowing what Brandon Knows*, the educational psychology concept of transfer was one of the intended learning goals for this first problem. The concepts of transfer and prior knowledge are intertwined in educational psychology. Transfer refers to the ability to use knowledge across similar contexts (low-road transfer) and, then, more divergent contexts (high-road transfer) (Salomon & Perkins, 1988). This usually requires some intentional effort either on the part of the student or through instructional help/tools from the teacher. Conceptually, prior knowledge is an anchor, and when prior knowledge is conceptually strong (i.e. concept is clearly understood by the student) then the concept can be applied to a new problem and extended or expanded to help solve similar problems with new or different features. Prior knowledge is activated, linked to new knowledge, and transformed and transferred to the new context. The process implies a continual building and expanding of knowledge based on one's experiences from one situation to another.

In the video that presents the problem to be solved in the first case, aptly named *Brandon Math Transfer*, Brandon used the skills he learned in solving one problem to solve a different problem. Brandon solves a math problem in which he has to determine

how many combinations of toppings are possible on a pizza. He develops a chart, using ones and zeros, to figure out all the possible combinations. A researcher then questions Brandon about his solution to the pizza problem and he is able to clearly explain the answer, making a connection between how the solution is similar to a prior problem with blocks.

**Assessment**

All of the video cases had a tab labeled "Evidence of Understanding". Under this tab the student groups were instructed to describe or develop a plan of assessment that would provide the teacher with evidence that students understood the material being taught and had met the learning objectives. Additionally, group members were to provide educational psychology justifications for using assessments and what the assessments say about knowledge representation. For each video case, there were online links to resources via a hypertext. On the Knowledge Web (KW), students could link to a page about assessment and different forms of assessment to consider. The KW described how assessments could be used to assess prior knowledge, knowledge development during the course of instruction (formative assessment), and knowledge gained at the end of a unit or course (summative assessment). Assessment tools generally fell into two categories, traditional measurement and authentic assessment. Traditional measurement techniques included restricted response forms such as essays, multiple-choice questions, matching, true/false, or fill in the blank. The definition of an authentic assessment was a form of assessment in which students perform tasks that demonstrate meaningful application of target knowledge and skills. Authentic assessment techniques included

performance testing, portfolios, dynamic assessment, curriculum-based assessment, and peer assessment.

The first video case, Knowing what Brandon Knows, did not specifically target issues of assessment. However, the groups were asked, “How do you know what he understood?” The question leads some groups to identify how Brandon demonstrated what he knew and how that demonstration provided evidence (assessment) of learning. Video cases 2, 3, and 4 specifically asked the groups to identify learning objectives for the lessons being designed and describe how evidence of understanding of those objectives would be gathered through an assessment strategy.

**Scaffolding**

Learning about “instructional strategies” was an important target objective in the course. Three of the four video cases asked the student groups to identify learning objectives and instructional strategies to help meet those objectives. The student groups, as they viewed the videos, were provided with resource links to related concepts that helped them explore, learn, and integrate these concepts into the problem solution. The concept of scaffolding was one of the instructional strategies described and linked to cognitive apprenticeship and reciprocal teaching. The definition of scaffolding on the KW was:

> In guided participation, students’ efforts are structured and the responsibility for learning a task is gradually transferred to them. The structure provided is often called scaffolding (a support, crutch, base) and the slow removal of the help is called fading. (http://stellar.wcer.wisc.edu//Dev/theories/TheoreticalPerspectives/SocioculturalTSocio/CognitiveApprenticeship)

Zhu (2006) defines scaffolding as a statement that guides a student in discussing concepts and contexts by offering a suggestion. The effective use of scaffolds as a

strategy to assist in the teaching/learning process has been widely researched and discussed in the literature (Palinscar, 1998). A related concept is the idea of "fading" which refers to reducing assistance as the learner becomes more capable.

Vygotsky (1978) developed the concept of the zone of proximal development (ZPD) which is the learning that a person is capable of achieving when assisted by a more capable peer or teacher. Scaffolding is one instructional strategy in which a teacher or more competent peer assists the student within her or his ZPD, tapering off this assistance as it becomes less necessary. The more capable other provides the scaffolds so that the learner can accomplish (with assistance) the tasks that he or she could otherwise not complete, thus helping the learner through the ZPD (Bransford, Brown, & Cocking, 2000).

In the second video case, Learning by Design, the teacher style emphasized the use of social constructivism and cognitive apprenticeship, and the related concept links included references to scaffolding. All of the six groups, during the course of the four video cases, presented the idea of scaffolding as an instructional strategy. The majority of posts about scaffolding come in response to the second and fourth video cases.

The following findings illustrate how these concepts were used and developed within the groups and the dialogic structures. Each of the three educational psychology concepts is examined within the three patterns of interactions; parallel, cooperative, and collaborative, respectively.

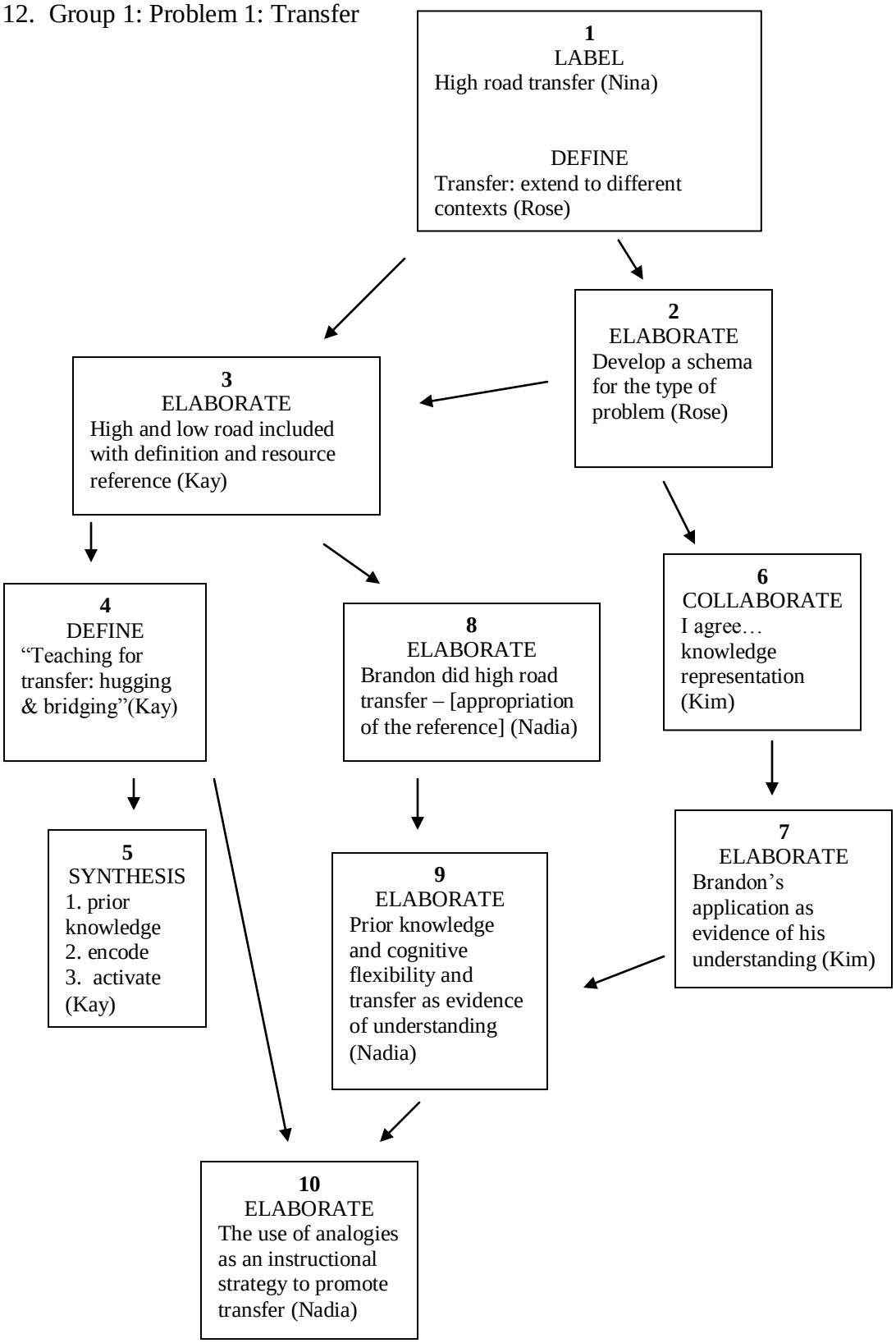
## Use of Educational Psychology Concepts as Evidence of Learning and Collaboration

### Transfer.

#### *Group 1.*

In Group 1: Problem 1, all of the group members worked with the concept of transfer. As individuals, they were able to analyze what Brandon was doing in the video case – using prior knowledge, transferring, and extending it to solve a novel problem (but with a similar underlying mathematical structure). As the students sequentially posted their ideas each one added some aspect to the dialogue. (See Figure 12).

Figure 12. Group 1: Problem 1: Transfer



Nina started with a naming the concept, “He [Brandon] was able to transfer prior knowledge from the blocks problem to help him solve the pizza problem”. The concept then gets defined, “Brandon was able to transfer his knowledge or ‘extend what has been learned in one context to new contexts’". A group member linked what they observed to educational psychology evidence (quoting a resource), differentiated different kinds of transfer (high road and low road), and contextually linked it to the video example. Kay then suggested that prior knowledge can be used as a way to “teach for transfer” by using instructional strategies that bridge the prior knowledge to the new context. One student imports resource information from the knowledge web (KW) that provided educational psychology rationales about why the use of prior knowledge helps with learning and understanding. The initial member postings focused on what the student [Brandon] does, but then evolves into the teacher perspective of instructional strategies (teaching for transfer). Additionally, Nadia added that Brandon’s demonstration of transfer of knowledge to a different context could be used as evidence of the student’s understanding of the material. As mentioned previously, Nadia posted last across all of the tabs and seems to benefit from prior posts and facilitator comments.

In the subsequent video cases, the group does integrate the concept of transfer into the solution, but with less frequency. In Problem 1 there are twelve specific references to transfer and a total of twelve in the next three problems combined. It seemed that the first problem served the purpose of establishing “transfer” as an important instructional goal, and, individually, group members demonstrated this understanding. In the subsequent problems, the posts restate what the goal of a teacher might be:

> Ms. Baker seems to have the objective of imparting the students with creative and adaptive problem-solving skills, the ability to transfer principles of science to the real world and the understanding of the role of tools and artifacts in problem-solving situations"(Nadia);
> and what students should be able to do:
> Through the use of prior knowledge and applying it to the instructional activities, the students also should be able to transfer their understanding to any future related activities, and use the information they have learned in real world situations" (Kim)

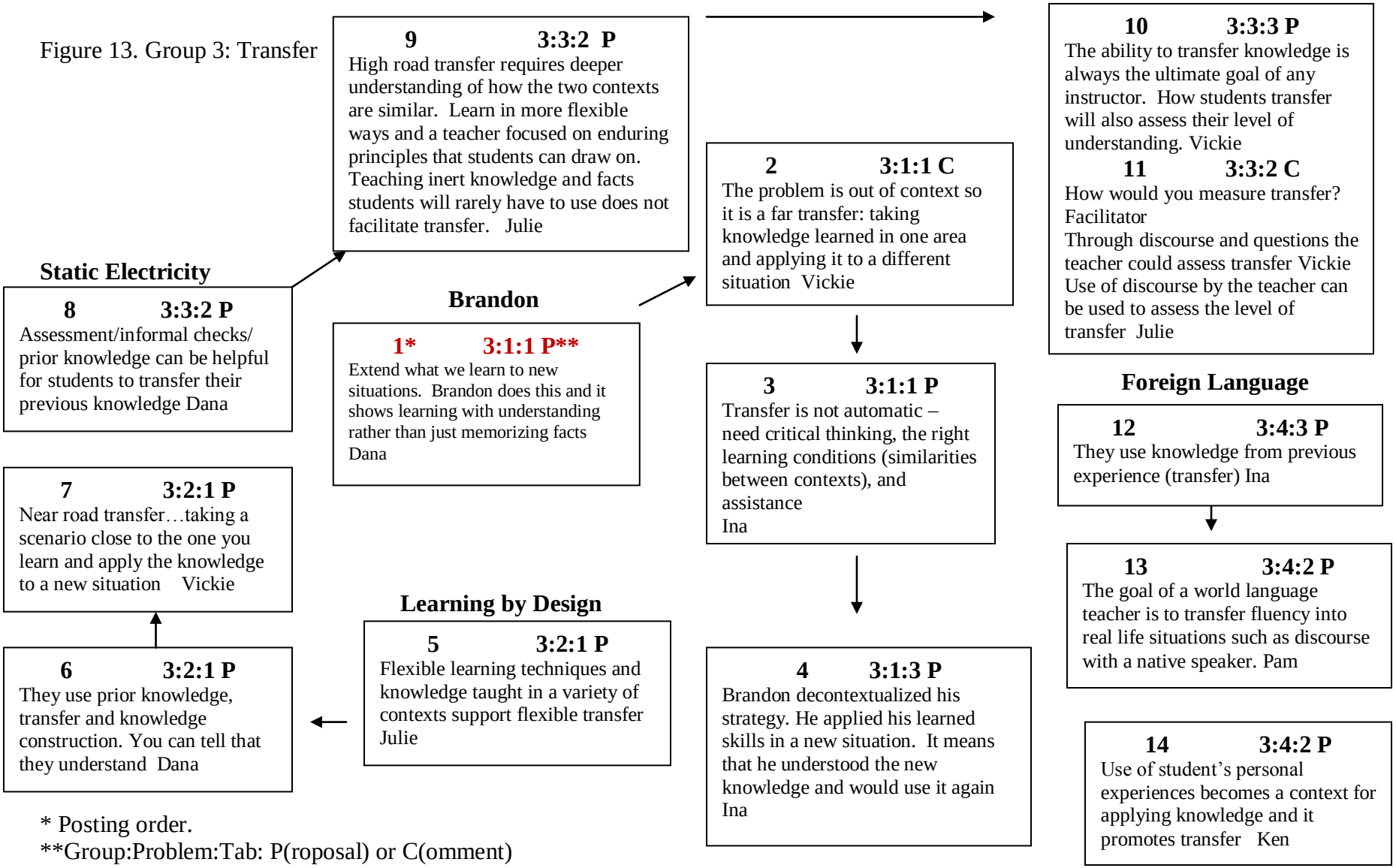
Members of the Group 1 continued to include transfer as a relevant concept in the problem solution and focus on the idea that concepts learned in the classroom can be transferred to and used in the "real world" or applied to real life situations. Problems 2, 3, and 4 started by asking the groups to identify instructional objectives for the lesson – this group included the concept of transfer of knowledge into real world situations or to other contexts as one of their objectives in each of these three problems. This agreement on the objectives by the group seemed to support the importance of including transfer, however there were only a few other postings that demonstrated how the group would facilitate transfer as a part of the overall solution to the problem via instructional activities. Four of the five group members mentioned transfer in the third and fourth problem solution. Individual group members offered a few suggestions on how to structure instruction to support transfer or how to use transfer as an assessment of learning. The postings focused on teaching for transfer; posting ideas that included opportunities for social interaction, building on prior knowledge, and experiments that help students use higher order thinking skills to promote transfer or see evidence of transfer. In Problem 1 Kay had referenced a resource for how to teach for transfer, however, specific ideas were not brought forward into the subsequent solutions and Kay made only one reference to transfer in Problems 3 and 4. No single individual seemed to take "ownership" of the

concept or develop it much beyond Problem 1 where the group labeled, defined, and set it as an objective in the classroom environment. Some members (Nadia in particular) seemed to benefit from prior posts of others. Individuals in the group accurately identified and used the concept of transfer. There was no evidence in the online dialogue that there was negotiation or interaction around the concept that could lead the group or an individual to deepen their level of understanding through collaboration with others.

***Group 3.***

Group 3 began in Problem 1 and integrated the concept of transfer into all of the subsequent problem solutions. The figure below (see Figure 14) gives an illustrative look at how and who posted about the concept of transfer across three problems. This group started slow in terms of interactivity, but began to interact in a cooperative pattern. The numbered boxes indicate the chronological sequence and indicate the problem and tab under which the post was made. A more detailed narrative about how the group incorporated the concept of transfer follows it.

Figure 13. Group 3: Transfer




* Posting order.
**Group:Problem:Tab: P(roposal) or C(omment)

The use of the concept of transfer began in Problem 1 about Brandon:

1. Dana:
   Transfer is affected by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures. (how people learn, 55). Students who only memorize facts have little basis for approaching this kind of problem- solving task. (how people learn, 56) A student who merely memorizes topics in his class would not have been able to transfer his math knowledge to the pizza problem. this shows that Brandon had transferred previous knowledge to the pizza problem making it less difficult to handle.
2. Vickie posted a comment in response to a proposal (which did not mention transfer) by another student.
   In this problem it would be "far" transfer or taking knowledge learned in one area and applying it to different situations. One example is applying concepts you learned in geometry to play a game of pool. You learned about angle of reflection but how many times did you take a protractor to a pool hall? Probably...none? So it's was the same concept when you see the problem you don't think to use a math equation to solve it.(Transfer, stepweb.org)

The facilitator recommended to Vickie to put her comments into a proposal.

3. Ina proposed: According to the concept of Transfer, people don't automatically remember prior knowledge or skills they have learned in order to apply it to a new problem or situation. This problem required lot of critical thinking, the right initial learning conditions, the proper assistance (in this case, the blocks), and strong similarities between the learning context and the new context in order for one to determine the right answer.
4. Ina, on another tab, elaborated: He ‘decontextualized’ his strategy. He applied his learned skills in new situations. Using flexible transfer.
   Ina proposed that his application of skills to a new situation indicates he understands and would be more likely to use this knowledge again.

In the Learning by Design video case, a science teacher engaged students in a project to design balloon cars, with the intent of helping them learn how forces combine and act on an object. The learning by design employed hands-on learning and scaffolding, as students faced continual challenges of making the design work properly.

5. Julie: Transfer: The fact that the students in Mrs. Baker's class were given the opportunity to transfer what they had learned to a new situation gave them adaptive, flexible learning techniques (How People Learn 235). Knowledge that is taught in a variety of contexts, such as the physical hands on building,

is more likely to support flexible transfer versus knowledge that is taught in a single context (How People Learn 236).

6. Dana lists ideas about what students in the video are doing: they use prior knowledge, transfer, and knowledge construction.
7. Vickie posts another definition, this time of "near road" transfer.
   Through the activity with the car the children will learn the constraints by testing but develop their own ways to use those constraints in their models. This is a form of near road transfer. Which is taking a scenario close to the one you learn and applying the knowledge you know to that situation. (transfer, p.1) In this case the knowledge learned is that from the experiment and that learned knowledge is than applied to the design of the car.

Problem 3, Redesign of a physics unit, a teacher, Blair, is seeking advice on how to incorporate some of the methods and techniques in his instruction that he has observed in another expert teacher.

8. Dana: Assessment, formal checks, prior knowledge can help students transfer their knowledge
9. Julie: Far(high road) transfer requires a deeper understanding of how the two contexts are similar in order to apply the underlying principles.
   The Cognitive Flexibility Theory is appropriate for this problem because it includes studying concepts in a variety of contexts and seeing the connection of main ideas through multiple sources & a number of different representations. Learning new ideas this way is thought to promote more flexible, adaptive knowledge, as opposed to rigid isolated facts; this allows for flexible transfer of the knowledge later
10. Vickie: To promote transfer its important for a teacher to focus their lessons on useful enduring principles that will have applicability outside of the classroom. Inert knowledge and facts students will rarely have to use does not facilitate transfer. One should focus their ideas around principles and concepts that the students will later need to draw upon and that are central to the specific discipline
11. The facilitator wants to know how to measure transfer and two students responded that the teacher could use discourse and questioning to assess the level of transfer.

Problem 4, teaching foreign language, presented the case of a French teacher who wanted to better align her teaching to new learning standards and incorporate social constructivist methods in her teaching.

12. Ina: They also use knowledge from previous experience (transfer and cooperative learning.

13. Vickie: The ultimate goal of any world language teacher is to get the children to be fluent and able to transfer that fluency into really life situations such as discourse with someone who is a native speaker of that language.
14. Ken: According to the KnowledgeWeb, "the use of students' personal experiences becomes a context for applying knowledge." Making direct connections between the lesson and students' daily lives promotes transfer of knowledge and enduring understanding. Evidence of understanding is measured by the students' ability to make connections between the objectives and their lives.

There are eleven proposals and four comments. There seemed to be little interaction among the group although some of the same ideas about transfer are mentioned across the students. Vickie, who first defined this concept and connected the concept to her own life (using geometry in the pool hall) went on to contribute multiple posts and had proposals in all four problems that included the concept of transfer. She seemed to extend what she knew about transfer from an initial definition and observation of what students do to a more detailed explanation which included the goal of a teacher (to see students transfer information) and how to use evidence of transfer as a way to assess a student's level of understanding. Her initial posting in Problem 1 was commented on by the facilitator: "it seems that what you wrote deserves to be called a proposal, not a comment...". In Problem 3 the facilitator asked Vickie to elaborate on a post about transfer. This early reinforcement and later scaffolding from the facilitator and the student's ability to recognize how the concept of transfer may apply in her own life may have contributed to the student's investment in this concept.

This group covers the important aspects of transfer. Dialogue included a definition, understanding what Brandon was doing, types of transfer (flexible, near, far), and teaching considerations (context, application to real world problems, using student's personal experiences). Vickie contributed much to the conversation, but other group

members add parts of the whole as well. Over time this group had a fairly equally distributed level of participation: however, interactivity remained low. This seemed to lead to a distributed level of knowledge at the individual level about the concept of transfer, but without the responsiveness and potential for more elaborated, negotiated group knowledge.

***Group 4.***

Group 4 posted across all problems using the concept of transfer and all six of the group members used the concept of transfer. The first posting by Monica focused on the activity, solving the pizza problem, and how the activity promoted learning and then how the discussion with the researcher helped Brandon recognize how he had transferred his knowledge. The group then formed the idea that the ability to transfer a concept from one context to another was evidence of understanding. "We know that Brandon understood because he was able to see the isomorphism between the blocks and the pizza problem" or "Brandon shows understanding in this problem, he was able to use transfer from a lesson weeks before when he used manipulatives". These were the second and third posts about transfer. The group went beyond the observation of transfer and the labeling and defining of the concept to comment that the activity promoted transfer and that the ability to transfer learning is evidence of understanding of that learning.

The student groups generally started the conversation about transfer by making observational comments about what Brandon was doing and tended to put the focus on what Brandon needed to do. This often led the group to focus on what the student needed to do [transfer] and only later (sometimes) on what the teacher or environment needed to do to promote transfer of learning. Posting would include a phrase such as, "the student

should…", putting the emphasis on the student and their responsibility verses the responsibility of the teacher. Group 4 seemed to make a more meaningful, deeper conceptualization of transfer right from the beginning (see Table 10) and have the perspective of what the activity can do to promote transfer and how it can be an assessment of understanding.

Table 11. Group 4: Problem 1 posts on the concept of transfer

| Tab 1 | Tab 2 | Tab 3 | Tab 4 | |
|---|---|---|---|---|
| Difficulty of pizza problem | | Evidence of understanding | | |
| | Enduring understanding | | Instructional activities | |
| | | | Monica | Postings by individual in chronological order as it relates to the concept of transfer |
| | | Caitlin | | |
| | | | Mara | |
| | | Amber | | |
| Amber | | | | |
| | | | Holly | |
| | | Rachel | | |
| | | Rachel | | |

Group 4 linked Brandon's ability to transfer information as evidence that he had a deep understanding of the abstract knowledge needed to solve the pizza problem. This is a slightly different approach than the previous groups. In addition to making the observation that Brandon demonstrated transfer of knowledge there was also information about the underlying reasons about why transfer takes place and a reference to the course text to support the ideas. Holly began the thread about transfer:

> The use of transfer in his work further supports the idea of his understanding of abstract knowledge. Successful transfer is dependent on the way the student views the knowledge obtained. If the growth in learning is looked upon as continual, verses discrete steps, there is an increased chance that transfer will occur (How People Learn, 65). It is obvious that transfer of concept occurred because Brandon was able to solve the pizza problem in a way that he had never been taught. Therefore, some sort of previous knowledge triggered his solution. If transfer was able to occur and abstract knowledge is

> shown to increase transfer (How People Learn 65) then the abilities of Brandon to transfer the information are demonstrations of abstract reasoning.

Caitlin continued on this perspective stating:

> Brandon's seemingly effortless use of transfer provides evidence that he understood the problem, because "transfer and wide application of learning are most likely to occur when learners achieve an organized and coherent understanding of the material. (*How People Learn*, p. 238-239).

Caitlin provided some extension of the concept by defining and giving evidence of what kind of transfer she thought Brandon was exhibiting and by acknowledging research done by another group member:

> According to Monica's research…I believe that Brandon exhibited what is known as 'high-road', or 'far' transfer, as opposed to 'low-road' or 'near' transfer. In far transfer, a person abstracts the underlying principles from one problem's context and uses them to solve a problem in a different context.

Another group member continued:

> Brandon's ability to transfer and pull in the other problem is evidence of his learning and understanding. The transfer was triggered by prompting

This observation, that transfer can be facilitated by prompting and that transfer can be used as evidence of learning, seemed to lead this group to consider the concept in detail.

Group 4 continued into Problem 2, Learning by Design, to identify situational characteristics that promote transfer. Holly indicated that for students to transfer their knowledge into real world situations the students need to bring in their own experiences and prior knowledge and the "interactive nature of group work is extremely important". Monica commented:

> another way to look for enduring understanding would be the students' transfer and application of principles of force and motion especially to real world situations. This would show the student's understandings of information previously and transfer it to the problem at hand which is a real world problem that allows students to work with hands-on material

The students made more specific links than the prior groups between an instructional strategy (interactive group work and use of hands-on materials) and promoting transfer of learning. Monica followed up her comment with a proposal that integrated prior ideas about the importance of transfer and that the transfer of knowledge is evidence of the students understanding of the material being taught.

In problem 3 and 4 the group recognized that, just as in the prior problem, it is important for a student to be able to "apply the basic concepts to different situations which would therefore use transfer of knowledge to other real world problems"(Monica). Amber commented: "If the students can understand and explain what they're learning rather than just regurgitating concepts like in Johnson's class they will be able to understand what they are learning better and will be able to transfer the information easier at a later time". Amber, in a subsequent post, stated that the teacher could assess students based on how much help is needed for transfer; the amount of "help" or "scaffolding" needed for transfer can be tracked and used as evidence of understanding. These are activities that the teacher would engage in and could use as a way to assess learning. The teacher appeared as a focus here, but only in terms of assessing the students understanding. As part of the assessment process, the use of scaffolding is mentioned as a factor that the teacher can track (the amount of scaffolding needed), but there is little information of *how* the students will get their understanding.

Group 4, at the start, focused their ideas about transfer by identifying Brandon's ability to transfer knowledge as evidence of understanding and the importance of a being able to apply knowledge to "real world" problems. The group continued with this idea across problem solutions – focusing on instructional activities to promote transfer and

using transfer as a way to assess understanding. The initial posts about transfer were similar to the other groups, but the development of the concepts and the focus on instruction and assessment in later posts was different.

In summary, a goal of the course was to help students learn about a variety of educational psychology concepts. For the concept of transfer, it would seem that students should know: what is the concept of transfer (observe, define), how to teach for transfer or what teaching conditions help promote transfer, and how a teacher can use it to assess a student's level of understanding and learning. There were three things: what transfer is, how to get it, and what it shows. All six groups at some point in the discussion across the problems observe transfer; mention that instructional activities or actions by the teacher can help promote transfer, and that one can use transfer as evidence of a student's understanding. The difference between groups is in the comprehensiveness in which they explored and applied the concept and in the way in which the concept is used by the group verses by individuals within the group. In parallel group processes, the members seem to build on their own understanding. In a cooperative process a few students seem to take on the concept and become the "go-to" person who takes responsibility to include the idea in the learning objectives and the activity and assessment sections or have an additive model of putting in their parts that become the solution. In each of these patterns of interaction, advancement of the concept is not substantial over the course of multiple problem solving episodes.

The more collaborative effort results in broader appropriation across the group; multiple members posting, supporting, and incorporating the concept into their suggested solution and comments. There is interactivity around the concept. Theoretically, all

members of the group see all of the posts that a group generates. The goal of the group is to answer questions by applying educational psychology concepts to the solutions of each video case. There may be instances where, if a concept has been applied to a solution, the group sees that the necessary work has been done – making subsequent posts by others unnecessary. However, this approach does not advance the concept in a dialogic manner. Collaborative efforts in a group, where interactivity and participation are high, make it easier for the course instructor to see what the individuals are learning as well as the group. Collaboration moves the concept around the group and provided opportunities for elaboration beyond just an information sharing level.

**Assessment.**

Assessment is the second educational psychology concept of interest. As mentioned previously, learning about assessment was an important part of three of the four video cases. Three of the cases specifically asked about assessment strategies – what kind of assessments to use to gauge student understanding of each learning objective and the rationales for choosing certain types of assessments. The following describes how assessment is integrated into problems based on the pattern of interaction in the group.

***Group 5.***

Group 5 is a group that displayed a parallel pattern of interaction. Group 5 had the fewest student comments and the fewest number of online interactions. In working with the concept of assessment, this group had difficulty focusing at the start of Problem 2. There were only two tabs for this case, Instructional Objectives and Evidence of Understanding. Several students in the group posted proposals under the Instructional

Objectives. The facilitator used comments to try to focus the group with statements such as, “these are teaching strategies, what objectives did you decide on…just the objectives belong here”. Juan, in the seventh proposal, after prompting from the facilitator to focus on objectives, listed the objectives for the lesson and after each objective listed specific formative and summative assessments that can be used. For example:

> 1. Understanding of concepts of force and motion
> Formative Assessment
> 1)Answer homework questions A & B from your textbook (Inquiry Materials Case 5: Pbl)
> A. Design Changes in the way balloons are used
> B. Design changes in the way straws are used
> including your predictions for each item of the above list
> about what you think will result from these changes.
> Summative Assessments ( 2 short answer quizzes.
> 1) First Short Answer Quizz
> a) Define Newton's three Laws of Motion
> b) Describe Newton's Third Law of Motion and explain
> its application to the balloon-car.
> 2) Second Short Answer Quizz
> a) Explain how forces are created and how they act
> to make your balloon car move forward.

The facilitator stated,

> This is a good summary-- but this is evidence of understanding-- just the objectives belong here. You might move this to the next tab and under the research section, include the psychological theory and research that backs your ideas. Why is overall evaluation a formative assessment rather than summative? What do the rest of you think?

This comment from the facilitator is one of several that make the same point. Three other students have posted on other topics, but not included issues of assessment. Four students, including Juan, move their proposals that were under the “wrong” tab to the tab “Evidence of Understanding” and repeat what they had previously posted without incorporation of new ideas or incorporation of ideas of others. Juan appeared to copy and paste his proposal from the one tab into the new tab, adding links to research he has

gathered about the assessments, but does not incorporate the rationales or theories that the facilitator had requested.

The following is a summary of ideas and comments that were discussed around the issue of assessment for Problem 2 under the tab "Evidence of Understanding":

> Lois: Involve students in decision making and self-monitoring as evidence of understanding. A journal entry each day or week can be evidence of learning (a formative assessment) and then an expanded version of the journal and summarize as a summative (conclusion) learning experience.
> Facilitator: What do the rest of you think?
> Juan responds with a comment: Keeping a journal helps support each student's developing stages of understanding. The teacher can collect these entries and evaluate them as evidence of understanding.
> Lois: Another type of evidence that teachers can use is "extending understanding to new situations" [adds a reference]. A complete discussion on observations and the reasons for cause and effect is a great way to see if the students are actually learning.
> Facilitator: Can you give an example of "extending understanding as it pertains to this case?
> Fran: The teacher can use the K-W-H-L-S method. This method sets guidelines for a project and demonstrates what the student knows. The student is forced to explain, demonstrating knowledge.
> Facilitator: any research back up for these ideas? How can the teacher use this? Make it concrete for her. Which objectives will you target?
> Juan: The Backward Design Process suggests a continuum of assessment methods to check for understanding (oral questions, observations, informal dialogues); open-ended prompts. Some ways this teacher can assess is a final oral presentation, each students writes a paper explaining what they learned. [Juan included a link to the text and to "facets of understanding" – listing six of them with a brief explanation. One of the facets is included here]. 1) Can Explain: in their final project presentation or gallery walk what they noticed when they used the balloons in different ways on the car and their effects, they can also provide data and factual research as supporting evidence.
> Facilitators; [both comment] In short, how can we use this to help the teacher see what the students know? Interesting idea, Juan. What does this say about the nature of student understanding in psychological terms?
> Lois comments: Juan, this is similar to what I was going to propose with the six facets of understanding. You can assess understanding through questions during the course of the lesson….[provides a quote from a reference]
> Tina: (This a proposal that she has moved from the first tab to this one…making it her only contribution for this case). Hands-on learning is the only way students can understand science… Thus, the experiment revealed that hands on learning,

> using trial and error and manipulation of tools can enhance learning and understanding.
> Facilitator: Yes, but how does this provide evidence of understanding?
> Karen: The teacher used self-knowledge to teach the kids the science lesson. The students did demonstrate this because they had to figure out what made the rocket work. [it is interesting to note that the students were working with cars not rockets)
> Facilitator: How can she assess this evidence? What objectives would this target?
> Juan: [This is the last proposal and a lengthy reiteration of the prior post that focused examples of formative and summative assessment for six facets of understanding. It reads like teachers lesson plan about what the teacher would do. For example] Learn about scientific inquiry process
>
> > Formative Assessment
> > 1) Answer all four parts of the "Problem Understanding" Design Diary sheet # 1 from your textbook (Inquiry Materials Case 5: Pbl)

For all of the postings in Problem 2 this group posted 15 proposals (more than any other group). Twelve of these proposals generate comments, however only four comments are from peers (three from the same person – Juan), there are 14 facilitator comments, and in ten of the twelve proposals, the first comment was from a facilitator. Group members seemed to be doing their own thing – paying little attention to each other, and to some degree paying little attention to the facilitator. Juan who specifically lists the instructional objectives and assessments to gather evidence of understanding contextualizes the concept of assessment to this problem. However, the assessments listed by this group (primarily by Juan) are a list of strategies to use and are not defined or developed to illustrate the underlying rationales for using them.

In Problem 3, Group 5, Fran started out with an assessment strategy that was more descriptive than in the prior problem and began to address issues of rationales:

> Many traditional forms of assessment of student learning are not very effective. This is mainly because they make generalizations and focus on memorization. Performance testing brings much better results. The

> teacher comes up with a criteria to observe the student's progress. A good performance test should include specific outcomes stated by the teacher; clarity concerning what is to be evaluated; and a statement of the evaluation procedure.

Lois posted a proposal that incorporated the concept of backward design – an approach that the class was encouraged to use as a guide for developing assessment strategies. Steven (who did not participate at all in Problem 2) posts a proposal about what assessments should be – valid, reliable, and standard. A peer commented, "How does the teacher use these three strategies to assess evidence of understanding? Does he even use these strategies at all?" In this group, this seems to be one of the few times that a group member asks a peer to be more specific. Steven's proposal is informational; he does not contextualize it to the problem at hand and has paraphrased information directly from the KW site on assessment without elaboration. Juan then posted a lengthy proposal, similar in style to his proposal in Problem 2, where he listed objectives, assessments, and activities to gather evidence of understanding for this lesson. The facilitator asked for more specifics and psychological rationale for using a certain assessment. Juan commented in response to his peers and the facilitator by giving more specifics about what he thought should happen in the classroom – it is a descriptive lesson plan and he included the following,

> The importance of having students write papers is to paraphrase and organize and deconstruct the bigger ideas into their own discrete words and understanding. This reflection makes them evaluate their initial misconceptions and revise them for conceptual change.

Three more group members posted three more proposals. Each proposal is that person's idea about what activity might help show evidence of understanding; games of physics jeopardy, students keeping a portfolio, or having them design an experiment. The concept of assessment that seemed to be a thread running through Juan's proposal and the

subsequent proposals is that students should have an opportunity to reflect on their work and demonstrate understanding by applying what they know in varied situations. There are some peer comments, suggesting that they being responsive, however, most of the proposals offer the individual's ideas and do not build on, show appropriation of ideas, or develop an idea across the group.

In Problem 4, the Foreign Language problem, Group 5 seemed more focused and had agreed on one set of objectives that gets posted under the first tab. Lois started with a proposal under evidence of understanding. She stated:

> Through the use of discourse and conversation, Beauchamp [the teacher] can really see how her students are advancing. The expectation of that cognitive activity will be apparent in dialogue is supported by the work of Vygotsky and other more recent sociocultural theorists (eg Lantolf & Appel, 1994; Newman, Griffin, & Cole, 1989), who argue that cognitive processes arise from the interaction that occurs between individuals. Through a gradual process of internalization, one comes to be able to use the language of others.

Lois seemed to have benefited from the feedback and comments from the facilitator in prior problems and included references and psychological rationales to her assessment strategy.

Lois focused on the specifics of this video case. Juan offered a more general idea that incorporated specifics of a lesson rather than an assessment strategy. At the end of a lengthy proposal about teaching techniques, he suggested that the teacher can use a "rubric" to assess the students' response to the instruction. Juan goes on to post comments on his proposals (in response to peer and facilitator comments) and post two more proposals about the use of a cross-cultural approach and a rubric-like formative assessment that listed tasks for the student to do (again, more lesson plan than assessment strategy). All but one group member posted a proposal about assessment. In the seven

proposals offered under this tab, six are commented on and in five of the proposals, the facilitator is the first to comment. In the other proposal, Juan is the first to comment - on his own proposal.

Individuals in the group develop their own ideas about assessment. Members post their ideas about how to assess student learning. There is not a clear definition presented in the beginning and it seems the group floundered around trying to figure out how to apply an assessment strategy to each problem. Strategies such as discourse, interaction, using experiments, and some combination of summative and formative assessment are presented individually. Juan is the only student that consistently provided detail, but it often lacked the depth of explanation that was expected (i.e. psychological rationales) or be contextualized to the specifics of the case and/or objectives. His proposals seemed to be on the teaching/learning aspect of the problem as if he was in a teaching course rather than one that was to be focusing on the how and why learning takes place and how to assess that learning.

The interaction is primarily between the student and the facilitator, with most of the first comments, and on multiple occasions the only comment, coming from the facilitator. The facilitator commented across the problems and asked students to focus the discussion, interact between each other, and provide psychological rationales for their proposals. The last facilitator comment under evidence of understanding in Problem 4 was, “How does this pertain to the unit we are designing? Also, how do these connect to psychology of learning and to the objectives of the unit we are re-designing?” This seemed to indicate that even at the end of successive problems the group was not contextualizing or specifying how and why assessments are used. In this group, it

seemed that there was limited forward progression on the concept of assessment, both within the group and among the individuals. The exception seemed to be Lois, who was responsible for some of the very few student comments that indicated interaction with a peer and not just in response to the facilitator.

In summary, the concept of assessment in the group was poorly developed. The parallel processes meant that individual students developed and posted an idea about assessment, however the goal of reaching a shared understanding of the psychological rationales for the use of assessments was not evident in this group. Student posted their individual ideas about assessment – primarily listing examples or paraphrasing ideas from the KW. Juan tended to dominate the discussion and despite prompts from the facilitator and peers did not elaborate on rationales. This group did not, online, post a clear definition of assessments and with a few exceptions did not elaborate beyond naming types of assessment. Each person shared an idea about assessment, but the lack of interactivity around information sharing left the idea poorly developed.

***Group 6.***

Group 6 used an interactive style of cooperation to complete the tasks presented. How did the specific dialogue about assessment look in this pattern of interaction?

This group benefited from one of the group members, Bryan, posting an extensive proposal about assessment at the very beginning of Problem 2 (the first time issues of assessment explicitly came up). Bryan listed each learning objective that the group had agreed on and then for each objective wrote about assessments. For example, part of what he wrote:

1. Understanding of concepts of force and motion
   Evidence of understanding the concepts of force and motion can be found in the

> student's ability to explain, apply, and (in the case of the tools and artifacts) interpret. The degree of their success in doing so would give Ms. Baker her evidence, good or bad. Because of the factual nature of the objective Ms. Baker might find it useful to make a content-based assessment. Sometimes referred to as restricted response tests, because of the limited range of possible answers, content-based assessments might take the form of a multiple choice test, essay, matching test, etc. Although it poses a rigid format, if Ms. Baker is careful in aiming the tests to inspire higher cognitive thinking true understanding can be found instead of student guess work.

He completed the proposal with a narrative about characteristics of "good assessments" from the knowledge web – validity, reliability, and standardization. This information was verbatim from the KW on assessment. For one of the objectives (Learning higher order thinking skills) Bryan asked for help,

"Someone feel free to take this one".

> Anna: USE…[she then goes on to list her own ideas about assessment] For example:
>
> 1. For understanding of concepts of force and motion formative assessment of student interpretations would be the best approach. By evaluating the quality of explanations- "systematic" & "justified" using terms, (Wiggins & McTighe) and giving comments Ms. Baker will be able to find evidence of understanding during the activity. At the end of the activity, a quiz (cf-WM) would be a good way to see if students are familiar with scientific terms that they have observed during it (Bransford).

Although posted after Bryan's proposal, it is less elaborate and focused on one formative assessment (quality of explanations) and one summative assessment (a quiz). Anna does not specify the types of assessment by name or offer rationales for their use.

Anna did respond to the request for help to fill in the objective left blank by Bryan:

> 4. To assess higher order thinking skills, Ms. Baker should look for perspective, application, interpretation and evidence of considering others' views and awareness of process (Wiggins & McTighe, Six Facets of Understanding), and peer learning.

Bryan reposts his proposal with this one change

> 4. Learning higher order thinking skills
> When we promote higher order thinking we are developing skills in application, analysis, synthesis, and evaluation. Such skills go beyond basic knowledge and comprehension and present higher cognitive thinking.
> Evidence of this enduring understanding can be analyzed and gauged by the six facets of understanding and their transfer to future problem or later stages of the existing balloon car project. Through performance testing which challenges the student to explore pertaining concepts and ideas deeply, Ms. Baker can find her evidence.

Bryan did adopt the idea that higher order thinking skills could be assessed by using the facets of understanding, and brought forward a couple of ideas listed by Anna, but also adds his own ideas.

Bryan and Anna took the responsibility for assessment in Problem 2. In Problem 3 the group seemed to use the same approach as in Problem 2 by focusing on the Facets of Understanding (FOU) outlined in the text (explain, interpret, apply, have perspective, empathize, have self-knowledge) as a framework for developing an assessment strategy. This approach provided a focus for how the group would discuss assessment. For example a part of Emily's proposal:

> Emily: Another instructional activity that would go along with this would be a journal the students can keep as the lesson goes on. The students can write down their ideas and their feelings on a topic. They can write down observations and make new entries when they make a connection or discover something new. This will provide the students with an opportunity to think more in-depth about the topic, and will cause them to formulate their ideas into explanations. This will provide with a chance to show evidence of understanding through explanation, interpretation, perspective, and self-knowledge (Wiggins and McTighe). Then if the teacher collects the journals and provides feedback it can become a formative assessment.
>
> Bryan comments: Are we proposing forms of assessment? If so I think, due to research from the knowledge web about the importance of assessing prior knowledge to gauge what is learned, we might consider assessing, through an activity involving analogy to prior knowledge, what the kids know and what they need to learn. Thus making our evidence of understanding easier to find after the unit.
> And on a side note the backward design chapter in Wiggins and McTighe

> provides the framework for this problem. There are 5 questions on page 13 which should be asked after moving on from determining acceptable evidence.
>
> Bryan proposed: To find evidence of understanding of the five instructional objectives the six facets of understanding can be applied. Using backward design and identifying specifically which facets can be attributed as evidence of understanding of a specific instructional objective I arranged the following: Besides instructional activities as forms of assessment, it might be beneficial to consider more traditional methods of assessment for basic unit information. Quizes over the course of the unit might display what cannot be completely observed, like an individual's understanding, due to class size and time. Facets such as interpretation, perspective, empathy, and self-knowledge can all be observed through oral questions, observation and informal dialogues during the instructional activities.

In this instance, although Bryan interacted with Emily through a comment, Emily did not specifically respond, but Bryan ended up posting a proposal that included some of what he commented about. Robert also added a new idea of using some "traditional assessments" such as quizzes. There were two peer comments, one facilitator comment and a comment from Robert about the proposal. This interaction seemed to work at setting a tone of agreement – how Bryan had taken some information from Emily and other prior comments (including suggestions for more specifics from the facilitator) and put them together in a way that others could agree. Emily stated, "Bryan, I see that you have tried to take my proposal a step further. I think this will help us get closer to the specifics that the professor is looking for and has suggested we think about."

In Problem 4, the group continued to use the FOU as the format to think about assessment. The proposal started with acknowledging that the proposal represents what the group had discussed in class – face to face - and that the group agreed to have one proposal and each member would contribute their part to the whole. The proposal is fairly long and complete – it generated thirteen peer comments and it is the only proposal under this tab (a highly unusual occurrence).The group had apparently agreed

that each person in the group would take a learning objective and write about evidence and that these would be combined to have a completed proposal that addressed evidence for all the objectives. Anna and Emily worked on two objectives separately and then combined them together. Ellie worked on two other objectives. Bryan, formerly active on this topic, did not post a proposal of any kind in this video case, although he did make a few (three) comments. Anna and Emily worked on and revising a proposal over the course of three days. The assessments are contextualized to the foreign language problem. The proposal suggested looking for explanation of rules (i.e. of conjugation) and application of those rules in oral or written work. Ellie posted a proposal and added ideas about scaffolding and "dynamic assessment". Ellie wrote,

> The teacher can use dynamic assessment when reviewing the letters to the pen pals to see where he/she needs to add more teaching for a student and where he/she can back off because the student understands. This process can allow a teacher to see when and where scaffolding needs to take place.

There had been agreement on the instructional activity in advance (in class) and this was the first proposal posted. The group had then divided the work on assessment and integrated the activity into the assessment plan.

In summary, the group had some of the higher numbers of student comments and one of the lowest totals of facilitator comments. There is evidence of revision in response to others by adding ideas offered by others. The group decided in the second problem to use the "facets of understanding" as the format to think about assessment. As a result, the discussion about assessment revolved around looking for evidence of students' explanation, application, etc. This seemed to work for this group; however, it does not seem that it led to a deep discussion about summative and formative assessments. Into Problem 3 the group was listing the FOU next to objectives as what to look for in student

work, however there was a lack of specifics about assessments and rationales for their use. Only in Problem 4, did Ellie define and suggest the use of dynamic assessment. It seemed like the commitment to a particular format might have been restrictive even when there was a high level of interactivity.

This group did demonstrate a level of participation and interactivity that would suggest a higher level of understanding and elaboration across the group. For example, this group had the highest number of metacognitive statements. Metacognitive skills concern the extent to which students can regulate their learning activities and, therefore, their own learning and relates to task and context characteristics (Flavell, 1992). Many of the metacognitive statements made by the group focused on individual learning and task completion. In this cooperative pattern a number of statements were needed to negotiate the completion of the task (context) versus being thoughtful about the concepts (content).

***Group 4.***

This group generated more student comments on proposals for each problem than any other group and more dialogue on the concept of assessment than any of the other groups. All of the group members actively participate across the problems.

Problem 1 did not specifically ask about assessment. However, the one comment from this group in Problem 1 came from Rachel. She stated:

> Ok- when I searched for "higher order thinking" on the knowledge web, I came up with some interesting stuff. It says that there are two theories about this subject: developmental, and instructional. Our friends, Lev Vygotsky and Jean Piaget were "contemporaries". (This is cool because Vygotsky is the founder of socio-cultural theory, which we talked about before.) Anyway, Vygotsky states that such "higher order thinking" has four characteristics, it is: self-regulated, consciously assessed, socially originated, and mediated through signs and symbols.

> CONSCIOUSLY ASSESSED- this is a big one, "learners are both aware of what they are doing and can explain it to others"- Brandon fits this model exactly.

This quote from Rachel exemplifies this group's informal and interactive tone that began in the first problem. The posting used a conversational tone, linked her findings to what they had been learning in the class and thinks it is "cool". This group had the most (10) comments that included a personal reference or self-disclosure and the most agree, evaluative, metacognitive, and seeking response statements. (Refer back to Figure 11.)

In Problem 2, Mara and Caitlin started with proposals that included the ideas of using collaborative learning and explanation to assess understanding. Mara stated, "collaborative learning needs to show that ALL in the group understand". There is an early use of a referenced article (Caitlin) to support an idea and a focus on getting the students in the video to demonstrate the use of "higher order thinking skills". The facilitator asked, "so you are saying that formative assessment can really help uncover misconceptions and be used to inform teaching, right?" Monica responded that "yes, I was saying how formative assessment can uncover misconceptions". Monica goes on to reference the text, gave a definition of formative assessments, and explained that formative assessments help the teacher and student monitor progress on a problem. Caitlin added, "maybe formative assessments are actually better at assessing competence". This early discussion seemed to provide the group with an understanding of formative assessments and the rationales for using them. Amber, in a comment, stated:

> From the research I did about formative assessment, it seems to me that it would be the best way to learn as a student. It is very hands on, interactive, and allows the students to be able to use prior knowledge, think critically and then later reflect on what they did and how they could improve. The feedback provided to the students is crucial to formative assessment and allows the students to learn

> more, think more critically and improve simply by a little scaffolding by the teacher's suggestions.

At one point, the facilitator suggested organizing the group's ideas. Monica seemed to take on this responsibility. She combined ideas presented by two other students into a more comprehensive solution. In this way, she seemed to appropriate the ideas of others and act as the organizer in the group. There was a synthesizing of the information and not just an additive dimension.

Having established this shared understanding, the group then went on to delineate what the activities would be that would provide the evidence. There were suggestions about how to design an in class experiment and involve the students and teacher. Caitlin posted two proposals – one outlining suggested formative assessments and another for summative assessments. Caitlin, at a suggestion of a peer, combined the two into a new proposal and deleted the prior, separate proposals.

> Caitlin: Really? I didn't know. Ok, I'll combine them…I just didn't want it to be too long or confusing. Please if anybody has any suggestions, changes, additions let me know so I can edit this.
> Mara: These are great ideas, Caitlin! I think that this proposal is concise and still covers so much. The focus on both summative and formative assessments was great!

This interaction is different from other groups who had several "agree" statements. This group does not just say, "I agree" as some other groups, but goes on to elaborate about what they find agreeable and encourage the originator of the proposal by name. Amber added an additional proposal and referenced information about formative assessment and the benefit to students learning, as well as a discussion on the use of summative assessment for final evaluation of learning.

At the completion of Problem 2 this group had developed a fairly complete view of assessment – the types, how, when and why to use it, and the ideas were shared across the group. The group made frequent supportive comments such as "I agree", but also provided additional suggestions to improve a proposal. For example, a peer might remind a student to include an idea, combine ideas, add clarification, or provide a research reference to support the concept.

In Problem 3, the task was to design a learning module for static electricity and ways to assess the learning. Again, this group was very active and interactive as evidenced by the number of student comments. Monica, an active organizer in the prior problem, started with a proposal under the tab for evidence of understanding that incorporated several of the six facets of understanding that were outlined in the text (explain, interpret, apply, have perspective, empathize, and self-knowledge). Monica focused on explain, interpret, and apply. Holly posted a proposal that added perspective and self-knowledge. In each of these proposals, it included what the student and teacher would be doing to achieve evidence of understanding. This became the framework for developing an assessment strategy to use in revealing if students had understanding. There were multiple comments to each of the proposals as the group negotiated what to include and how to best detail what "evidence" will be visible in the student learning. Holly stated,

> Okay let's put all this together. I think we can cover our evidence of enduring understanding down to three of the six facets. Please keep in mind while reading this that most of this info can be found on pg 66 and 77 of your Wiggins and McTighe book.

Holly pulled the information from prior proposals and comments to narrow the focus (from 5 facets to 3) and incorporated rationales from four of her peers who had been active in posting and commenting.

Under the tab for instructional strategies, Monica took on the responsibility to see that the activities decided on by the group would help to display student learning in the case. Again, there are multiple comments to each proposal and Monica went back and revised the final proposal to incorporate suggestions from Amber and Caitlin. Amber had suggested a question and answer section to stimulate peer discourse and learning and Caitlin wanted Monica to include that uncovering misconceptions helps with learning. Both of these made it into the revised proposal.

This group now had a fully formed idea about assessment. Problem 2 helped them develop an understanding of the terms of assessment and their uses. In this problem, the group was able to negotiate more application and rationales. For example, there was some divergence on an activity; whether the students should design their own experiment or do one the teacher has designed.

> Amber: Hands on activities promote metacognition, they become aware of themselves and assess their readiness …I also found something called procedural facilitation which seems to solidify my idea about the benefits of hands on activities. Students in the procedural facilitation program take turns presenting their ideas to the group and detailing how they used prompts in planning to write (they're supposed to be actually writing something, but I think it could work with just discourse).The teacher also models these procedures. Thus, the program involves modeling, scaffolding, and taking turns, which are designed to help students externalize mental events in a collaborative context.
> Caitlin: Sorry guys, I didn't mean to cause confusion with my question about making up an experiment, I just couldn't remember what happened in Etkina's classroom! I agree that having them make-up and do their own experiments is NOT the best way to get them to learn the concepts (and it is also very impractical). I agree with everyone else that they should be given a pre-designed experiment to do, with a prediction sheet. I also like what Holly and Mara said about having the students design an experiment in the end (but not test it) because

> it seems like that could be a good assessment of their transfer and of their mastery of the material.
> Monica: the psychological rationale of doing the experiments is for the most part what Amber wrote in the proposal. Experiments promote metacognition, transfer, and are a form of assessment for both the student and teacher because it allows the progress of learning to be uncovered to the teacher (and student).

Monica went on to revise and incorporate ideas from the group into the final activity suggestion. The activity included a variety of ideas that the group had negotiated and was not just additive from one group member to the whole.

This group used frequent supportive statements and suggestions. Again, the ideas seem to belong to the group – the lack of individual ownership allowed for a safe environment for all to work with the ideas. Group actions of collective responsibility, democratic processes, diversity of ideas, improvable ideas, and use of authoritative sources are characteristics of knowledge building discourse (refer back to Table 9 for the interaction pattern in this problem). I think in the group it is worth noting too that the facilitator was not as active. For Problem 3 only one of the facilitators was commenting and two of her five comments were the last comments made. This is in contrast to other groups where the facilitator was commenting first – maybe needing to push the student discussion forward. Here the facilitator was suggesting and encouraging, but not the driver. In knowledge building language, this is referred to as epistemic agency – where students themselves find their way in order to advance. The interesting question seemed to be is whether this group, by the nature of its composition, was more interactive and effective in this process or what influence the facilitator had as she stepped back allowing students to take greater responsibility versus making first comments and thus becoming more central to moving the process forward.

Problem 4 focuses on learning a foreign language, French. Caitlin started with a lengthy proposal that included this statement:

> We plan to use multiple forms of assessment to gauge students' understanding. We will include formative, or authentic, assessments as well as more traditional, summative assessments. Formative assessments, such as observations, dialogues, and projects, are targeted at uncovering how a student's mind works, the way he or she organizes thought and ideas, and how a student interacts in the social environment (KW). The intent is to encourage students to move on to higher levels of cognitive and experiential skills rather than to generate a product to earn a grade. We will also include formal summative assessments, such as quizzes, throughout the lesson. These forms of assessment are aimed at gathering what information a student has acquired up until the time of the assessment, which is a good indicator of their current level of understanding. These quizzes can be derived directly from the worksheets and activities in the unit, such that all of the assessments, formal and informal, will collectively provide an accurate longitudinal indicator of progress and understanding.

This proposal generated six comments (the facilitator is comment number six; see Table 11 below) including a response from Caitlin in which she directly responded to several of her peers. Caitlin had revised this in response to a comment and commented on her own proposal.

> Caitlin: seems like enough of us agree that confidence is not what we're looking for as evidence…so I got rid of it. Monica agreed that assessments seem more like activities.

Table 12. Group 4: Problem 4 posting on assessment

| Tab 1 Objectives | Tab 2 Evidence of Understanding | Tab 3 Instructional Activity | |
|---|---|---|---|
| | Caitlin-P | | Postings by individual in chronological order as it relates to the concept of assessment |
| | Caitlin-C | | |
| | | Monica-P | |
| | Mara-C | | |
| | Amber-C | | |
| | Caitlin-C | | |
| | Rachel-P | | |
| | Amber-C | | |
| | Mara-C | | |
| | Caitlin-C | | |
| | | Caitlin-C | |
| | Monica-C | | |
| | Amber-C | | |
| | Facilitator-C | | |

There are two more proposals posted in which Rachel and Monica offer additional ideas that add to rather than incorporate Caitlin's proposal. Rachel offered a lengthy comment regarding the use of an instructional planning rubric. Monica appropriated this comment as she outlined the activities that the teacher would use to engage students in learning and lead to evidence of understanding. Monica started her proposal under the tab for instructional activities. There were six revisions to the proposal in response to comments from peers and the facilitator. Four of her five peers comment and she takes the responsibility to develop the proposal in collaboration with her group. There was an extensive list of learning activities that link to the objectives, and an explanation of how these activities generate evidence of learning.

The group had developed an integrated approach to assessment. Caitlin indicated that in class they were instructed to talk about assessment in both tabs. "It is an activity

and evidence." The group seemed comfortable in doing this and effective in working thorough the problem solution collaboratively. Ideas are shared, proposals revised in response to comments, and supportive comments are made. For example Caitlin states, "Monica you did a great, thorough job here. That was a great example of assessment!!!"

The concept of assessment seemed to be well defined and correctly applied. The group offered research evidence to support their ideas, rationales for using assessments, and applied their assessment strategy in a contextualized manner fit for the problem at hand. They recognized the benefit of using multiple types of assessments that help student learning and inform teacher performance. Initial ideas are built onto as they solve each problem – not just recycling assessments that have been identified in prior problems, but problem solving to decide what is best for each problem solution. Once the group developed a shared meaning of assessment (grounding), they focus on clarifying the proposed instructional activities and assessments that integrated the concepts into the context of the case. The interactional dialogue is supportive and open to a diversity of ideas. No one member of the group seems to dominate although a couple of students do take on the responsibility to initiate and then coordinate the input into a final solution. These group members do not muscle out other ideas to promote their own, but gather and synthesize ideas from peers. There is an iterative process where revisions incorporate ideas from the group as members come back around to review, comment and revise.

Collaborative group work involves working on a planned task and includes positive interdependence, social support, and a shared negotiation and evaluation of the group product. At this level of interaction is it possible to find instances of knowledge building within the group – idea diversity, improving ideas, and shared responsibility for

contributing and refining the problem solution. These processes, situated in the group, reflect the epistemological view of *knowledge-creation* that emphasizes collective responsibility for the development of knowledge and creation of new knowledge (knowledge building) (Bereiter & Scardamalia, 2006). This group also took on epistemic agency – responsibility for their own learning with less dependence on the authority of the facilitator/instructor than has been seen in other groups.

**Scaffolding.**

All of the six groups, during the course of the four video cases, presented the idea of scaffolding as an instructional strategy. (See Table 12.)

Table 13. Number of posts by students about the concept of scaffolding across video cases

| Video Case | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Group 1 | | 1 | 1 | 3 |
| Group 2 | 3 | 2 | | 2 |
| Group 3 | | 2 | | 2 |
| Group 4 | 1 | 7 | 2 | 1 |
| Group 5 | | 5 | | 5 |
| Group 6 | 2 | 1 | 2 | 4 |

The majority of posts about scaffolding came in response to the second and fourth video cases. The second case, Learning by Design, focused on small collaborative groups working together with the assistance of the classroom teacher. Related learning concepts

linked to cognitive apprenticeship, collaborative learning, and social knowledge construction that use scaffolding as a strategy for the teaching and learning process. Interestingly, however, the fourth problem was about a beginning foreign language class and the concept links were more about concepts such as attention, memory, and declarative knowledge (not about cognitive apprenticeship), but did link to social knowledge construction. How did this concept get used in groups with different interactional patterns?

***Group 1 and Group 5.***

Group 1 and 5 used parallel patterns of interaction. The concept of scaffolding is not well developed or distributed among group members. In Group 1:

> Rose: (Problem 2) The teacher will employ certain strategies to accomplish these objectives such as allowing the students to work as a team in a collaborative effort, through authentic instruction which will help the students work gain value outside the classroom by helping them to construct knowledge in a meaningful way(knowledge web), scaffolding in which the teacher slowly gives the students less guidance and to allow them to do most of the work on their own…

This is the only reference this student made about scaffolding across all the problems and did not define the term or apply it correctly.

> Nadia: posts these three references to scaffolding
>
> Problem 3: Another very important instructional activity that should be used to enhance Mr. Blair's teaching efficacy is reciprocal teaching in which "the teacher models the four comprehension strategies (clarifying meanings...asking questions, summarizing, predicting)...", uses scaffolding and fading as students develop their understandings in the activity (knowledge web).
> Problem 4: Madame must use the four learning strategies of reciprocal teaching (clarifying, questioning, summarizing, and predicting) in order to use her own French as a model of fluency and correct grammar/vocabulary. She will use scaffolding to support their learning as they process information…
> Problem 4: Madame creates real world situations in the classroom that must be dealt with only in French. Her technique of immersing the students in the French language supports her efforts in reciprocal teaching and will help her (and

> indirectly help her students) use scaffolding and fading as the students develop. This aids the students in developing their schemas as they are using their cognitive abilities to take in new information…

Note the similarities between all the posts. She correctly linked scaffolding to reciprocal teaching, but there was no development of the concept and only the vaguest of applications. One other student in the group used the concept of scaffolding. In Problem 4, Kim linked scaffolding to reciprocal teaching as a technique that the teacher can employ; "scaffolding and fading supports as the learner accomplishes early tasks". The concept and the application are not "improved" over time.

Group 5 is the other group that had a low level of interactivity. This group had the most posts about scaffolding of any group; having five postings each in Problems 2 and 4 (eight proposals and 2 comments). Nine of the ten posts were by two different group members. The first proposal was by Lois who does not initially define scaffolding but included it as a tool in teaching. Lois proposed, "self-directed learning recognizes the role of motivation and volition. Teachers are scaffolding learning by making learning VISIBLE rather than boring". Lois referenced research that supports making science "visible" to students. This post also recognized that scaffolding does not just have to be verbal, but can be found in instructional tools as well. Juan commented and stated, "Lois, you point out some interesting information about scaffolding". Tina posted her own proposal and defined scaffolding and stated, "scaffolds may be provided by teachers or tools, procedural scaffolds, conceptual scaffolds, metacognitive scaffolds. All three are revealed by Mrs. Baker, as shown in the video". Juan proposed that due to the abstractness of physics more scaffolding may be required (and he provides references to support this statement) and that simplified tasks or classroom dialogue can be used to

scaffold students' initial attempts at learning. In Problem 4 Lois posted a lengthy proposal that included how the teacher provides scaffolding support, as well as peers in a collaborative problem solving dialogue. Juan then posted another proposal about students engaging in a community of learners and scaffolding one another by modeling and working in groups and that the teacher needs to scaffold according to the individual needs of the student.

In this example Lois and Juan work and extend the use of scaffolding. In Problem 1, Juan reinforced the use of the concept by Lois and then the two of them did all but one of the postings/comments. This "dialogue", other than a direct comment in the beginning, is not clearly linked after that. However, these two students may have informally accepted responsibility for including this concept – finding it, using it, researching about it. There is not a link with a method of teaching or theoretical perspective, however, it is a teaching strategy that can be used effectively (Lois summarizes a research study that supports the effectiveness of scaffolding) and, unlike other groups, notes that scaffolds can be something other than just discourse.

In this pattern group members seem to work in a disconnected way. There is lack of elaboration or evidence of distribution across the group about this concept.

***Group 2, 3, 6.***

Groups 2, 3, and 6 have an interactive style characterize by cooperation. The concept of scaffolding, in this interaction pattern, is integrated into a solution when a member takes responsibility for the concept *and* it becomes integrated into the broader solution within the group.

Posts about scaffolding in Group 2 are concentrated in Problem 1 under the tab labeled “Instructional Activities”. Geri started by indicating in a proposal that Brandon was able to transfer his understanding of one math problem to another because of the scaffolding activities of the interviewer. Lynn commented and offered to look up the idea of “teacher scaffolding promotes learning”. Geri revised her proposal that clarified the information about scaffolding. This was followed by a comment by Rena indicating, “through scaffolding, the researcher was able to bring about the connection between the two problems which might not have been noticed”. Three of five group members interact around the one (and only) proposal under this tab. The interaction seemed to reinforce the concept, and led to research and clarification about how to apply it in this problem. However, it is worth noting the scaffolding by the interviewer did not help Brandon solve the problem (he had solved the problem), but the interviewer helped him recognize the connection with a previous problem. In Problem 2 an additional group member included scaffolding in a list of items to be researched as it applied to the problem and Lynn, who in the prior problem offered to look up “teacher scaffolding”, provided a quoted reference to support the use of scaffolding as a strategy in the teaching and learning process. In Problem 4 Geri, the member who first introduced scaffolding, noted research that demonstrated interaction between non-native speakers and native speakers “promoted scaffolding by which the native speakers assisted the non-native speakers in composing ideas and grammatical functions”.

Other than the initial interaction around this concept, it did not seem to get much traction in the subsequent problems. It was unclear if the group had a clear understanding or definition of scaffolding. The postings around the first problem seemed to link

scaffolding with the interactions (primarily questions) between Brandon and the researcher. The subsequent posts list scaffolding as an instruction strategy, but do not link it with a theoretical perspective, a teaching method (i.e. reciprocal teaching) or the concept of fading. The observations and comments about scaffolding in Problem 1are not developed further in later problems. Scaffolding is recognized as a strategy to be used, primarily by the teacher, but how it is used and the psychological rationales are not developed in this group. I do think it is an example of a member, in this case Lynn, taking some responsibility to move the concept into the problem and getting it included across three of the cases and by four of the five group members.

In Group 3 there were a total of four posts by three different group members across all the video cases. The posts were all proposals and in one instance, scaffolding is simply one of several listed types of instructional strategies. The first post by Ina in Problem 2 did include the definition from the KW and linked scaffolding to Vygotsky and the zone of proximal development (which is also defined). This same student later, in Problem 4, proposed that, "skilled partners provide help (scaffolding) and slowly remove the help (fading) when a student demonstrates knowledge in the area of study". Ina seemed to demonstrate her understanding of scaffolding by incorporating all of the important elements of scaffolding; a definition, a link to an educational theorist, presenting it as a teaching strategy that a skilled partner would use and the link with fading as the student gains understanding. In Problem 4 Dennis commented, "having someone skilled in the language to help push the students would help them build an enduring understanding and is also a good example of scaffolding". This is in response to a proposal that native speakers can help non-native speakers with learning a foreign

language – the proposal did not use the word scaffold, however it did describe the teaching strategy. Group knowledge of the concept of scaffolding cannot be determined by the postings. This may be an example of cooperation where one group member contributes this strategy, scaffolding, to the whole group. There is little interaction around this concept and only one group member develops and integrates it into a specific problem solution. Other group members, seeing the concept included, do not see the need to say more. This strategy seemed to be the implicit use of a more knowledgeable peer.

In Group 6 posts about scaffolding are spread across all the problems. Three of the five group members talked about scaffolding (it is the two male members of the group that do not use it in a proposal or post). This group listed scaffolding as an instructional strategy. It is not defined or linked with a method of teaching or theoretical perspective. A typical post was "procedural facilitation involves modeling, scaffolding and taking turns which help students externalize mental events in a collaborative context" and a reference to support the idea was included. This was a comment by Ellie and was then incorporated into a revised proposal by another student – an indication of interaction and appropriation between two students. In a cooperative group, a group member that offered new, relevant information as a part of the solution would have that piece incorporated into the final solution. There was not a change to the initial information. It was incorporated; shared, not negotiated.

One item in a list of items that help students learn is how scaffolding was listed. In the last problem Ellie, who had previously provided the comments and research about scaffolding, is prompted by a peer's comment stating, "is your research about scaffolding a part of this proposal". Ellie then revised and provided more detail about scaffolding and

fading and how a teacher can guide students and see where and when a student needs assistance; “to see where she [teacher] needs to add more teaching or back off”. Ellie had added this into a revised proposal, “I added it [scaffolding] to the proposal. Does everyone think it fits?” Members did not respond to her question. This seemed to be an interaction between a few group members over the course of all the problems to insert scaffolding as an instructional strategy. Rather than just settling on one person, the concept was passed off from one to another. It was Anna, Anna, Emily, Emily, Ellie, Ellie, Anna, Ellie, Ellie. However, in the end, at least one group member had seen Ellie as the knowledgeable member about the concept of scaffolding and encouraged her to include what she knew in her proposal. In response to the comment, Ellie did revise the proposal.

In this group, the concept seemed to be distributed around the group and one member took some responsibility to integrate the concept of scaffolding into problem solutions. However, it was underdeveloped as a concept in Group 6.

***Group 4.***

This group demonstrated evidence of collaborative interaction by the number of comments and proposal revisions and has nine references to scaffolding with four proposals and five comments that span all four video cases. All six of the members of the group post either a comment or proposal about scaffolding. For example the first post about scaffolding is by Rachel who posted a comment in Problem 1:

> …in a different vein of sociocultural theory, is the concept of "exculturation" where you learn with peers who have a higher ability level, and a note I had that says "the place to teach a student is just beyond where he currently is" -- that is, the idea that a student can be pushed a little bit further if they are able to do something independently, but with a little

> bit of supportive help. I just realized that this would be an example of scaffolding.

The majority of the postings about scaffolding came in the second problem. This problem had focused on learning concepts like cognitive apprenticeship, with links to reciprocal teaching and scaffolding. Group 4 seemed effective in focusing on those targeted concepts and integrating them into the problem solution. (A goal for student learning in the course.) In Problem 2 Rachel started with proposing that cognitive apprenticeship be an instructional objective and defined scaffolding and fading as a part the strategy. Monica commented, "Rachel -good research – I didn't know about the fading concept. These are associated with Vygotsky and the ZPD". Two more students supported the use of scaffolding as a way to help students learn and suggested that scaffolding can help students achieve more sophisticated ways to think and be a part of formative assessment in the structure of feedback to students. In this interaction, four of the six members of the group participate and three of the five postings are comments. There was a willingness to admit something that was not previously known, to provide supportive comments to a peer and comments that added to what has been proposed. The comments did not just add a piece of information, the comments help to evaluate and think through what the group wanted to do. In this example it is not just a sharing of information, there is a clear dialogue about negotiation ("I didn't know about…) and creating something new between the group members. In the paradigm of knowledge building – democratizing knowledge (all individuals are invited to contribute to the knowledge advancement); epistemic agency (students themselves find their way in order to advance); community knowledge and collective responsibility (students contribute to improve their collective knowledge).

There are three additional posts in the next two problems. The posts focus on the use of scaffolding as an instructional tool and Amber made the connection that scaffolding can also be used as evidence of student understanding; "the amount of scaffolding necessary to get students thinking on their own can be an indication of what they do and don't know. Scaffolding can promote transfer and the amount of scaffolding can be a means of evaluating enduring understanding". This seems like a nuanced application of the concept. It is contextualized, appropriately applied and explained. It connected scaffolding to learning outcomes (transfer, enduring understanding). Amber had four of the last five posts about scaffolding and this may be an instance where the group had incorporated the concept and Amber went on to take responsibility to include it in the problem solution. However, getting to this point was not her sole responsibility. The concept was refined and the group created a shared understanding of scaffolding.

In summary, development of the concept of scaffolding seemed to be effected by the level of interactivity within the group. The groups where members participated by including scaffolding as an instructional strategy, but did not have interaction around the concept showed a pattern where the concept was not well developed and knowledge about the concept was not distributed around the group (lack of evidence in postings). In the parallel interactions, some of the information is poorly formed and vague, in cooperative groups, an individual or two may include important aspects of the concept, but development and integration is still at the level of sharing. In the collaborative group, the interaction results in a shared negotiation of the concept and a deeper level of distribution and integration across the group.

**Summary**

The findings described ways in which groups interacted and how educational psychology concepts were integrated into problems solutions. The discourse showed evidence of individual learning, social construction of learning, and collaborative knowledge building within a group. Groups that demonstrated a more interactive style of interaction and worked to negotiate a shared understanding of the problem solution were able to develop a more sophisticated understanding of educational psychology concepts.

# Chapter 5 Discussion

In this section, I discuss the research question and consider how the main findings for each question relate to the broader literature. The overarching research question was: What characteristics of an online problem solving discourse can be described and what do those characteristics suggest about interaction and student learning over time?

## Patterns of Participation and Interactivity

The course in educational psychology used a blended instructional structure that included in class, face to face work, as well as engaging in four online PBL cases. Approximately half of the course grade was based on the online work. The students were instructed to post 2-3 entries for each video and respond (comment) to at least two other notes in the discussion. Students varied considerably in their response to the PBL structure and course requirements.

There were instances of non-participation. For example, in Group 3: Problem 1 when Julie and Ernest did not participate in the online problem solving at all. There were others whose participation was sporadic; such as Byran in Group 6 who started off posting proposals in the first three problems, only to back off to only three comments in the fourth problem. Other group members provided a steady stream of postings; such as Juan in Group 5 or Monica in Group 4.

Participation did not guarantee interactivity and interactivity did not necessarily mean high levels of participation. In the groups where parallel patterns of participation were occurring a member could be posting frequently or not at all, but the characteristic was that the posting was individualistic and not interactive (with the exception of

interaction with the facilitator). Juan, for example, was an individual who posted frequently and in great length; however he seldom commented on others or made revisions based on comments, and was often in a back-and-forth pattern of communication with the facilitator. There were other individuals who combined participation with interactivity. Monica, in Group 4, consistently posted proposals and comments and helped the group organize, negotiate, and revise proposals as a part of a problem solution. This was accomplished with more limited support from the facilitator.

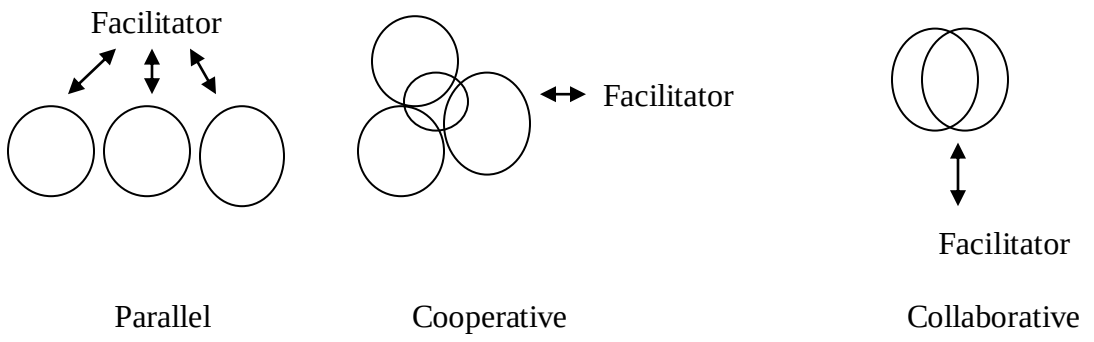



Figure 14. Representation of three patterns of interaction.

In Figure 14, the parallel pattern is represented by students working individually with some interaction with the facilitator. The facilitator is “above” and positioned as the authority within the group. In cooperative interaction patterns, students are working on a piece of the solution and then putting it together for the center “solution”. There is more agency within the group and a focus on task-oriented processes. In this case the facilitator was able to step to the side to support/scaffold the work of the group. In the collaborative pattern, the group shared and jointly negotiated the problem solution. The facilitator was there to provide some additional perspective, but only after others had

commented. In each example of participation information was shared – by the individual for an individual solution (parallel), by an individual to be used as part of a solution (cooperative), or shared *and* manipulated *and* revised among the group to create a group solution (collaborative). Participation did not necessarily result in interactivity or in collaboration.

This is consistent with Suthers et al. (2007) findings that information sharing is not enough and does not sufficiently explain when collaborative convergences do happen in a group. Suthers et al. (2007) found that higher performing dyads actually shared less information, but showed more interactivity.

Several groups, when examining types of statements made, appeared to be interacting. However, in closer examination some statements that might intuitively suggest interaction, such as statements of agreement, were more cheering on other group members who were doing the work. Metacognitive statements suggest that the members were thinking about the work they were doing. In Group 1, working in parallel, there were a lot of metacognitve statements, but half were from the same individual. In Group 6 the metacognitive statements were oriented to the task (cooperative work) and not necessarily the content of the task. In Group 4 the metacognitive statements reflected summarizing the agreement among the group and application of new knowledge. Barron (2000) writes that during small group problem solving, in order for convergence to occur, "students must organize themselves to engage in coordinated activity. Coordination is fundamental for the establishment of what has been called mutual knowledge or common ground" (p. 404). This coordination, although supported by the online environment, did not occur in all the groups. The lower levels of participation,

such as information sharing, did not require coordination as each person in the group completed the task individually. Some coordination was required for cooperation to occur in the group. More sophisticated coordination (negotiation) could be seen in the dialogue of collaborative groups and problem solutions that showed a distributed level of knowledge.

What is the influence of interaction and participation on the dynamics in the groups? Figure 15 shows the relationship between interactivity and participation and some characteristics of the interrelationship that began to emerge. For example, low interactivity and low participation result in asymmetrical participation and a lack of group process (for the task or interpersonally). In contrast, high participation and high interactivity result in a group dynamic that resemble knowledge building discourse.

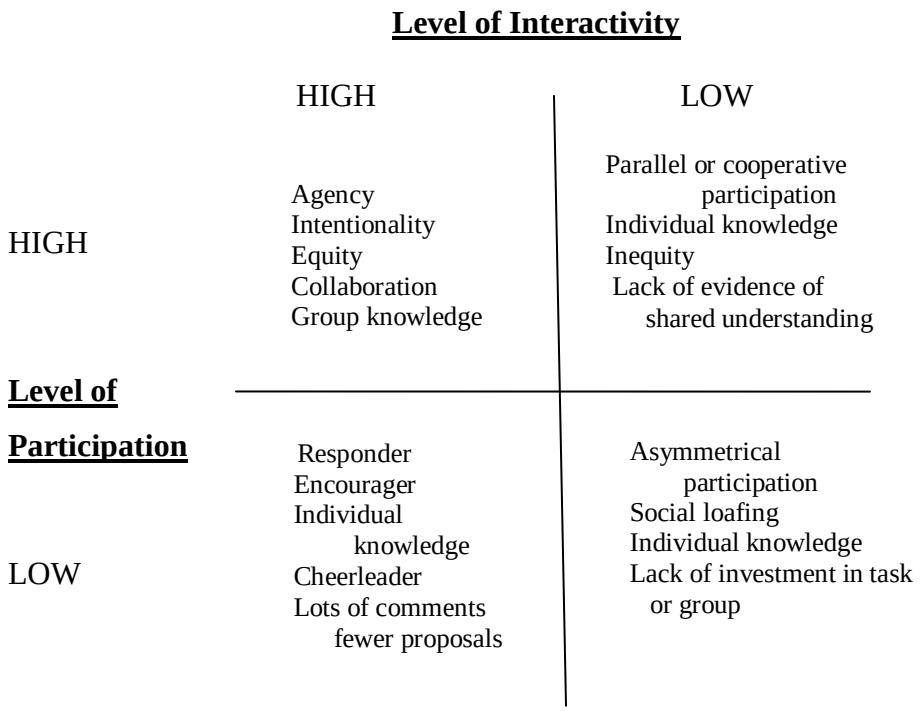



Figure 15. The relationship of participation and interactivity

As Suthers & Medina (2011) suggest, sharing information is not enough. Even with a high level of participation (often in the form of information sharing) if interactivity is low the result is individualistic learning and not collaboration. Additionally, a member can be interactive, but not necessarily contributing content information that would move ideas and the group forward.

Principles of knowledge building (Bereiter & Scardamalia, 2006) have also been used to both guide and study group collaboration online (Law & Wong, 2003; Zhang et al., 2007; Zhang, et al., 2009). The 12 principles of knowledge building include: real ideas and authentic problems, improvable ideas, idea diversity, rise above (creating higher level concepts), epistemic agency, community knowledge / collective responsibility, democratizing knowledge (all are invited to contribute), symmetric knowledge advancement (reciprocal advancement between person/organization), pervasive knowledge building, constructive use of authoritative sources, knowledge building discourse, and concurrent, embedded and transformative assessment. The combination of these principles set knowledge building instruction apart from other approaches to collaborative learning (Scardamalia, 2002). In examining the collaborative pattern of participation and interaction in Group 4, these elements seemed to be present (see Table 13). This level of interactivity - both in quality and quantity can be difficult to achieve in this type of learning environment (van Aalst, 2006). PBL incorporates many aspects of the knowledge building principles and attempts to create a culture that is authentic and empowering to students as they solve complex problems. Assessment of PBL practices indicated that students went beyond understanding of concepts to understand principles that link concepts and procedural application (Gijbels et al., 2005).

Table 14. Knowledge building in Group 4

| (KB) principles | Online problem-based learning (PBL) |
|---|---|
| Real ideas | Initial problems were formulated by the instructor Problems were authentic, open ended, and real world representations of domain practices. |
| Improvable ideas | Ideas were refined/improved in an incremental manner. The interaction was iterative in nature and culminated in a final product that addressed the question. |
| Idea diversity | Students participated in a nonthreatening, non-judgmental environment where ideas were treated as something to be explored; not as right or wrong |
| Rise above | Concepts are appropriated beyond what was initially known. |
| Epistemic agency | Students identify what they need to know |
| Community knowledge Collective responsibility | Students were assigned to groups that remained the same over the course of the semester. They worked together and took joint responsibility for solutions. |
| Democratic knowledge | There was equity in the distribution of participation and interaction within the group. |
| Symmetric knowledge advancement | Distributed knowledge through the problem-solving process was valued. |
| Pervasive KB | The processes of problem-solving were valued for use in the classroom. |
| Constructive use of resources | Referencing and use of sources from the KW were frequent. They made constructive use of knowledgeable peers and the facilitators. |
| KB discourse | Knowledge advancement was contextualized to the problem and the community as defined as the group. Reflection and metacognitive practices were used. |
| Concurrent, embedded transformative assessment. | Students were asked to assess their work and others. Assessment was on-going as ideas or problem-solutions were refined toward a final solution. |

Creating online spaces where small groups collaborate is complex. Suthers (2006) described collaborative interaction as intersubjective meaning-making. The author suggested that meaningful collaboration happens not just in the sharing of information, but when a member "takes up" something that was shared by another group member and forms a related expression which is then accessed by the original member (what Suthers call a "round trip"). His research suggests that it is in this unit (the uptake and round trip) that student learning can be examined. This approach suggests that students need to be active agents and when these processes are examined, learning can be understood. As described by Bereiter & Scardamalia (1987), "intentional cognition may be briefly defined as the setting and deliberate pursuit of cognitive goals – goals of learning, solving, understanding, etc., both in school and outside" (p. 361). Students must be motivated, engaged, and interactive in an effortful and intentional way for productive collaboration to take place. In the online environment examined in this study students were engaged at various levels. Recommendations for improving interaction may include helping students to recognize interaction (as well as participation) as an important activity.

**Student Learning**

Students learned about educational psychology in this undergraduate course. (Derry et al., 2006; Hmelo-Silver et al., 2009). The earlier work on a similar data set demonstrated this through the use of open-ended pre-post data. In this study, I demonstrated how understanding of concepts developed through discourse. Examination of the collaborative problem-solving process revealed examples of discourse that showed examples of individual learning, social construction of knowledge, and the collaborative

knowledge building of a group. Learning was achieved by students working through a problem within a small group and with the assistance of a facilitator (Barron et al., 1998; Hmelo-Silver & Barrows, 2006).

However, facilitation can also be disruptive. In several groups, when the facilitator was the first one to comment on a proposal it set the stage for an interaction between the student and facilitator and seemed to strengthen the authoritative stance of the facilitator. Zhang, Lundegberg, & Eberhardt (2011) found that some forms of questioning (open-ended and not built on participants' ideas) and revoicing (responding too quickly after the participant) by the facilitator disrupted the flow of ideas and interactivity.

**PBL Environment**

Several authors have outlined features in an online environment that are needed to create a place for collaboration to occur. PBL, by definition, includes the use of real-world, ill-structured problems that have multiple possible solutions. The problem-solving work is student centered with guidance from a facilitator (Hmelo-Silver, 2012). Bridges et al. (2012) has studied blended environments like the case represented here where both face to face and online work is combined to promote student learning. Guzdial & Turns (2000) suggest what features should be in an online environment to support discussion (discussion management, facilitation, and anchoring features). Each of the features was present in this online environment. The online platform included clear ways to participate and follow discussion online (discussion management features). It was clear to the students where and what kind of posting could be done online. There were also links to hypertexts, resources, and the KW that were just a click away as well as input

from the facilitator (facilitation features). The idea of an "anchoring feature" is central to the PBL model. Each case was "anchored" in the case, with a video and narrative to focus the group, as well as specific tasks to accomplish or questions to answer. Additionally, Paulus (2005) found that when the online task was structured to afford more opportunities for synthesis students engaged in more collaborative dialogue – an affordance that was also available in the online and classroom environment. There is not yet evidence that supports the hypothesis that PBL helps students become better collaborators. There is evidence that students do work together to provide collaborative explanations. There is also evidence that demonstrates that the collaboration in groups is a key factor in student learning and motivation but that not all groups collaborate well (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2008).

In a survey of students participating in online discussion, Wang (2007) found that sustained discussion was supported by small, cohesive groups, structure of the online discussion, enforced deadlines for the work, and direct links between the activity and assessment of learning. In each of these cases it seems that the PBL environment in this case meets the criteria that are needed to help promote collaboration and sustain engagement. However, even with all of the necessary computer mediated tools and knowledgeable facilitation collaboration was not common.

Limitations of PBL environments have been identified. Students who benefit the most from this model instruction tend to have prior knowledge that they can bring to the problem-solving process, are motivated with high levels of self-regulation and have good social skills (Ertmer & Dillion, 1998; Ertmer, Newby, & MacDougal, 1999). Teachers require training to implement PBL in order to apply the instructional method effectively

(Blumenfeld et al., 1991; Hmelo-Silver, Nagarajan, & Day, 2002) and effectively facilitate the process (Hmelo-Silver & Barrows, 2006). Additionally, design issues include: creating a safe environment for ideas and the exchange of ideas (Stepich, Ertmer, & Lane, 2001), creation of problems that afford comprehension and scaffolding and avoid over-contextualization ( Hmelo-Silver & Azevedo, 2006), and afford the integration of prior knowledge and goal setting (Eversen, Salisbury-Glennon, & Glenn, 2001) and the development of dynamic assessments (Brandsford & Schwartz, 1999; Gijbels et al., 2005).

**Limitations**

Limitations include the highly contextualized nature of a case study description and the complexity of the phenomena. In this case study there was a variety of factors that must be considered as limitations.

First, this case encompassed a great deal of data. There were six groups engaged in four problem solving cases. This resulted in pages of student postings, comments, and facilitator comments. The focus of the research was on interaction and several educational psychology concepts. It is possible that looking at the data with other questions in mind could reveal different issues of interest and/or importance.

Second, this was a “blended” course involving both face to face and online interaction. The face to face interaction was not considered and could offer explanations for the findings that were outside the scope of this case study. All of the complexities of the course design and social interactions are not represented.

Third, there is no way to establish if this group of participants is representative of a larger community of preservice teachers or others who might engage in hybrid PBL.

Thus, the knowledge gained from the findings is context dependent. However, the complex and natural setting offers some insights into understanding online, small group work.

Fourth, the purpose of this qualitative study was not to generalize the findings to other populations or settings, but to describe the phenomenon being investigated. Cresswell (2007) suggested that there are lessons to be learned. It is the decision of the readers of this study to decide what is applicable to their practices. It may not be representative, however some findings may be considered by the reader to be transferable, or "ring true" to their work and find some application.

**Implications**

There are several implications for instructors who implement online and PBL learning to consider as a result of this study. First, designers of computer mediated environments for small group collaboration must consider that even when currently recognized features for engagement are present, getting students to collaborate continues to be a challenge. The structure in this online environment offered a space to post research and post their problem solutions. It seems that some of the group members jumped right to the solutions and a space to negotiate these solutions was not as available or used to promote an interactive discussion. The highly structured nature of the cases may have led students to more concrete thinking about solutions that mitigated the need for negotiation or constructive argumentation around the solution.

Instructors may need to be clearer about what they expect to see in student online dialogue and teach students more explicitly what type of interaction is expected. Students in this course were instructed to participate, and despite other instructions,

modeling from the professor, face to face support, and facilitation online many of these students missed opportunities to interact. A rubric that helps students understand levels of participation and interaction (i.e. from information sharing to negotiation) and set expectations may provide clearer guidelines. Suthers (2009) model of the up-take and the "round trip" might be instructive to students as instructors may ask student to make their thinking more visible online, providing more elaborated postings, acknowledgement of peers, and summarizing statements.

Motivation and student agency are important factors. Some students may be motivated by more direct requirements for interaction that are tied to class assessment (although this did not seem to be a factor for some students in this course). Additionally, the facilitator needs to think about how they encourage and scaffold students. Recent research suggests that jumping in too soon or questions that are too open ended (not contextualized to ideas that the student has started to develop) may be less productive. Facilitator need to be aware of the type/level of interaction or participation that the group is engaging in; helping less interactive groups to recognize the pattern of interaction and move toward more engagement. There are challenges associated with helping the student engage, be receptive to others, and then turn this into productive discourse. In order to "see" the thinking online students may need to be instructed on talking aloud strategies that are employed in face to face environments to employing these to their online dialogue. This level of participation and instruction about quality interactions, may help students (and those that teach the student) see more clearly how problem solutions are shared and distributed across the group.

**Summary**

There are diverse explanations of student learning in the PBL and online environment - levels of interactivity, facilitation, and the structure of the online environment. In the acquisition metaphor prior knowledge and the use of learning strategies (i.e. question asking, interactive argumentation) assist the learner in creating mental models, schemas, and conceptual knowledge change. Students in the parallel level of interaction may also be students that subscribe to an individualistic learning model – ascribing authority to the instructor and building their own knowledge. Constructivists situate learning in a domain and create opportunities for social participation (co-construction) to solve an authentic challenge or problem and to appropriate domain knowledge and reasoning skills. In this model the students may understand the social nature of knowledge construction, but continue to situate knowledge in the realm of the individual as in the cooperative groups. In the knowledge-creation metaphor individual learning is extended to collective responsibility for the learning and knowledge that is produced in the classroom or broader community. Learning was achieved through the active and creative practices of working with knowledge. Students in the collaborative group accepted full epistemic agency in all aspects of the learning process – from ideas generated, approaches to problem solving, task evaluation, and self-assessment.

# Chapter 6 Conclusion and Final Reflections

The findings of this research add to a growing body of knowledge about computer supported collaborative learning and PBL. These finding can help to support effective instructional designs and practices. This is particularly important because there is a growing use of online courses in higher education. It is estimated that 81% of all U.S. institutions of higher education offer online courses and it is estimated that 15% of all postsecondary students enrolled in online courses in 2002 (Hiltz & Golman, 2005). These numbers have increased and are projected to continue to increase. Research on online collaborative group problem solving is a relatively new area of study. Researchers in CSCL have indicated the need for research at this "meso" level of description (Jones, Dirkinck-Holmfeld, Lindström, 2006; Koschmann, 2001). "As we investigate the relationships among participants of networked learning, we come to a better understanding and deeper explanations of the collaborative processes that involve the individual students" (Hakkarainen, Lipponen, Järvelä, 2002). Bridges et al. (2012) has suggested that there is a need for further analysis of interactional data in PBL to support theory building around this "process approach to learning" (p. 100).

Merriam (1998) suggests, case study findings can suggest what to do and not to do, illustrate complexities of a situation, explain what worked and did not work, discuss alternatives, and evaluate, summarize and suggest potentials for applicability. Of particular interest is if PBL online discourse resembles knowledge-building discourse and the ramifications of those findings. In light of some of the recent research and writings about online work and collaboration (Bridges et al., 2012; Hmelo-Silver & Eberbach, 2012; Suthers & Medina, 2011) there is more work that needs to be done. Collaboration

and collaborative discourse represent both the means (in group activity) and the end (learned collaboration, participation in disciplinary discourse practices, and self-directed learning skills) in student learning. The relationship between interaction and participation and the use of tools and facilitation are complex phenomena that will need further study into the future.

**Final Reflections**

This process has helped me learn and grow both professionally and personally. As I was completing this dissertation, I went back and read some of my early memos to myself. These memos were my thoughts and feelings about the work that I was doing (and sometimes not doing). Early on in the process, as I was familiarizing myself with the data, I had a real concern about the data. The chronological white board and the screen images from the student view were different. This is what I wrote in a memo to myself:

> Spent time with the data. The last time I was concerned that what was on the student view didn't match up with the chronology whitebrd history. Well, I figured it out today. The students hit save and it is posted (a proposal) so if they are writing something long they could save it several times and it gets posted each time . You can see the time stamp as being minutes apart. After talking to Cindy, we agreed that the last posting in a series like that would be the only one of interest and that would be analyzed. The data is not as confusing as I thought and, in fact is pretty straight forward. BUT, I wanted to make sure that the data was accurate and consistent across the different formats on the STELLAR platform. I am confident that the data I am analyzing is true to what the students posted.

Re-reading that entry and now looking at the finished dissertation I continue to feel confident that my findings are accurate to the voices of the student. This is an essential aspect of qualitative research – honor the voices of the participants. My Chair and support group helped me understand the data from multiple vantage points, remaining

true to the participants' dialogue yet representing many more aspects of this complex phenomenon.

My own voice was harder to find. It was up to me to look at the data and then be confident that my analysis was representational of what was happening in the groups. I had to be the "decider" – creating a narrative description of what I thought was happening in the dialogue. This was very difficult for me. I have occasionally thought about the fact that this data is from my dissertation chair. What if she does not like what I found? Although, this crossed my mind as a potential conflict or source of intimidation I do not think it was a factor. It was not a factor for several reasons: our frequent meetings, supportive assistance, and a real sense of freedom to let the data lead me to whatever might be found. Additionally, most of my professional life has been working with others and solving problems that I had the expertise to fix. Here I was essentially working for myself, by myself, on a problem that did not have a concrete "fix" and in an area where I did not have "expert" experience. I know these doubts about myself slowed me down even when I had the help of others. The final result is a sense of confidence about the work.

The findings were not particularly unexpected and, I think, similar to other finding in the literature about PBL and small group learning in an online setting. It is my hope that these findings will add further perspective to teaching and learning in an online PBL environment. The findings highlight the importance of participation *and* interactivity.

**References**

Barron, B. (2000). Achieving coordination in collaborative problem-solving groups. *Journal of the learning sciences, 9*(4), 403-436.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., Bransford, J. D., & The Cognition and Technology Group at Vanderbilt. (1998). Doing with understanding: Lessons from research on problem and project-based learning. *Journal of the Learning Sciences, 3/4*, 271-312.

Bereiter, C. & Scardamalia, M. (1987). *The psychology of written composition.* Hillsdale, NJ: Erlbaum.

Bereiter, C. & Scardamalia, M. (1989). Intentional learning as a goal of instruction. In L. Resnick (Ed.). *Knowing, learning, and instruction: Essays in honor of Robert Glaser.* (pp. 361-392). Hillside, NJ: Erlbaum.

Bereiter, C. & Scardamalia, M. (2006). Education for the knowledge age: Design-centered models of teaching and instruction. In P. Alexander & P. Winne (Eds.) *Handbook of educational psychology.* (p. 695-713). Hillsdale, NJ: Erlbaum.

Bogdan, R.C. & Biklen, S.K. (1998). *Qualitative research for education: An introduction to theory and methods* (3rd ed.). Boston: Allyn & Bacon.

Booth, S., & Hultén, M. (2003). Opening dimensions of variation: An empirical study of learning in a web-based discussion. *Instructional Science, 31,* 65-86.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palinscar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26* (3 &4), 369-155.

Bransford, J.D., Brown, A.L. & Cocking, R.R. (2000.) How people learn: Brain, Mind, Experience, and School. Washington, D.C.: National Academy Press.

Bransford, J.D, & Schwartz, D.L. (1999). Rethinking transfer: A simple proposal with multiple implications. In A. Iran-Nejad & P. D. Pearson (Eds.). *Review of Research in Education* (p. 61-100). Washington, DC: American Educational Research Association.

Bridges, S.M., Botelho, M.G., Green, J., & Chau, A.C. (2012). Mulitimodality in Problem-based Learning (PBL): an Interactional Ethnography. In S.M. Bridges, C.P. McGrath, & T. Whitehill (Eds.). *Problem-based learning in clinical education: The next generation,* (pp.99-120). Netherlands: Springer.

Brooks, J.G. & Brooks, M.G. (1993). *In search of understanding: The case for constructivist classrooms.* Alexandria, VA: Association for Supervision and Curriculum Development.

Campos, M. (2004). A constructionist method for the analysis of networked cognitive communication and the assessment of collaborative learning and knowledge-building. *Journal of Asynchronous Learning Network, 8*(2),

Chan, C.K.K., Lam, I., & van Aalst, J. (2003, April). Social-constructivist assessment, knowledge building discourse, and conceptual understanding. Paper presented at the meeting of the American Educational Research Association, Chicago, IL.

Chernobilsky, E., DaCosta, M.C., & Hmelo-Silver, C. (2004). Learning to talk the educational psychology talk through a problem-based course. *Instructional Science, 32,* 319-356.

Chinn, C., Anderson, R. & Waggoner, M. (2001). Patterns of discourse in two kinds of literature discussion. *Reading Research Quarterly, 36* (4), 378-411.

Chinn, C., O'Donnell, A., & Jinks, T. (2000). The structure of discourse in collaborative learning. *Journal of Experimental Education, 69* (1), 77-98.

Creswell, J. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W., & Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-130.

Derry, S. J. (2006). eSTEP as a Case of Theory-Based Web Course Design. In A. O'Donnell, C. Hmelo-Silver, & G. Erkens (Eds) *Collaborative learning, reasoning, and technology* (pp. 171-196). Mahwah, NJ: Erlbaum.

Dillenbourg, P. (1999). What do you mean by "collaborative learning"? In Dillenbourg (Ed.). (2004), *op cit.* (pp. 1-19).

Dillenbourg, P., & Traum, D. (2006). Sharing solutions: Persistence and grounding in multimodal collaborative problem solving. *Journal of the Learning Sciences, 15*(1), 121-151.

Dillenbourg, P., Traum, D., & Schneider, D. (1996). Grounding in multi-modal task-oriented collaboration. In P. Brna, A. Paiva & J. Self (Eds.), *Proceedings of the European Conference on AI in Education.* (pp. 401-407).

Donath, L., Spray, R., Thompson, N., Alford, E., Craig, C., & Matthews, M. (2005). Characterizing discourse among undergraduate researchers in an inquiry-based community of practice. *Journal of Engineering Education, 94*(4), 403-417.

Ely, M., Anzul, M., Friedman, T., Garner, D., & Steinmetz, A. M. (1991). *Doing qualitative research: Circles within circles.* New York: The Falmer Press.

Engle, R. & Conant, F. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction, 20 (*4), 399-483.

Ennis, R. (1987). A taxonomy of critical thinking dispositions and abilities. In J Baron & R. Sternberg (Eds.). *Teaching thinking skills: Theory and practice* (pp.9-26). New York: Freeman.

Ertmer, P. & Dillion, D. (1998). 'Shooting in the dark' versus 'breaking it down': Understanding students' approaches to case-based instruction. *International Journal of Qualitative Studies in Education, 11* (4), 605-613.

Ertmer, P., Newby, T. & MacDougall, M. (1996). Students' responses and approaches to case-based instruction: The role of reflective self-regulation. *American Educational Research Journal, 33* (3), 719-752.

Eversen, D.H., Salisbury-Glennon, J.D., & Glenn, J. (2001). A qualitative study of six medical students in a problem-based curriculum: Toward a situated model of self-regulation. *Journal of Educational Psychology, 93*(4), 659-676.

Fjermestad, J., & Hiltz, S. R. (1999). An assessment of group support systems experimental research: Methodology and results. *Journal of Management Information Systems, 15* (3), 7-149.

Flavell, J. H. (1992). Metacognition and Cognitive Monitoring: A new area of cognitive-developmental inquiry, in Nelson,T. O. (Ed.). *Metacognition. Core readings,* Boston: Allyn and Bacon, pp. 3-8.

Gerbic, P., & Stacey, E. (2005). A purposive approach to content analysis: Designing analytical frameworks. *Internet and Higher Education, 8,* 45-59.

Gijbels, D., Dochy, F., Van den Bossche, P. & Segers, M. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research, 75* (1), 27-61.

Graesser, A. Baggett, W. & Williams, K. (1996). Question-driven explanatory reasoning. *Applied Cognitive Psychology,* 10, 17-31.

Graesser, A.C. & Person, N.K. (1994). Question asking during tutoring. *American Educational Research Journal,* 31, 1, 104-137.

Graesser, A., Person, N., & Magliano, J. (1995). Collaborative dialogue patterns in naturalistic one-to-one tutoring. *Applied Cognitive Psychology, 9,* 495-522.

Greeno, J. G., Collins, A. M., and Resnick, L. B. (1996). Cognition and learning. In D. C. Berliner and R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 15-46). New York: Macmillan.

Gruber, S. & Boreen, J. (2003). Teaching critical thinking: using experience to promote learning in middle school and college students. *Teachers and Teaching: Theory and Practice, 9* (1), 5-19.

Gunawardena, C., Lowe, C., & Anderson, T. (1998). Transcript analysis of computer-mediated conferences as a tool for testing constructivist and social-constructivist learning theories. In *Distance Learning '98: Proceedings of the annual Conference on Distance Teaching and Learning* (14th, Madison, WI, August 5-7, 1998).

Guzdial, M. & Turns, J. (2000). Effective discussion through a computer-mediated anchored forum. *Journal of the Learning Sciences, 9*(4), 437-469.

Hatano, G. & Inagaki, K. (1991). Sharing cognition through collective comprehension activity. In L.B. Resnick, J.M. Levine, & S.D. Teasley (Eds.), Perspectives on socially shared cognition. (pp. 331-348). Washington, DC: American Psychological Association.

Hakkarainen, K., Lipponen, L., & Järvelä, S. (2002). Epistemology of inquiry and computer-supported collaborative learning. In R. Hall, N. Miyake (Eds.). *CSCL 2: Carrying forward the conversation* (pp. 129-154). Mahwah, NJ: Erlbaum.

Herrenkohl. L.R. & Guerra, M.R. (1998). Participant structures, scientific discourse, and student engagement in fourth grade. *Cognition and Instruction*. 16, 431-473.

Hiltz, R. & Goldman, R. (2005). *Learning together online: Research on asynchronous learning networks.* Mahwah, NJ: Erlbaum.

Hiltz, R., Kim, E., & Shea, P. (2007). Faculty motivators and de-motivators for teaching online: results of focus group interviews at one university. *Proceeding of the 40th Hawaii International Conference on System Sciences.* Retrieved online at: http://web.njit.edu/~hiltz on October 18, 2007.

Hmelo-Silver, C. E. (2003). Analyzing collaborative knowledge construction: Multiple methods for integrated understanding. *Computers & Education.41, 397-420.*

Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and how do students learn? *Educational Psychology Review.16,* 235-246.

Hmelo-Silver, C., & Azevedo, R. (2006). Understanding complex systems: Some core challenges. *Journal of the Learning Sciences,* 15, 53-61.

Hmelo-Silver, C. & Barrows, H. (2006). Goals and strategies of a problem-based learning facilitator. *Interdisciplinary Journal of Problem-based Learning, 1* (1), 21-39.

Hmelo-Silver, C. & Barrows, H. (2008). Facilitating collaborative knowledge building. *Cognition and Instruction, 26*, 48-94.

Hmelo-Silver, C. E.; Derry, S., Bitterman, A., & Hatrak, N. (2009). Targeting Transfer in a STELLAR PBL Course for Pre-Service Teachers. *Interdisciplinary Journal of Problem-based Learning*: *3*, 2, 24-42

Hmelo-Silver. C., & Eberbach, C (2012). Learning theories and problem-based learning. In S.M. Bridges, C.P. McGrath, & T. Whitehill (Eds.). *Problem-based learning in clinical education: The next generation,* (pp.3-12). Netherlands: Springer.

Hmelo-Silver, C. & Lin, X. (2000). Becoming self-directed learners: Strategy development in problem-based learning. In D. Evensen & C.E. Hmelo (Eds.). *Problem-based learning: research perspectives on learning interactions (*pp. 227-250). Mahwah, NJ Erlbaum.

Hmelo-Silver, C.E., Nagarajan, A., & Day, R.S. (2002). "It's harder than we thought it would be": A comparative case study of expert-novice experimentation strategies. *Science Education, 86*, 219-243.

Hogan, K., Nastasi, B., Pressley, M. (2000). Discourse patterns and collaborative scientific reasoning in peer and teacher-guided discussions. *Cognition and Instruction, 17,* (4), 379-432.

Jones, C., Dirckinck-Holmfeld, L., & Lindström, B. (2006). A relational, indirect, meso-level approach to CSCL design in the next decade. *Computer Supported Collaborative Learning, 1*(1), 35-56.

Kali, Y. (2006). Collaborative knowledge building using the Design Principles Database. *Computer-Supported Collaborative Learning, 1*, 187-201.

Kienle, A. & Wessner, M. (2006). The CSCL community in its first decade: Development, continuity, connectivity. *Computer-Supported Collaborative Learning, 1,* 9-33.

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal questioning. *American Educational Research Journal, 27*(4), 664-487.

Kohler, F.W. & Greenwood, C.R. (1990). Effects of collateral peer supportive behaviors within the classwide peer tutoring program. *Journal of Applied Behavior Analysis,* 23, 307-322.

Koschmann, T. (2001). Revisiting the paradigms of instructional technology. In G. Kennedy, M. Keppell, C. McNaught, & T. Petrovic (Eds.). *Meeting at the crossroads. Proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education* (pp. 15-22). Melbourne: Biomedical Multimedia Unit, The University of Melbourne.

Kreijns, K., Krischner, P., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior, 19,* 335-353.

Lai, M. & Law, N. (2006). Peer scaffolding of knowledge building through collaborative groups with differential learning experiences. *Journal of Educational Computing Research,* 35(2), 123-144.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge, UK: Cambridge University Press.

Law, N. & Wong, E. (2003). Developmental trajectory in knowledge building: An investigation. In B. Wasson, S. Ludvigsen, & U. Hoppe (Eds.). *Designing for Change in Networked Learning Environments.* (pp. 1-6). Netherlands: Khuwer Academic Publishers.

Lee, E., Chan, C., & van Aalst, J. (2006). Students assessing their own collaborative knowledge building. *International Journal of Computer-Supported Collaborative Learning, 1,* 57-87.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry.* Thousand Oaks, CA: Sage.

Lowery, N. (2002). Construction of teacher knowledge in context: Preparing elementary teachers to teach mathematics and science. *School Science & Mathematics, 102* (2), 68-84.

Luppicini, R. (2007). Review of computer mediated communication research for education. *Instructional Science, 35,* 141-185.

Marshall, C. & Rossman, G.B. (2006). *Designing qualitative research* (4th ed.). Thousand Oaks, CA: Sage.

Maurino, P. (2006). Looking for critical thinking in online threaded discussions. *e-Journal of Instructional Science and Technology, 9*(2). Retrieved online at: http://www.usq.edu.au/electpub/e-jist/doc/vol9_no2/papers/full_papers/ maurino.htm on December 12, 2007.

Meier, A., Spada, H., & Rummel, N. (2007). A rating scheme for assessing the quality of computer-supported collaboration processes. *Computer-Supported Collaborative Learning, 2,* 63-86.

Merriam, S. B. (1998). *Qualitative Research and Case Study applications in Education.* San Francisco, CA: Wiley & Sons.

Miles, M.B., & Huberman, A.M. (1994). *Qualitative data analysis.* Thousand Oaks, CA: Sage.

Moss, J. & Beatty, R. (2006). Knowledge building in mathematics: Supporting collaborative learning in pattern problems. *Computer-Supported Collaborative Learning, 1,* 441-465.

O'Donnell, A. (2006). The role of peers and group learning. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology* (2nd ed., pp. 781-802). New York: MacMillan.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research, 74*(4), 557-576.

Palinscar, A.S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 45,* 345-375.

Panitz, T. (1999). Collaborative versus cooperative learning: A comparison of the two concepts which will help us understand the underlying nature of interactive learning., Retrieved from http://www.capecod.net/~TPanitz/Tedspage on Jan. 12, 2012.

Patton, M.A. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage

Paulus, T. (2005). Collaborative and cooperative approaches to online group work: The impact of task type. *Distance Education, 26* (1), 111-125.

Paulus, T., & Roberts, G. (2006). Learning through dialogue: Online case studies in educational psychology. *Journal of Technology and Teacher Education, 14*(4), 731-754.

Puntambekar, S. (2006). Analyzing collaborative interactions: Diversgence, shared understanding and construction of knowledge. *Computers & Education, 47,* 332-351.

Roschelle, J. (1996). Learning by collaborating: Convergent conceptual change. In *CSCL: Theory and practice of an emerging paradigm*. T. Koschmann (ed.). Mahwah, NJ: Erlbaum.

Salomon, G., & Perkins, D. (1988, September). Teaching for transfer. Educational Leadership, 22-32.

Scardamalia, M. (2002) Collective, cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.). *Liberal education in a knowledge society* (pp. 67-98). Chicago: Open Court.

Scardamalia, M. & Bereiter, C. (2003). Knowledge building. In *Encyclopedia of Education.* (2nd ed., pp. 1370-1373). New York: Macmillan Reference.

Siegel, M.A., Derry, S.J., Steinkuehler, C.A., Kim, J.B., Seymour, J. (2001, April). What and how preservice teachers learn: Designing a course that fosters development of useful theoretical knowledge and the assessment methods to capture it. Paper presented at the meeting of the American Educational Research Association, Seattle, WA.

Spradley, J. P. (1997). The ethnographic interview. New York: Holt, Rinehart & Winston.

Stahl, G. & Hesse, F. (2006). ijCSCL – a journal for research in CSCL. *Computer-Supported Collaborative Learning, 1,* 3-7.

Stake, R. (1995). *The art of case research*. Thousand Oaks, CA: Sage.

Steinkuehler, C. A., Derry, S. J., Woods, D. K., & Hmelo-Silver, C. E. (2002). The STEP environment for distributed problem-based learning on the world wide web. *Computer Support for Collaborative Learning* (CSCL '01). Mahwah, NJ: Erlbaum.

Stepich, D. A., Ertmer, P. A., & Lane, M. M. (2001). Problem-solving in a case-based course: Strategies for facilitating coached expertise. *Educational Technology Research and Development, 49*(3), 53-69.

Suthers, D. (2006). Technology affordances for intersubjective meaning-making: A research agenda for CSCL. *International Journal of Computer Supported Collaborative Learning, 1*(3), 315-337.

Suthers, D., Medina, R., Vatrapu, R., & Dwyer, N. (2007). Information sharing is incongruous with collaborative convergence: The case for interaction. In C. Chinn, G. Erkens, & S. Puntambekar (Eds.). *The Computer Supported Collaborative Learning (CSCL) Conference 2007.*( pp. 714-716). New Brunswick, NJ: International Society of the Learning Sciences.

Suthers, D. D., & Medina, R. (2011). Tracing interaction in distributed collaborative learning. In S. Puntambekar, G. Erkens & C. E. Hmelo-Silver (Eds.), *Analyzing Interactions in CSCL: Methods, Approaches and Issues* (pp. 341-366). New York: Springer

University of Wisconsin (1999). *eSTEP: The project*. Retrieved: December 12, 2007 from http://www.wcer.wisc.edu/estep/research.asp.

van Aalst, J. (2006). Rethinking the nature of online work in asynchronous learning networks. *British Journal of Educational Technology, 37*(2), 279-288.

van Zee, E. & Minstrell, J. (1997). Using questioning to guide student thinking. *Journal of Learning Sciences, 6,* 2, 227-269.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.). Cambridge, MA: Harvard University Press.

Walker, A., & Leary, H. (2009). A problem based learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinarey Journal of Problem-based Learning, 3*,(1), 12-43.

Wang, X. (2007). What factors promote sustained online discussions and collaborative learning in a web-based course? *International Journal of Web-Based Learning and Teaching Technologies, 2*(1), 17-38.

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks, CA: Sage.

Zhang, M., Lundeberg, M., Eberhardt, J. (2011). Strategic facilitation of problem-based discussion for teacher professional development, *Journal of the Learning Sciences, 20,* 342-394.

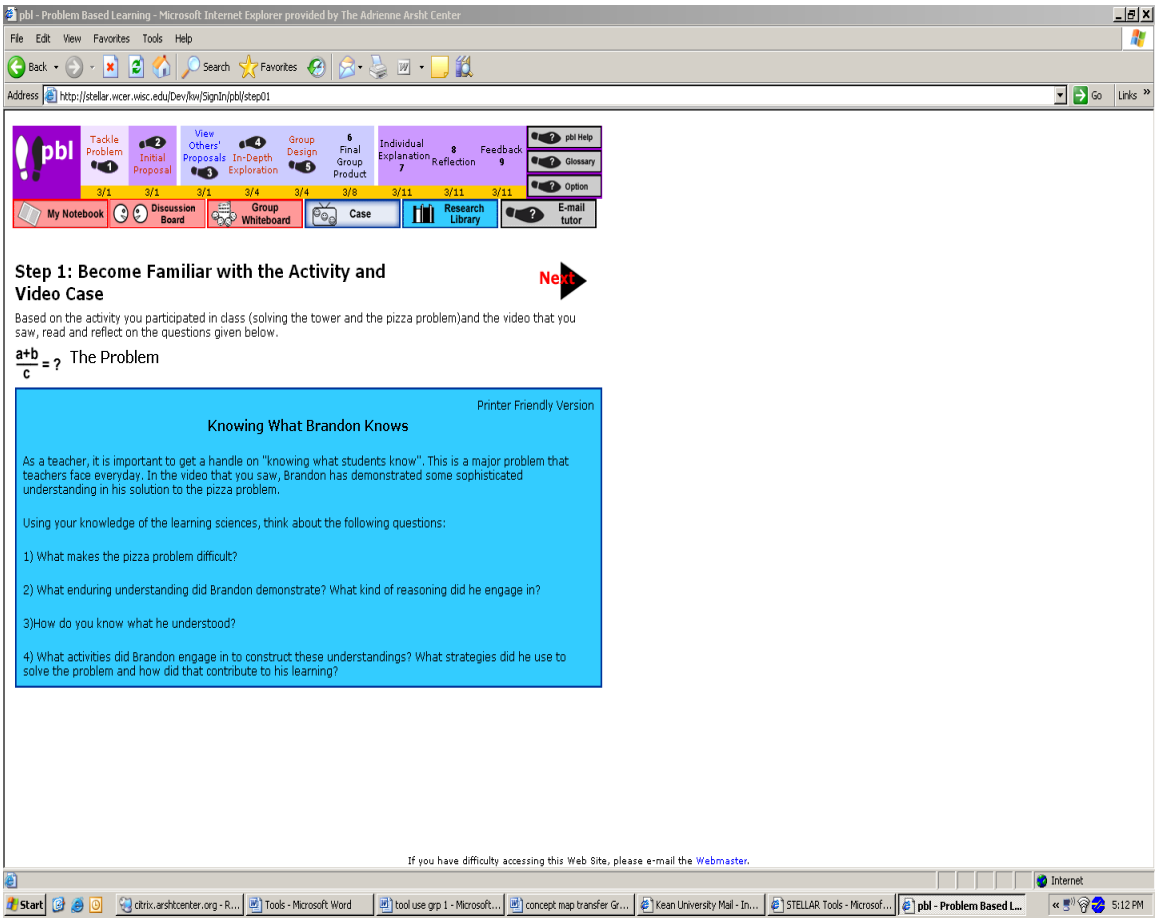
Zhang, J., Scardamalia, M., Lamon, M., Messina, R. & Reeve, R. (2007). Socio-cognitive dynamics of knowledge building in the work of 9- and 10- year-olds. *Educational Technology Research and Development, 55,* 117-145.

Zhang, J., Scardamalia, M., Reeve, R. & Messina, R. (2009) Designs for collective cognitive responsibility in knowledge building communities. *Journal of the Learning Sciences, 18* (1), 7-44.

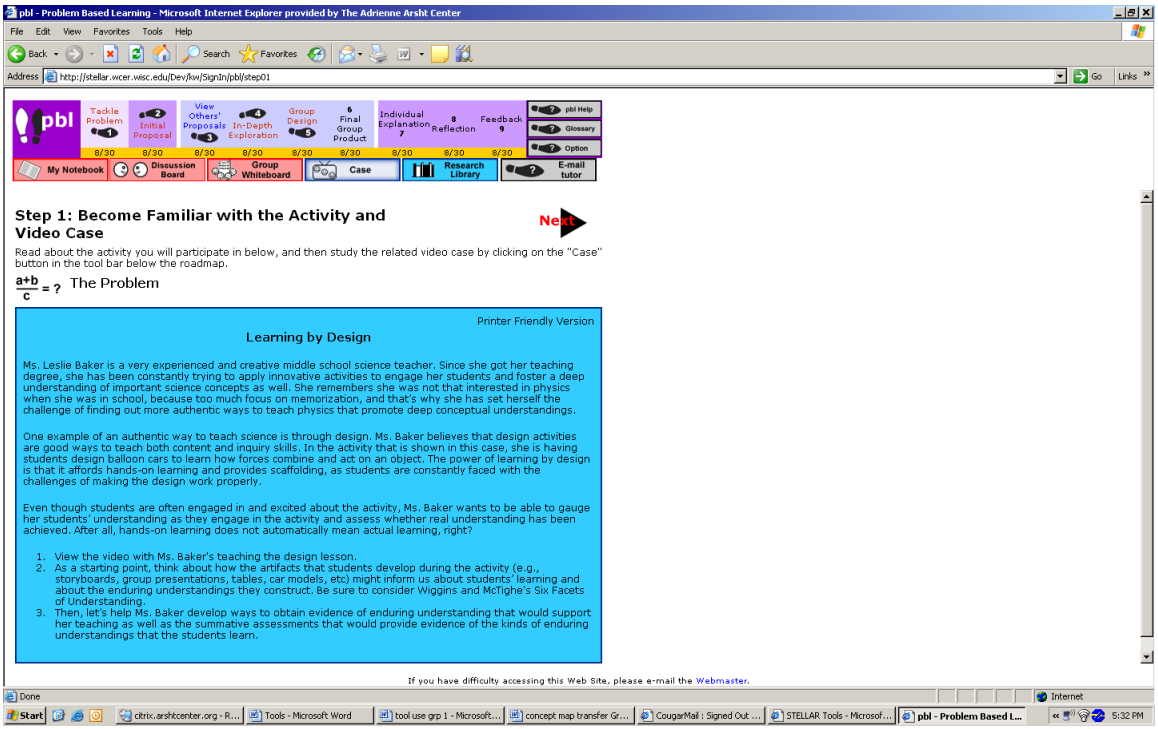
Zhu, E. (2006). Interaction and cognitive engagement: An analysis of four asynchronous online discussions. *Instructional Science, 34,* 451-480.

## Appendix A: Screen views of all four online PBL cases

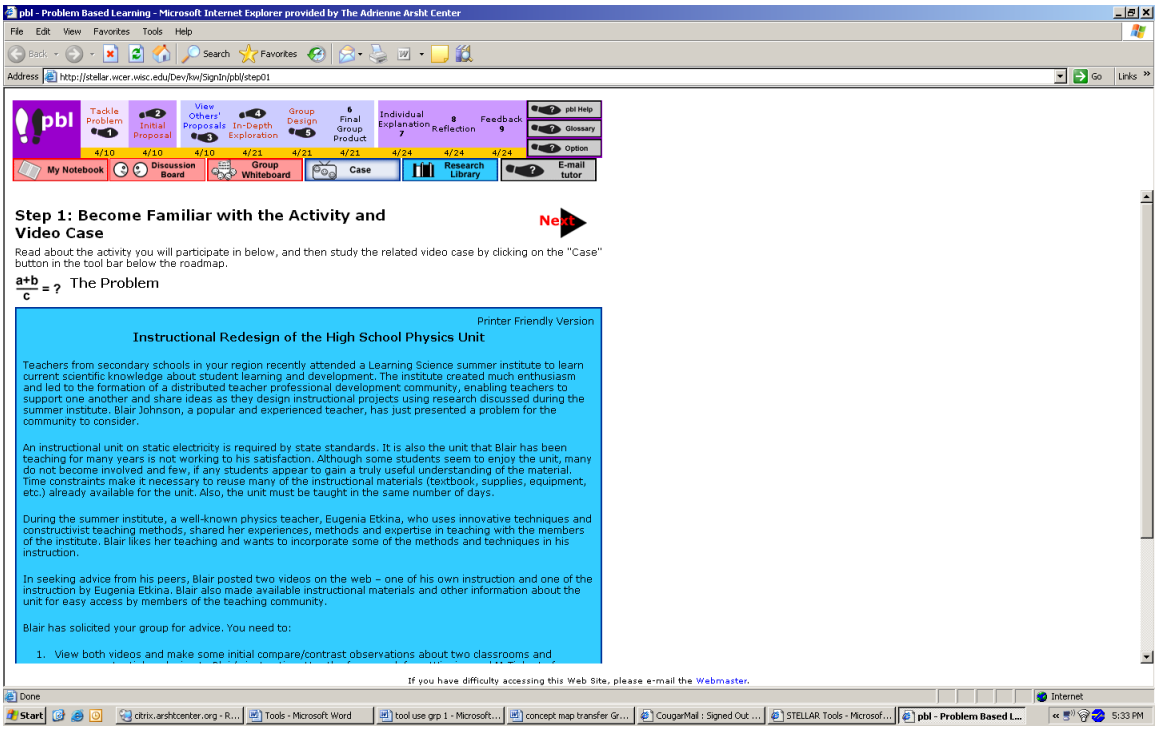
Student view of STEP module: Problem 1: Knowing what Brandon knows



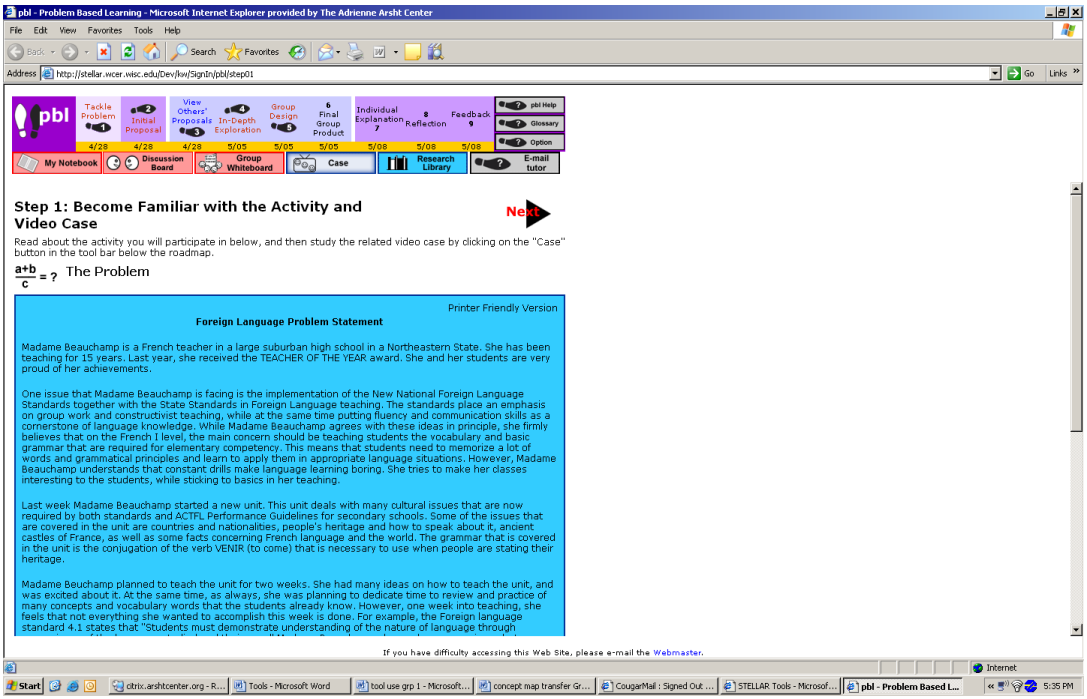
Student view of STEP module: Problem 2: Learning by design



Student view of STEP module: Problem 3: Redesign of physics unit



Student view of STEP module: Problem 4: Foreign language problem



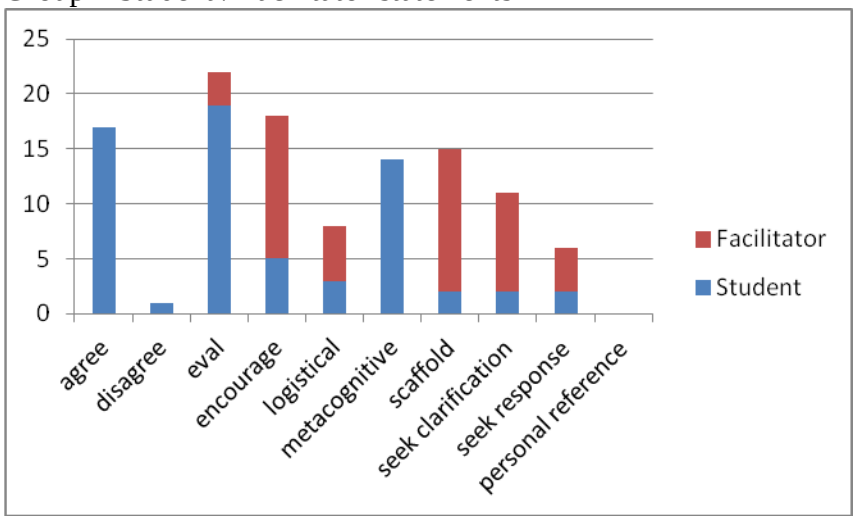
**Appendix B: Educational Psychology Concepts**

List of all identified educational psychology concepts from the data:

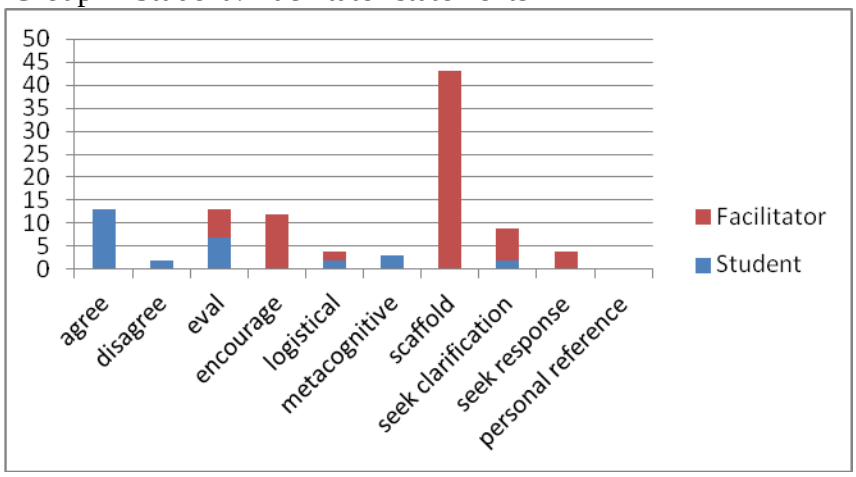
- Analogy
- Assessment: all types; i.e. summative, formative, traditional
- Assimilation / accommodation
- Cognitive flexibility
- Culture / learning styles
- Discourse
- Disequilibrium
- Enduring understanding
- Expert knowledge / Knowledge construction / isomorphism
- Heuristics / functional fixedness
- HOTS (higher order thinking skills)
- Instructional strategies
- Knowledge: declarative / procedural / domain
- Memory
- Metacognition
- Miscellaneous
- Misconceptions, reasoning, sociocultural learning, stereotype, peer learning, problem type-task characteristics, risk-ambiguity
- Scaffolding
- Schema
- SRL (self-regulated learning)
- Tool use
- Transfer
- Zone of proximal development

**Appendix C: Graphs of student / facilitator statements**

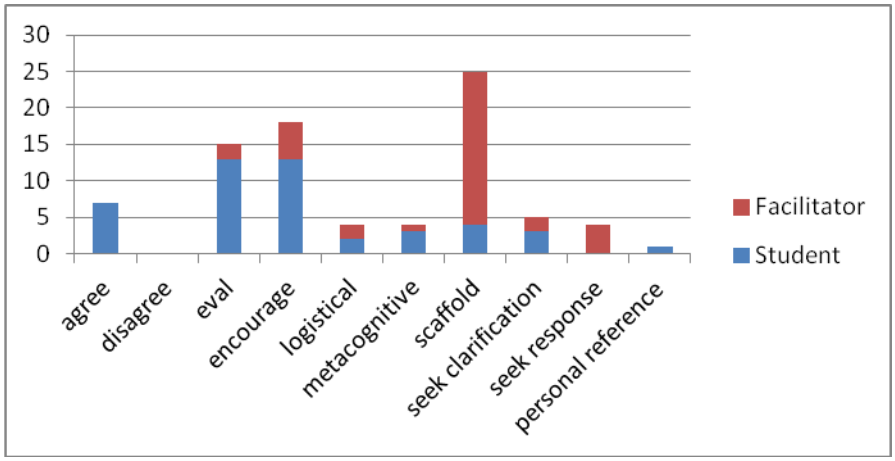
Group 1 Student / Facilitator statements




Group 2 Student / Facilitator statements

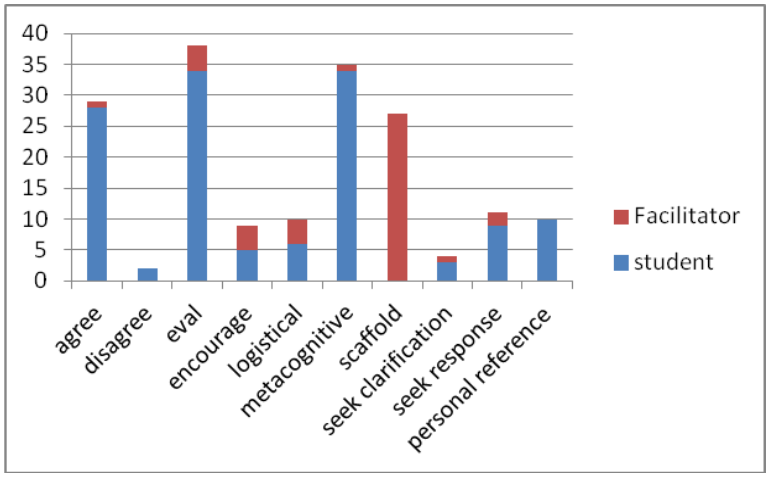



Group 3 Student / Facilitator statements

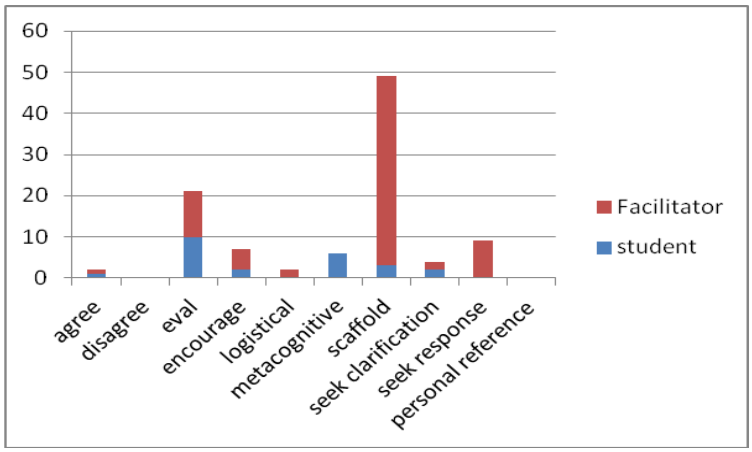


**Appendix C: Graphs of Student / facilitator statements**

Group 4 Student / Facilitator statements




Group 5 Student / Facilitator statements




Group 6 Student / Facilitator statements