AN EXAMINATION OF THE VALIDITY OF THE VaNTH OBSERVATION SYSTEM (VOS)

By

Monica Farmer Cox

Dissertation

Submitted to the Faculty of the

Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Leadership and Policy Studies

December 2005

Nashville, Tennessee

Approved:

David S. Cordray

John M. Braxton

Kenneth Wong

Ellen B. Goldring

Thomas R. Harris

Alene H. Harris

ACKNOWLEDGEMENTS

This work was supported primarily by the Engineering Research Centers program of the National Science Foundation under annual grant EEC-9876363 and was supported secondarily by a Dissertation Enhancement Grant from the Vanderbilt University Graduate School. All data were collected within the VaNTH Engineering Research Center. I especially thank Center Director, Dr. Thomas H. Harris, Assistant Director, Ms. Janiece Harrison, and all VaNTH researchers and staff for their support of my research and outreach efforts within VaNTH for the past five years. You have been academic and organizational role models for me, and I look forward to extending the knowledge that I received during my tenure in the ERC. In addition, I appreciate the expertise of the eleven content experts who completed my questionnaires— Sean Brophy, Karen Carney, Susan Goldman, Greg Light, Cherie McCullough, Banu Oney, Bob Plants, Jim Pelligrino, Anthony Petrosino, Joan Walker, and Bugra Yalvac.

I owe much gratitude to my dissertation committee members. First, I want to acknowledge the assistance of Dr. David Cordray, one of the most brilliant, patient academicians I have ever met. As the chair of my dissertation committee, he has helped me to hone my quantitative skills and has pushed me to academic levels that I never thought that I could reach. His accessibility during the dissertation process has made this experience a successful one, and I look forward to mentoring future students as effectively as he has mentored me. I also want to thank Dr. John Braxton, my departmental advisor, for allowing me to focus upon the field of engineering education within my coursework and for encouraging me to pursue my dreams even though I walked the road less traveled by other students in the department. I also appreciate Dr.

Alene Harris, a research advisor, friend, and mentor who embraced me as a new graduate student and treated me like family during some of the most difficult times of my life. Finally, I wish to thank Dr. Thomas R. Harris, Dr. Ellen Goldring, and Dr. Kenneth Wong for their input during this process. They are some of the most respected professors in the nation, and I am honored to have worked with them.

I also acknowledge the support of professors and staff at Peabody College (especially Dr. Jim Hogge and Dr. Ellen Brier), within the Department of Leadership, Policy, and Organizations (especially Ms. Rosie Moody and Ms. Renee Morgan), and within the Department of Engineering Education at Purdue University. They have given me words of advice and encouragement that have helped me to complete this dissertation in a timely manner.

Personally, I acknowledge my husband, Ishbah Cox, for his love and support. He has helped me to stay focused upon the goals that I have set for myself and upon the goals that we have set for our family. As my “rock” of support, he has sacrificed so much to help me achieve my goals, and I look forward to the day that I can help him reach his ultimate professional destination as well. I thank my parents and in-laws, Jimmy and Teresa Farmer, and Ruben and Lynn Cox, respectively, for their prayers of strength.

Last, but not least, I want to thank God for opening professional doors of opportunity for me in the engineering education field and for giving me a chance to affect how future generations of students are taught engineering.

TABLE OF CONTENTS

Appendix

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This dissertation examines the validity of the VaNTH Observation System (VOS), a direct observation instrument developed to assess whether curricula innovations within bioengineering are being implemented by the VaNTH Engineering Research Center (ERC), a Center with a research focus on bioengineering educational technologies. The innovations within the VaNTH ERC are developed using the four dimensions of the "How People Learn" framework (Bransford, Brown, & Cocking, 1999). This chapter briefly describes the need for curricular change within bioengineering, provides an overview of the VaNTH Observation System, and describes the HPL framework underlying innovations in the VaNTH ERC.

Needed Curricular Changes in Bioengineering Education

As the demand for innovative technology increases within the United States, the number of highly-qualified engineers must also increase. The Accreditation Board for Engineering Technology (ABET) mandates that engineering graduates demonstrate several skills, such as the ability to solve engineering problems, to apply science-based, engineering and mathematics knowledge, and to effectively work in interdisciplinary teams (Herkert, 1999). To date, over 2,700 engineering programs at approximately 550 colleges and universities nationwide have fulfilled these accreditation requirements.

Despite the number of U.S. institutions with qualified engineering programs, several barriers still exist. First, attrition among women and underrepresented minorities within science and engineering programs is higher than attrition among white students and men, thereby resulting in lower graduation rates for women and underrepresented minorities (NSF, 2004). In addition, although more underrepresented minorities received science and engineering degrees between 1990 and 2000, the educational gap between minorities and whites is still large. Finally, U.S. engineering institutions are now in direct competition with engineering institutions in other countries that can provide educational access to students pursuing engineering degrees.

In an effort to address these challenges within engineering, researchers have conducted empirical studies to identify pedagogical practices that lead to positive student outcomes within engineering classrooms. These researchers note that teaching and learning within engineering differs from teaching and learning within other disciplines because engineering is a "hard/applied" field of study that generates high consensus among colleagues in the field, focuses upon inquiry, mastery of the environment, and the development and application of products and processes (Lodahl, & Gordon, 1972, Biglan, 1973, Neumann et al., 2002). Cooper and Robinson (1998), Springer et al. (1998), and Cudd and Wasser (1999) report that in-class student collaboration within engineering classrooms increases students' critical thinking skills and has positive effects on student achievement, persistence, and attitudes more than traditional engineering classroom environments. In addition, Cabrera et al. (2001) report that engineering classes with greater emphases on faculty-student interactions and faculty guidance have positive effects on student learning.

To meet the educational standards of ABET, to increase the number of underrepresented minorities and women obtaining engineering degrees, to reduce the educational gap between different kinds of students, and to increase the quality of the students' educational experience within engineering classrooms, assessments of current engineering classrooms are needed. These assessments may document classroom practices that increase learning and the classroom activities that deter learning. Because of the absence of valid assessment instruments that quantify educational practices within engineering classes, however, Neumann (2001) and Quinlan (1998) recommend the development and use of discipline-specific assessment instruments. Empirical research reporting the validity of these discipline-specific instruments is needed prior to their use within classrooms. The purpose of this dissertation is to assess the validity of a recently developed classroom observation scheme – the VaNTH Observation System (VOS) (Harris, 2003).

Brief Background of the VaNTH Observation System (VOS)

As part of the VaNTH Engineering Research Center (ERC) in Bioengineering Education and Technology, the VaNTH Observation System (VOS) was developed. VaNTH is a multi-university Engineering Research Center developed to maximize the educational experiences of bioengineering students at *V*anderbilt University, *N*orthwestern University, the University of *T*exas at Austin, and the *H*arvard/Massachusetts Institute of Technology Division of Health Science and Technology. In 1999, the National Science Foundation funded this ERC, the first Center devoted solely to bioengineering educational technologies. The goal of the VaNTH ERC is to "unite educators and engineers, in industry and academia, to *develop curricula and technologies* that will educate future generations of bioengineers" (VaNTH, 2003). These curricular changes were guided by the "How People Learn" (HPL) framework developed by Bransford, Brown, & Cocking (1999). More than in traditionally-taught classes, in HPL classes learning activities are *learner-centered* (i.e., students' prior experiences and misconceptions are factored into how course content is presented to students), *assessment-centered* (i.e., formative and summative assessment techniques are used to provide opportunities for students and faculty to receive feedback), *knowledge-centered* (i.e., lecture material is organized and presented so that students develop deep understanding of course concepts) and *community-centered* (e.g., students are taught in collaborative learning). This HPL framework focuses on the transfer of learning from students' previous academic experiences so that students become adaptive experts in their areas of study (Bransford, Brown, & Cocking, 1999).

In developing and testing these HPL-inspired curricular changes, the VaNTH ERC involved a collaboration of professionals from Bioengineering Domains (e.g., Biomechanics), Learning Sciences, Assessment and Evaluation, and Learning Technology. In an effort to evaluate the implementation of new educational materials within multiple bioengineering courses, VaNTH researchers used portions of the VaNTH Observation System (VOS) to collect data within several bioengineering courses (Bell et al., 2003; Cordray et al., 2003; Cox, 2003; Cox & Harris, 2004; Harris et al., 2002; Jansen et al., 2003; Roselli & Brophy, 2001; Roselli & Brophy, 2003).

The VaNTH Observation System (VOS) is a four-part classroom observation instrument, adapted from the Stallings Observation System (SOS) for K-12 classrooms

(Stallings & Kaskowitz, 1974; Stallings, 1977, 1978, 1980, 1986; Stallings & Frieberg, 1991) and is designed to record and quantify the frequency and sequence of classroom activities in which dimensions of the "How People Learn" (HPL) framework (Bransford, Brown, & Cocking, 1999) are implemented in bioengineering courses. The four parts of the VOS capture (1) teacher-student interactions, (2) student engagement levels, (3) descriptive lesson information (including lesson content, lesson context, observer comments, and extenuating circumstances), and (4) global classroom aspects during a class period (Harris, 2003). The VOS and its components will be discussed in greater detail in Chapter 2. Because the HPL framework is so central to the content of the VaNTH Observation System, the next section provides an overview of the key ideas underlying the HPL framework.

The "How People Learn" Framework

Newly developed educational materials within bioengineering classes in the VaNTH ERC incorporate the "How People Learn" (HPL) framework, as set forth in the National Research Council's monograph, *How People Learn: Mind, Brain, Experience, and School* (Bransford, Brown, & Cocking, 1999). This framework encourages teachers to diversify their teaching by incorporating the four dimensions of knowledge-, learner-, assessment-, and community-centeredness into their current class lessons (Figure 1-1). These elements, coupled with traditional teaching techniques, are expected to optimize students' learning (Bransford, Brown, & Cocking, 1999).

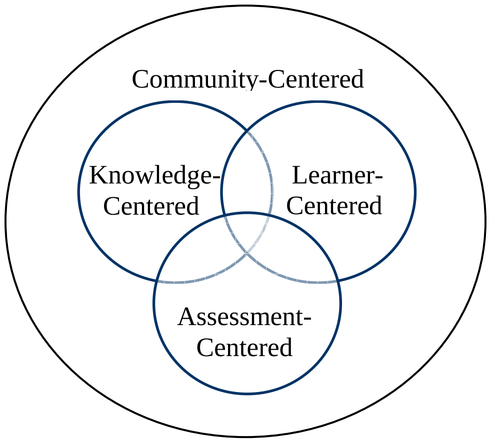

Figure 1-1. The “How People Learn” (HPL) Framework

A *learner-centered environment* pays explicit attention to the learning styles, preconceptions, skills, prior experiences, knowledge, and beliefs that students bring into a classroom (Bransford, Brown, & Cocking, 1999). This means that although the content of a class lesson may remain consistent each time it is taught, learner-centered classes will vary because instructors incorporate students’ individual experiences and possible misconceptions into the development of the class lesson. Learner-centered approaches include a professor’s asking a student to refer to information from another class that he/she has taken (e.g., “Given what you know about muscle physiology, what two phenomena could explain a runner’s difficulty running?”), a professor’s asking a student to think about how he/she felt when they had a particular experience (e.g., “Think about the muscles that you would use to pick up a child.”), or a professor’s asking a student to predict an outcome (e.g., “What do you think would happen if we increased the amount of substrate in this model?”).

Knowledge-centered environments closely connect with disciplinary curricula development by building on presentation of facts from lecture and by focusing on principles that lead to students' deep understanding for future application of material. In addition, knowledge-centered environments promote *learning with understanding* through the organization of course concepts into domain areas with students' understanding of the conditions in which this information may be applied. Understanding the global aspects of a lesson is a vital knowledge-centered instruction. Bransford, Brown, and Cocking (1999) recommend that instructors explain the purpose of a lesson, any historical points of a discipline or domain, the relationships between that domain and other domains, and the application of the domain's knowledge. For example, a knowledge-centered approach includes a professor's using a simulation that demonstrates course concepts and principles that he/she has taught in class.

Assessment-centered environments allow students to make their thinking and learning visible through the use of various types of formative and summative assessment techniques. Formative assessment gives students and faculty immediate feedback about in-class teaching and learning and is usually not graded. On the other hand, summative assessment is associated with grades and measures student learning. An example of summative assessment includes professor-created exams or graded projects covering course content.

Within an assessment-centered environment, formative assessment occurs when a professor initiates comments and questions directed to students and receives feedback about how well students comprehend the material. This kind of feedback can be made more formal through the use of technology. For example, a technology-based, assessment-centered approach within a biomedical engineering class might include a professor’s asking students to use a classroom communications system such as the Personal Response Systems (PRS) to answer in-class questions as in the following scenario: A biomechanics professor begins a lecture about free body diagrams. To test students’ understanding of this concept, he uses a computer and data projector to display four free body diagrams on a screen and asks students to select the correct one for the remainder of a woman’s body if a leg is removed and the weight of the leg is neglected. Each student then uses a handheld remote to beam an answer to the system. When all students have submitted an answer, the computer projects a graph showing the distribution of students’ answers, giving both the professor and students immediate feedback. By compiling and sorting students’ responses, the PRS can pinpoint course concepts that need further discussion (Roselli & Brophy, 2002).

A *community-centered learning environment* encourages both students and faculty to learn from one another and fosters students’ development of professional identity in class and out of class. Community-centered approaches involve students’ in-class collaboration. Outside of the actual classroom environment, community centeredness can be developed through the use of chat rooms, listservs, and on-line electronic programs (e.g., Prometheus) in which students can e-mail one another and correspond with the professor. Community centeredness promotes a learning environment such that students, teachers, and other interested participants (1) share norms that value learning and high standards, (2) interact, (3) receive feedback, and (4) learn (Bransford, Brown, & Cocking, 1999).

In addition to the four “centerednesses,” Bransford, Brown, and Cocking (1999) differentiate HPL classroom activities from traditionally taught classes in several ways and pinpoint classroom activities that increase student learning. In HPL terms, expert teachers, as well as being knowledgeable about their academic content and the best principles to teach relevant concepts, do things differently in terms of the questions they ask of students, how they use the student answers they receive, and the in-class student collaboration they foster. These teachers recognize that memorization and text mastery do not necessarily signify that student learning is occurring, that presenting only fact-based questions that can be answered with a “yes” or with a “no” response allows students’ misconceptions to remain, and that since students transfer learning from previous experiences, there is a need to help students correct their misconceptions. Thus, they ask higher-order questions to determine students’ prior conceptions and misconceptions and to determine how well students do – and do not – understand content and processes studied, with the goal of making this visible to both the teacher and the student. Based on the student responses they receive, expert teachers recognize and act on the need to modify their instructional activities to correct misconceptions and to build on students’ prior knowledge. Also, these teachers allow for student collaboration. Bransford, Brown, and Cocking (1999) write that collaboration among students increases students’ understanding of course material via peer learning. In other words, when students interact with each other and with faculty within classrooms, they obtain firsthand knowledge about the norms and expectations of their academic community.

The STAR Legacy Cycle (Schwartz et al., 1999) is a lesson design that incorporates the HPL elements of knowledge-, learner-, assessment-, and community-centeredness; this cycle has served as the framework for lesson development in the various VaNTH bioengineering domains. The Legacy Cycle begins when students are presented a central question or a "challenge" that leads into learning activities for a topic. Students next explore their misconceptions and initial ideas. From here, experts provide students with initial basic information and clues to guide them towards a solution. Students then use available resources that help them develop their answers to the challenge, as initially posed. After formative assessment – and recycling back to additional resources if needed, there is a public disclosure of information that assesses how well students understand course concepts.

One of the major goals of the Assessment and Evaluation thrust of the VaNTH ERC is to estimate the effects of the "value added" to bioengineering student learning as a result of HPL framework interventions. VaNTH investigators hypothesize that students exposed to HPL-based innovations will achieve a greater level of learning than students not exposed to HPL-based innovations (Roselli & Brophy, 2001; Cordray et al., 2003; Harris et al., 2002). For this reason, most VaNTH assessment categorizes bioengineering classes as HPL-based or non-HPL based upon the presence or absence of HPL-driven innovations within these classes. Both direct observation methods (e.g., the VaNTH Observation System) and survey methods (Cordray et al., 2003) are being used to note differences in HPL and non-HPL classes within the VaNTH ERC. This dissertation addresses the validity of the VOS as a means of registering the extent to which the HPL framework has been implemented within VaNTH and to assess the extent to which the pedagogy in HPL-inspired courses differs from traditional (non-HPL) courses.

Dissertation Research Questions

To date, the VOS has been used exclusively to observe classes within the undergraduate biomedical engineering department at Vanderbilt University. As of May 2004, five trained classroom observers had taken approximately 182 class session observations over five academic semesters. A total of fifteen bioengineering faculty have been observed within freshman-level to senior-level courses[1]. The current assessment method reports the percent of individual HPL dimensions that are present within Classroom Interaction Observation (CIO) data (Roselli & Brophy, 2001; Roselli & Brophy, 2003).

Although the VOS was developed to capture HPL-oriented elements within bioengineering classrooms, no previous research has examined the validity of the VOS. This study, however, examines the validity of the VOS and determines whether the VOS accurately registers key dimensions of the HPL framework within two portions of the instrument (the Classroom Interaction Observation and the Global Ratings), thereby possibly enhancing confidence in the VOS data.

With these observations, there is now a sufficient amount of data to examine the extent to which the VOS accurately indexes the key dimensions of the HPL framework. Assessing the validity of the VOS is essential prior to using it in courses inside and outside of the VaNTH project. In other words, tests need to be made to see if the VOS captures the elements, particularly the HPL elements, that it is has been created to capture.

---

[1] Observed courses include Physiological Transport Phenomena, Biomedical Instrumentation, Biotechnology, Biopharmaceuticals, Biomechanics and Biomaterials, Medical Imaging, Systems Physiology, Introduction to Biomedical Optics, Freshman Seminar, and Senior Design.

Thus, the purpose of this research is to examine the validity of inferences that can be drawn from the VOS. This research will assess the extent to which portions of the VOS accurately reflect key dimensions of HPL-inspired instruction in bioengineering classrooms. Specifically, this five-part study seeks to examine the following questions:

- To what extent do content experts familiar with the HPL framework agree with the HPL classifications derived from the CIO portion of the VOS?
- How comprehensively does the Global Ratings portion of the VOS represent the four HPL dimensions (i.e., knowledge-, learner-, assessment- and community-centeredness) and their interdependencies?
- How well does the current approach to index the amount of HPL activity represent the "HPLness" of a class session?
- Does the sample of real-time coding of classroom interactions accurately capture all interactions in a classroom?
- Does the HPL Index derived from the CIO portion of the VOS distinguish pedagogy in known HPL and non-HPL (traditional) courses?

Dissertation Overview

The remainder of this dissertation is comprised of four chapters. Chapter 2 discusses the origins and components of the VOS, presents research findings from data collected using the VOS, and provides a synopsis of observation instruments in which various types of validity have been examined. Chapter 3 provides detailed discussions of the methods to be used in five studies designed to answer the questions identified above. This chapter describes the samples, research methodology, and data analyses underlying each of the five studies. Chapter 4 reports the results of the five studies along with brief conclusions pertaining to each study. Finally, Chapter 5 discusses the implications of the research and offers recommendations for future studies.

Significance of the Research

This research is significant for several reasons. First, it examines the validity of the VaNTH Observation System, the first direct observation classroom instrument developed to measure HPL dimensions in engineering classrooms. Second, it examines ways of quantifying the amount of “HPLness” within VOS-observed classes. Finally, this research will examine differences within and across faculty in their use of HPL and traditional pedagogy, thereby setting the stage for faculty development programs targeted at improving pedagogy within engineering classrooms.

This study will attempt to determine whether the VOS accurately registers key dimensions of the HPL framework. In addition, this study notes which HPL elements are measured by the VOS and which HPL elements not measured by the VOS. This information may result in a revision of the VOS or the development of new instruments that measure HPL constructs not measures directly by the VOS. Before the VOS is widely distributed and labeled to be a reliable and valid observation tool, this portion of the research is mandatory.

The current method of indexing the amount of “HPLness” in courses relies on the simple percentage of individual HPL dimensions that are present within Classroom Interaction Observation (CIO) data. This study will examine if other methods of indexing HPLness improve upon current practices.

This research is also significant because it gives engineering faculty a new way to assess their teaching. Since the HPL framework was derived from decades of literature on learning, and since the joint influence of the four dimensions leads to more effective instruction (Bransford, Brown, & Cocking, 1999), the VOS provides an ideal way for bioengineering faculty to note the amount of "HPLness" that is present within their instruction. VOS data, coupled with other methods of teacher evaluation, such as student ratings and course material evaluation, may provide a more comprehensive picture about how teachers convey information to students within courses over time and could provide alternative methods for teacher evaluation within engineering classrooms.

Since the VOS notes teaching differences within HPL and traditional engineering courses, profiles of HPL-oriented engineering courses and traditional engineering courses may be reported. Differences between HPL courses taught by "seasoned" faculty who have taught using HPL-oriented materials for several semesters may also be compared to HPL courses taught by "novice" faculty who are teaching using HPL-oriented materials for the first time. With this information, educational researchers, administrators, and faculty may refine current knowledge about effective practices within engineering classrooms. Future studies may map variables within this research to student outcome variables such as retention and academic achievement in an effort to see if there are correlations among these variables. Higher education institutions and university teaching centers then may translate empirical findings into application and may provide educational training about effective classroom practices to current and new engineering faculty and to engineering doctoral students pursuing careers in academia.

CHAPTER II

THE ORIGINS AND STRUCTURE OF THE VaNTH OBSERVATION SYSTEM (VOS) AND VALIDATION ISSUES

The purpose of this chapter is to provide the reader with an introduction to the origins of the VaNTH Observation System (VOS), the Stallings Observation System. Next the VOS's purpose, components, and data collection process will be explained. Third, a summary of VOS research findings to date will be presented. Fourth, summaries of validation methods used for other classroom instruments will be given and will be classified by validation type. Finally, proposed research studies will be introduced and will be connected to validation literature presented earlier in the chapter.

Origins and Purpose of the VOS

The Stallings Observation System (SOS)

Developed in 1969, the Stallings Observation System (SOS) consisted of three components that registered the presence and absence of over 600 in-class student and teacher behaviors and activities (Adolf, 1983; Stallings, 1977, 1978, 1980)[2]. The primary purpose of the SOS was to describe the implementation of educational models directed at low-income students enrolled in Head Start and other preschool programs. The SOS

---

[2] This instrument was also known as the Stanford Research Institute observation instrument or the Classroom Observation Instrument (COI) (Stallings & Kaskowitz, 1974). In 1977, the COI became known as the Stallings Observation System (SOS) (Stallings, 1978). The COI was derived from Flanders' (1970) observation system in which the teacher was the primary focus of a classroom observation. Unlike the COI, however, classroom movements and nonverbal actions of teachers and students were not recorded by the Flanders system.

evaluated the adherence of teachers to the models' guidelines, and observed the relationship between student outcomes and classroom instruction (Stallings, 1978)[3]. The SOS has been used in several K-12 studies. The major purpose of this system has been to note how K-12 teachers use their time within classrooms, and, as a result, Stallings has found that most teachers monitor seatwork for approximately one-half of a class period, participate in organizational activities for approximately 38% of a class period, and actively teach students for approximately 12% of a class period (Stallings, 1986). She also reported that the majority of teachers in classrooms where students were high achievers spent their time actively teaching and actively monitoring students.

Purpose of the VaNTH Observation System

In an effort to assess the presence or absence of HPL-inspired pedagogical practices within postsecondary engineering classrooms and to give bioengineering instructors feedback about their teaching, Dr. Alene Harris and her colleagues within the VaNTH ERC revised the Stallings Observation System and added a fourth component, thereby creating the VaNTH Observation System (VOS) (Harris, 2003). To date, the VOS has been used to generate profiles of traditional and HPL-oriented bioengineering classrooms.

---

[3] The COI consisted of (1) the Physical Environment Information, in which information is gathered once per class period about in-class seating arrangements and student and teacher uses of equipment and resources, (2) a Classroom Check List, in which information about independent and simultaneous class activities and student and teaching groups is gathered four times an hour for five hours a day over a three day period, and (3) a Five-Minute Observation , in which information about classroom interactions is collected four times an hour five hours a day for three days per classroom. A total of sixty observations are taken per classroom. The FMI (Stallings, 1977) looked at (1) who the speaker was, (2) to whom he or she was speaking, (3) what the message was, and (4) how the message was given (or what its intention was).

VaNTH Observation System Components & Data Collection

The VaNTH Observation System (VOS) records from direct observation four types of data: (1) Classroom Interaction Observation (CIO), sampled real-time, which records student and faculty interactions; (2) a time-sampled Student Engagement Observation (SEO), which notes whether students are engaged or unengaged with academic tasks, (3) qualitative Narrative Notes (NN) on the lesson content, lesson context, extenuating circumstances, and additional information about the classroom, and (4) Global Ratings (GR), which provide summative information about major aspects of the pedagogy underlying the class session. Harris (2003) describes in detail the structure and content of the VOS.

Classroom Interaction Observation (CIO)

The first part of the VOS is referred to as the Classroom Interaction Observation or CIO. The CIO captures specific information about the nature and types of interactions among students and faculty, along with information about their use of various types of instructional materials (e.g., media, computers). Of particular importance is data collected about faculty-student contacts and cooperation among students, since these are well documented principles of good practice in undergraduate education (Caboni, Mundy, & Duesterhaus, 2002). As Stallings (1986) recommends, student-teacher interactions are recorded through direct observation, allowing instructional time to be parsed as a percent of time that students are involved in specific academic and organizational activities.

The CIO is a professor-focused portion of the VOS that captures student and faculty interactions and the presence of HPL dimensions within classrooms. Within each three-minute CIO coding session, VOS observers record approximately thirty to forty-five code strings at the speed of speech. These interactions are grouped into code strings of *who - to whom – what - how - media* (Harris, 2003) (Figure 2-1).

Who and *to-whom* categories note who is initiating or responding to in-class interactions. Interactions within both categories may occur among a professor or instructor (P), all students in the class (E), one student (F), the same student as the previous interaction (S), a small group of students representing more than one but not over half the class population (g), a large group of students representing half to all but one student in the class (G), a visitor (V), or media (M).

WHO	TO WHOM	WHAT	HOW	MEDIA
Professor **E**veryone **F**irst student **S**ame student Small **g**roup Large **G**roup **M**edia **V**isitor	**P**rofessor **E**veryone **F**irst student **S**ame student Small **g**roup Large **G**roup **M**edia **V**isitor	**1** fact ? **2** higher order ? **3** response **4** instruction **5** social comment **6** activity-related comment **7** acknowledge or praise **8** guide **9** correction **0** no response **A** active monitoring **P** passive Monitoring	**K**nowledge-centered **L**earner-centered **A**ssessment-centered **C**ommunity-centered **O**rganization **B**ehavior	**B**oard **O**verhead **C**omputer **S**imulation **D**emonstration **V**ideo **R**esponse system **N**one

Figure 2-1. VaNTH Observation System Classroom Interaction Observation (CIO) Codes (Harris, 2003)

The *what* category describes twelve types of in-class interactions that may occur during the CIO cycle. These interactions identify the presence of questions, responses, acknowledgements and/or praise, guides, corrections, or professor-initiated student monitoring. More specifically, the *what* categories note the following: the initiation of a lower-level fact-based question (1), the initiation of a higher order question (2), the response to a question (3), in-class instruction (4), social comments (5), activity-related comments not directly related to academic content (6), acknowledgements or praises by the professor (7), a guide by the professor (8), correction by the professor (9), no response to a question asked by the professor (0), active monitoring such that the professor walks among students during in-class activities (A), and passive monitoring such that the professor is stationary as he/she watches students during in-class activities (P).

For postsecondary classes, the *how* category identifies the presence or absence of each HPL dimension and classroom organization. (For K-12 classes, however, behavioral activities are also noted.) More specifically, VOS observers record activities to be knowledge-centered (K), learner-centered (L), assessment-centered (A), community-centered (C), or organization (O). Of the *how* category components, only the knowledge-centered and organization codes are mutually exclusive.

The *media* category reports the type of media that a professor is using during a class session. The seven types of media noted within the Classroom Interaction Observation are the board (B), the overhead projector (O), computer (C), simulation (S), demonstration (D), video (V), and a personal response system (R). Observers may also note the absence of media (N). All media categories are mutually exclusive.

For example, if a professor asks a student a higher order question about a diagram displayed on the board, the corresponding CIO code string would be “P-F-2-K/L/A-B” such that “P” represents the professor who is initiating the question (*who*), “F” represents the student to whom the professor is asking the question (*to whom*), and “2” represents the higher order question that was asked (*what*). HPL dimensions represented are knowledge-centered (K), learner-centered (L), and assessment-centered (A) (*how*). The use of the board is represented by “B” (*media*).

Student Engagement Observation (SEO)

The second part of the VOS is the Student Engagement Observation (SEO). The SEO provides information about the number of students present within a class and the number of students engaged or not engaged in specific class activities (Figure 2-2). Stallings (1986) found that teachers who promoted more classroom interactions and fewer seatwork activities had students who were more engaged in academic tasks. In addition, Stallings (1986), Bransford, Brown, and Cocking (1999), and Evertson (1985) report positive relationships between students’ academic engagement and their achievement scores.

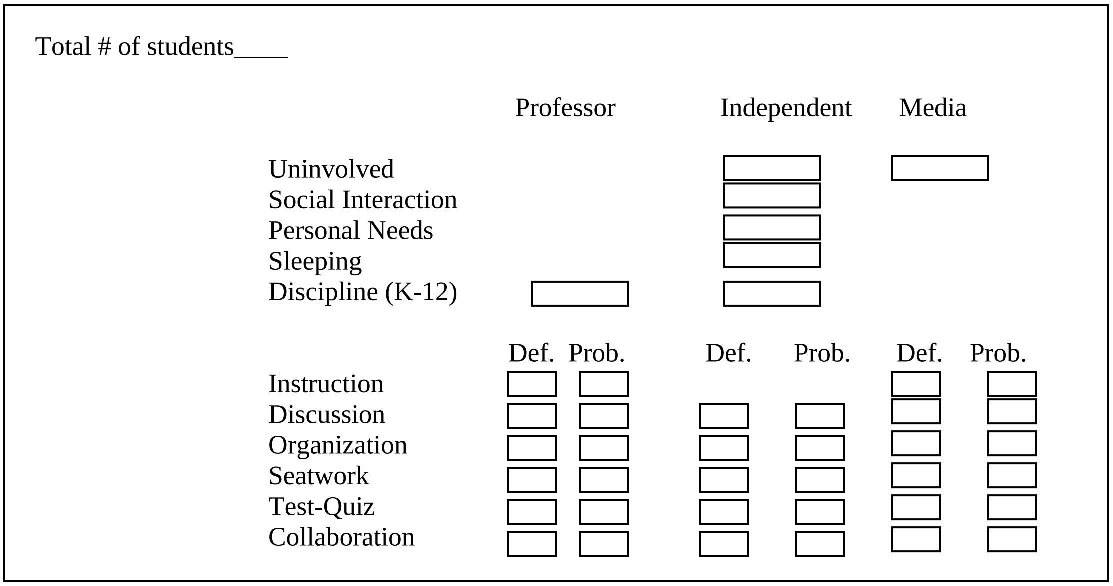

Figure 2-2. VaNTH Observation System Student Engagement Observation (SEO) Codes (Harris, 2003)

The SEO is a student-focused portion of the VOS that takes a thirty- to sixty-second "snapshot" of five undesirable categories and six desirable categories. Undesirable activities include student uninvolvement (e.g., staring into space, reading a book), social interactions among students, student concentration on personal needs (e.g., digging in a backpack for a water bottle, filing fingernails, or brushing hair), sleeping, and being disciplined (K-12 classes only). Students can also be uninvolved with media (e.g., writing e-mail, chatting on-line, or playing computer games). An observed undesirable behavior is coded simply as occurring. The majority of students, however, are "definitely" or "possibly/probably" engaged in desirable classroom activities during a class session. Students "definitely" or "possibly/probably" engaged are involved in sanctioned classroom activities such as instruction, discussion, classroom organization, independent seatwork, tests and quizzes, and collaboration. For all desirable categories excluding instruction, students may be engaged independently, with a professor, or with media.

Suppose that there are thirty-five (35) students sitting in a classroom. One student is sleeping, two students are talking, and one student is checking e-mail on his laptop. The rest of the students are definitely engaged in an instructional video that is explaining the functions of the heart. A VOS observer would input the following information: total number of students is thirty-five (35), one student is sleeping independently, two students are involved in social interaction independently, one student is uninvolved with media, and thirty-one (31) students are definitely engaged in instruction with media.

Narrative Notes (NN)

Braxton, Bray, and Berger (2000) report that students are more likely to be socially integrated, to show commitment to an institution, and to reenroll at an institution when they perceive faculty to organize and prepare their teaching with clarity and skill. Details about how faculty members' present academic content within a classroom environment are obtained via the third part of the VOS, the Narrative Notes (NN).

The Narrative Notes allow an observer to input qualitative information about a lesson via keyboard for one to two minutes after a SEO. More specifically, the Narrative Notes provides a contextual framework for a lesson by presenting information about *lesson content, lesson context, extenuating circumstances,* and *observer comments* (Harris, 2003) (Figure 2-3). Currently, the Narrative Notes portion of the VOS provides additional information about classroom limitations or situations that might hinder the implementation of HPL-oriented, challenge-based instruction.

Type A (Professor lectures)	**Type B (Professor questions)**	**Type C (Professor leads/guides problem solving)**	**Type D (Students lead class)**	**Type E (Organization)**
A1-Content knowledge (the facts) *A2*-Procedural knowledge (how to solve a problem) *A3*-Demonstrative (how to do something) *A4*- Connecting prior experiences/bridging/ reflecting/historical	*B1*- Socratic method *B2*- Question & Answer *B3*- Open discussion (higher-order, open-ended, what-if, etc.)	*C1*- Guided by professor *C2*- Independent sample problem working *C3*- Cooperative group sample problem working *C4*- Case-based problems *C5*- "Stump-the-professor" problem (students pose "what-if" questions)	*D1*- Student presents information *D2*- Student explains how to solve a problem	*E1*- Organization with students *E2*- Organization alone (e.g., repairing computer, searching for chalk)

Figure 2-3. VaNTH Observation System Narrative Notes (NN) Lesson Context Categories (Harris, 2003)

The *lesson content* portion of the Narrative Notes gives observers opportunities to describe what is being taught by a professor and how the lesson is being taught, respectively. Within this section, observers may provide information about any examples, procedures, or topics related to academic content. For example, in a biomechanics course in which the professor is defining torsion, an observer may type, "The professor is giving a torsion example. He related the course concepts to a turkey wishbone he is flexing in his hands and is telling students that they can observe the torsion concept after breaking a turkey bone during Thanksgiving dinner."

The *lesson context* categorizes a professor's lesson delivery or teaching style into one of five categories: "Type A"- professor lecturing, "Type B"- professor questioning, "Type C"- professor leading and guiding problem solving, "Type D"- students leading class, and "Type E"- in-class organization (Figure 2-3). Biomedical engineering experts familiar with lesson context within postsecondary bioengineering classrooms identified these in-class teaching behaviors, along with multiple permutations of each. In the same torsion example above, the professor is lecturing. For this reason, an observer might list the following three *lesson context* categories: "A1"- content knowledge (the facts), "A3"- demonstrative (how to do something), and "A4"- connecting prior experiences/bridging/ reflecting/historical. These categories are listed since the professor defines torsion, explains examples of torsion in their everyday lives, and connects the concept of torsion by applying torsion principles.

The *observer comments* note anything that might occur within the classroom and cannot be captured by the Classroom Interaction Observation or by the Student Engagement Observation portions of the VOS. An observer might type, "I cannot see the faces of students sitting in the front of the classroom. A student who was previously coded as uninvolved with media during the SEO is now using a calculator to solve a problem."

Finally, the *extenuating circumstances* part of the Narrative Notes describes any limitations or circumstances that might affect students' learning as well as other information not captured within other parts of the VOS (Harris, 2003). This portion also allows observers to explain any problems that they or the professor have with technical equipment and any environmental conditions that might affect student attendance or participation. Using the same Biomechanics class example, an observer might type, “It is the Friday before Thanksgiving break. The professor is commenting that half the class is absent.”

Global Ratings (GR)

Similar to Louisiana’s purpose for developing the System for Teaching and Learning Assessment and Review (STAR) to evaluate teachers’ classroom activities (Chauvin, 1991), the Global Ratings (GR) were created to assess key elements of teaching and learning within observed classes. Unlike the STAR, however, this final part of the VOS evaluates faculty’s teaching and learning patterns and records HPL principles and global elements of effective teaching once at the end of a class period.

For the Global Ratings, VOS observers rate seventeen items or indicators using a three-point Likert scale. Each item represents either signaling with cognitive organizers, assessing students’ understanding, or maintaining lesson engagement (Figure 2-4).

The first five Global Ratings items note faculty members’ ability to signal with cognitive organizers. In other words, observers rate the extent to which faculty organize, connect, and present academic content to students. Faculty are rated upon how thoroughly they present verbal and written information about what students are going to learn (chronological outline) as well as what students should know at the end of the day’s lesson (behavioral objectives). In addition, faculty are rated upon the number of linkages they make among parts of the day’s lesson, the extent to which students engage in an HPL-oriented challenge, and the extent to which students make connections to their prior learning experiences during class.

The next five Global Ratings items provide information about in-class assessment activities. Observers record information about the extent to which observers check for students' understanding before class, during class, and after class. In addition, observers rate faculty based upon the percent of students that initiate clarification questions and higher order, extending questions during class.

The final seven Global Ratings items relate to lesson engagement. Observers note the fraction of the class with which observers make eye contact and physically move among students. In addition, VOS observers rate faculty's levels of visual aid usage, the number of faculty-initiated clarifying and higher order hypothetical questions, and the amount of time that students spend interacting in in-class collaborative activities.

A. Signaling with cognitive organizers

1. Communicating the lesson's chronological order
2. Communicating the lesson's behavioral objectives
3. Signaling the lesson's unfolding/linkages
4. Providing an HPL challenge
5. Making connections to prior learning

B. Assessing students' understanding

1. Pre-assessment of students' understanding of a concept
2. Ongoing assessment of students' understanding during a lesson
3. Post-assessment of students' understanding after a lesson
4. Students' asking questions for additional clarification
5. Students' asking extending questions (e.g., What if…?)

C. Maintaining lesson engagement

1. Making eye contact with students
2. Moving among students
3. Using appropriate visual aids to explain the lesson
4. Encouraging/Accepting student questions
5. Professor asking clarifying questions
6. Professor asking hypothetical questions
7. Students collaborating with others in in-class problem solving

Figure 2-4. VaNTH Observation System Global Ratings (GR) Categories (Harris, 2003)

Data Collection Cycle

Collecting data with the VOS requires that an observer sit in a classroom for an entire class period, start coding at the beginning of class, and stop coding when class is dismissed. The first three parts of the VOS (Classroom Interaction Observation, Student Engagement Observation, and Narrative Notes, respectively) record data in a cyclic pattern using a keyboard and a hand-held Personal Data Assistant (Figure 2-5). The Classroom Interaction Observation (CIO) records data for three consecutive minutes, the Student Engagement Observation (SEO) collects data for approximately thirty to sixty seconds, and the Narrative Notes (NN) record typewritten notes between one and two minutes. At the end of a class period, Global Ratings are taken once. This data is then transferred from the handheld Personal Data Assistant to a VaNTH-designed Data Management program (Norris et. al, 2004).

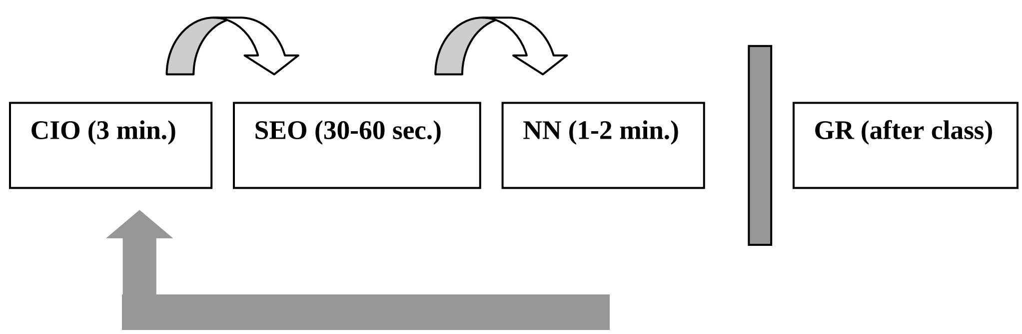

Figure 2-5. Observation Cycle for the VaNTH Observation System

VaNTH Observation System Data Analysis

Once the classroom data has been downloaded, it is saved in Microsoft Excel files and is cleaned manually. To date, the only VOS data that has been analyzed across multiple courses is CIO data. The tool used to analyze this data is the VOS Data Manager (VDM) (Norris et al., 2004). The VDM can generate the following reports from CIO data: (1) the HPL content distribution (i.e., the percent of observed instances of the four HPL dimensions) for an individual class session, (2) the average HPL content distribution for multiple class sessions, (3) HPL content distribution comparisons between individual class sessions and multiple class sessions, (4) HPL content distribution comparisons across several individual class sessions, and (5) the HPL content distribution of segments within an individual class.

Figure 2-6 shows the HPL content distribution for three years of CIO data for HPL-oriented and traditional classrooms using the current assessment method. Although the results show that, on average, HPL-oriented classes have higher instances of HPL-oriented activity, the sum of the dimensions is greater than 100% because some interactions involve multiple “HOW” categories (e.g., a professor’s academic question to a student would be both knowledge-centered and assessment-centered) that are not mutually exclusive. New ways to analyze VOS data need to be developed to capture the interplay among the four HPL dimensions. At present, analyses of the “HOW” categories do not allow us to examine combinations of HPL dimensions that reflect optimal instruction.

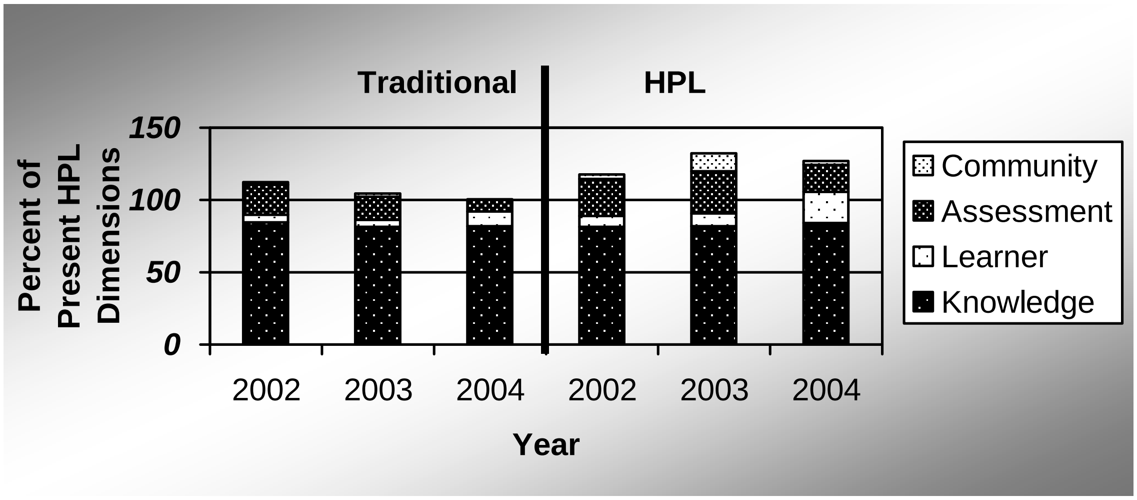

Figure 2-6. Comparisons of Traditional and HPL-Oriented Classes Using the Current Assessment Method

HPL-Based and VaNTH Observation System Research Findings to Date

VOS Findings for HPL-Based and non-HPL Courses

During the spring 2003 semester, Cox and Bell (2003) analyzed Classroom Interaction Observation (CIO) data collected within in an HPL-based Biomechanics class, a non-HPL Biotechnology class, and a non-HPL Systems Physiology class at Vanderbilt University. For the three courses, the authors calculated the percent of time that HPL dimensions (knowledge-centered, learner-centered, assessment-centered, and community-centered) were used, differences in instructional patterns, and differences among the three faculty. Twenty-two HPL-based class sessions were observed and fifteen non-HPL class sessions were observed. Compared to non-HPL courses, HPL-based courses were more knowledge-centered (means=86.8 versus 85.0), more learner-centered (means= 14.5 versus 4.3), more assessment-centered (means=30.6 versus 15.9) and more community-centered (means=7.4 versus 0.6).

During the same semester, Bell, Cox, and Harris (2003) analyzed Student Engagement Observation (SEO) and Narrative Notes (NN) to compare student engagement levels and differences in teaching context within four sessions of one HPL-oriented Biomechanics class and within four sessions of one non-HPL Biomechanics class at Vanderbilt University. Approximately forty-six students were enrolled in each of the two classes. Consistent with previous findings (Roselli & Brophy, 2001; Cordray et al., 2003; Harris et al., 2002), the HPL-based course reported a higher occurrence of question-and-answer than non-HPL courses and greater instances of student collaboration.

Cox and Harris (2004) analyzed data within twenty-five bioengineering classrooms (one for each of twenty-five class sessions) during fall 2001 and spring 2002. Nine Global Ratings were taken in HPL-based classes, and sixteen Global Ratings were taken in non-HPL classes. Seven professors (two females and five males) were included in the sample. For the each of the seventeen items in the Global Ratings, VOS observers scored faculty Likert scale (0, 1, 2, or 3), depending upon the presence or absence of certain teaching behaviors. Frequencies were observed for HPL and non-HPL professors, and the percentage of observed instances was calculated. Although the authors found that the professors teaching HPL-based courses were more likely to exhibit teaching behaviors congruent with the HPL framework than non-HPL-based professors, non-HPL professors in this study were more likely to engage in continuous assessment during class period, use visual aids, and ask students more complex questions than their HPL counterparts.

Bioengineering Domain Findings about HPL-Based Instruction

VaNTH Observation System Findings in Biomechanics Classes

Harris et al. (2002) and Roselli and Brophy (2001, 2003) compared HPL-based Biomechanics classrooms to non-HPL Biomechanics classrooms. Harris et al. (2002) found that a professor who taught an HPL-based course spent less time lecturing than he did in the non-HPL version of the same course (effect size of -0.37). The professor also spent more time engaging in question-and-answer sessions in the HPL-based course than in the non-HPL course (effect size of 0.29). Using data collected with the VOS, Roselli & Brophy (2001) found that when comparing professors' pedagogical patterns within one HPL-based Biomechanics course and within two non-HPL Biomechanics courses, the HPL course contained more question and answer activities, and the non-HPL courses contained more lecture. Over time, the professor teaching the HPL-based Biomechanics course increased in the percent of class time spent in assessment-centered activities (7% to 32%) and the percent of class time spent in knowledge-centered activities (71% to 87%).

VaNTH Observation System Findings from an Optics Class

Jansen et al. (2003) report students' levels of engagement as captured by the Student Engagement Observation (SEO) portion of the VaNTH Observation System during the implementation of a biomedical optics HPL-based challenge. Using graphs of student engagement trends, the authors found that during non-HPL-based instruction, students were engaged initially, but began losing interest about halfway through the class period. During problem-based learning, or HPL-based activities, however, the students were not initially engaged (due to a longer set up time for HPL-based instruction) but maintained engagement from the middle to the end of the class period. In fact, student engagement monotonically increases during the entire class period.

VaNTH Observation System Research Summary

Direct observation methods confirm the presence of HPL elements within classes utilizing HPL-based pedagogy. HPL-based classes report higher instances of knowledge-, learner-, assessment-, and community-centered activities than non-HPL-based classes. In addition, when compared to traditional classes, HPL-based classes report higher occurrences of question-and-answer and student collaboration. Although these findings are encouraging, to date, there has been no direct assessment of the extent to which the VOS accurately measures dimensions of the HPL framework. Implied in the results of prior studies in the notion that HPL dimensions are additive, indexing the amount of HPLness in a given course. The meaning behind such an index has not been systematically examined. The CIO and the GR portions of the VOS have been used to index the extent to which HPL-inspired pedagogy is present, but the content of each portion of the VOS, relative to the HPL framework, has not been systematically examined, nor has the relationship between these two portions of the VOS. The next section examines the various ways in which the validity inferences from the VOS and its sub-parts can be examined.

Methods for Validating Classroom Observations Schemes

Judd et al. (1991) define validity as “the extent to which a measure reflects only the desired construct without contamination from other systematically varying constructs

(p. 51).” Educational researchers have examined the content, criterion, construct, discriminant, convergent, and concurrent for numerous K-12 classroom observation instruments. Validity of instrumentation has been investigated in a wide variety of topics. These include, for example, the emotional climate of a classroom (Hyson et al., 1990); the quality of classroom interactions (Bredekamp, 1986; Friedman, 1987; Elett et al., 1991); differences in classroom environments (Ross, 1976); students’ language arts skills (Tindal & Parker, 1987; Doherty et al., 2002); students’ achievement motivation (Chiu, 1997); students’ social anxiety (La Greca et al., 1988); students’ creative performance (Han, Marvin, and Walden, 2003); students’ time on-task (Stallings, 1978; Reed & Edelbrock, 1983); student functioning related to marital and family systems (Fish & Dane, 2000); students’ problem behaviors (Abikoff, 1977; Schachar et al., 1986; Lett and Kamphaus, 1992; Stage et al., 2002; Miller et al., 2004); teachers’ instructional performance and effectiveness (Wiersma, 1983; Brown & Wells, 1988; Cloud-Silva & Denton, 1989; Silverman & Buschner, 1990; Chauvin, 1991); and self-selected small task groups within classrooms (Keyton, 1985, 1987). The methods that researchers used to examine the validity of these instruments are described in the next section.

Content Validity

Content validity examines “the extent to which a measurement reflects a certain intended domain of content (Carmines & Zeller, 1991, p. 20).” Experts familiar with the domain are usually actively involved in the initial validation process. For example, using a three-step process, Fish and Dane (2002) examined the content validity of the

Classroom Systems Observation Scale, an instrument that assesses preschool through sixth-grade functioning related to a model of marital and family systems.

First, fifteen experts examined clinical definitions of an existent clinical scale, met in an informal group setting, and compiled a list of 150 items. The 150 items then were sent to 25 education, social work, family therapy, and school psychology experts. These experts reduced the scale to 75 items. A final group of twelve experts then examined the 75 items and placed them into subscales, rating each of the categories on a scale. After taking a series of half-hour to hour-long observations, observers tallied the behaviors that did or did not occur during the observation and reduced the final scale to forty-seven items—twenty that represented a Cohesion dimension, thirteen that represented a Flexibility dimension, and fourteen that represented a Communication dimension. From here, classroom observers collected data within nine suburban classrooms and within nine urban classrooms, resulting in a total of 118 observed pre-kindergarten to sixth-grade class sessions.

The authors tested the interobserver reliability, test-reliability, and scale intercorrelations of the final CSOS model. Statistically significant values were found at the $p < 0.01$ level when examining the test-retest reliability of the Cohesion dimension (0.77) and the Flexibility dimension (0.79). Using Pearson correlation coefficients to calculate scale intercorrelations, the authors also found statistically significant correlations between the Cohesion/Flexibility dimensions (0.54) and the Cohesion/Communication dimensions (0.34) at the $p < 0.01$ level. Factor analysis also confirmed the presence of the three dimensions within the study. The authors concluded that the final three dimensions are consistent over observers and time, are different from one another, and are accurate measures of the original theoretical framework.

Criterion Validity

Criterion validity is defined as “the degree to which an instrument’s scores are related to external criteria believed to measure the attribute of interest (Doherty et al., 2002, p. 83).” Several authors have examined the criteria of classroom instruments (Stallings & Freiberg, 1991; Tindal & Parker, 1987; Doherty et al., 2002).

Stallings and Freiberg (1991) compared Classroom Observation Interaction/ Stallings Observation System data output to the objectives of twenty-two Follow Through educational models, which were designed to assess instruction in classrooms for low-income students. For three days, two parts of the SOS, the Classroom Check List (CCL) and the Five-Minute Observation (FMO), were used to collect data within non-Follow Through and Follow Through classrooms. The CCL was used to collect data all three days, while an adult-focused FMO was used to collect data for two days and a child-focused FMO was used to collect data for one day. Different variables within the CCL and the FMO were used within the observed classes based upon the classes’ implementation of the Follow Through educational models. The authors applied the Spearman-Brown formula to evaluate the consistency of CCL and FMO correlations during the two days of adult-focused observations. A coefficient above 0.70 implies that a classroom maintains “approximately the same rank order on observed scores from day to day (Stallings, & Freiberg, 1991, 9. 117).” Variables within the CCL had consistency coefficients above 0.70 except for one variable, and variables within the FMO had consistency coefficients above 0.85 except for one variable. In sum, approximately 84% of the 140 coefficients had consistency coefficients greater than 0.70, and only one variable, the amount of time that a child was engaged within numbers, mathematics, and arithmetic, reported a low consistency coefficient across multiple Follow Through models.

In another study that examined the behaviors of special education students within two remedial language arts programs, “Breaking the Code” and “Eclectic,” Tindal and Parker (1987) compared classroom observation data to students’ word list reading scores from the beginning, middle, and end of the year and compared correlations between the two observation instruments. To collect the classroom data, two graduate students observed forty-eight hours of instructions within four “Breaking the Code” program classes and two “Eclectic” program classes for three months using a fifteen-second momentary time sample (MTS) instrument and a two-minute event record (ER) instrument. The MTS instrument noted the percent occurrence of academic engaged time for individual students during fifteen-second increments, and the ER instrument noted the frequency of discrete behaviors for individual students during each two-minute cycle.

The authors hypothesized that high response rates for reading, writing, and spelling on the ER would correlate positively with high engagement rates on the MTS. Results show that correlations between MTS and ER data range from 0.32 to 0.84 with all but one of the fifteen categories being significant at the $p < 0.05$ level. Since the “Eclectic” program focused more on oral and silent reading of text and the “Breaking the Code” emphasized spelling and writing letter combinations and words, the authors hypothesized that high reading test scores and the ER variable related to oral reading responses would correlate highly with “Eclectic” program results. Although the correlations between the “Eclectic” program and reading scores were higher than the correlations between “Breaking the Code” and reading scores, the coefficients were not significant at the $p < 0.05$ level for the ER instrument.

Similarly, to examine the criterion validity of the Standards Performance Continuum, Doherty et al. (2002) compared teachers’ pedagogy within language arts classes to five Standards Performance Continuum categories (i.e., joint productive activity, language and literacy development, contextualization, challenging activities, and instructional conversation) that were based upon the sociology of learning. The authors hypothesized that teachers with higher Standards Performance Continuum ratings would also report higher student normal curve equivalent scores on end-of-the-year standardized tests. For each standard, teachers received ratings from “0” to “4” where “4” means that teachers are using multiple standards simultaneously. Although students in classes where English was the language of instruction reported high SPC scores that predicted their language and vocabulary achievement, students within Spanish-speaking classes did not report higher English language and vocabulary achievement. The SPC scores for the English only classes were statistically significant at the $p < 0.05$ level.

Concurrent Validity

Doherty et al. (2002) define concurrent validity as “the degree to which scores on an instrument are related to scores on other instruments measuring the same dimensions administered at the same time (p. 81).” The instruments of interest within the concurrent validity portion of the study are the Standards Performance Continuum (Doherty et al., 2002), the Classroom Practices Inventory (Hyson et al., 1990) and the Direct Observation Form (Reed & Edelbrock, 1983).

In addition to noting the criterion validity of the Standards Performance Continuum, Doherty et al. (2002) examined the concurrent validity of the SPC by calculating correlations between the SPC, the Teacher Roles Observation Schedule (TROS), and the Classroom Observation Measure (COM). The TROS noted the purpose of nature of teacher's interactions via the observation on thirty-three dichotomous variables. The COM evaluated classroom organization and pedagogy via the use of twenty Likert-scale items. For the 177 class sessions, SPC data were collected in the same frequency as TROS and COM data, thereby resulting in multiple SPC ratings per observation during TROS data collection and one SPC rating per observation during COM data collection. The authors found a positive significant relationship between the SPC scores with the Purpose of Interaction and Nature of Interaction scores of the TROS (0.44 and 0.33, respectively). TROS items were regrouped, however, to represent the specific SPC standards. Correlations then ranged from 0.43 to 0.64. The authors also noted a significant correlation between the SPC scores and COM scores (0.54 where $p < 0.001$). No correlations were made to the SPC stand of contextualization, however, since this item is not represented within either the TROS or the COM.

Hyson et al. (1990) report information about the development of the Classroom Practices Inventory (CPI), a 26-item instrument exploring the emotional climate of educational programs for four- and five-year old children. Twenty items dealt with National Association for the Education of Young Children guidelines established for 4 to 5 year old children (ten appropriate behaviors and ten inappropriate behaviors), and six items related to the emotional climate of a classroom. Each item was rated using a five-point Likert scale (i.e., “not at all like this classroom” to “very much like this classroom”). Observers collected data within 207 classroom sessions for approximately 2 ½ hours, researchers. The majority of the observed classes were part of an Academic Environments study, which represented preschool programs with reputations as either very academic or very “nonacademic” or play-oriented. Factor analysis found that 53% of the variance within the CPI was represented by creativity via open-ended, divergent teacher-initiated questions. In looking at five academic and five “nonacademic” Academic Environments preschool programs, the authors found that differences between the two types of programs were significant ((t)8= -4.11, $p < 0.01$) and that the mean CPI score for the academic programs was 2.24, and the mean for the “nonacademic” program was 3.94 on a five-point scale. These results are consistent with the expectations for the “nonacademic” programs in the sample to focus more on creativity and playfulness.

Reed and Edelbrock (1983) assessed the validity of the Direct Observation Form by comparing in-class on-task behaviors to teachers’ reports of these same behaviors. Correlations between observed classroom behaviors using the DOF and teacher-reported problem behavior, school performance, and adaptive functioning were examined within two studies— (1) twenty-five boys who were referred for special services because of their emotional problems and (2) fifteen boys who were referred for special services because of their emotional problems and fifteen boys in the same classroom who had not been referred for special services. On average, results across two observers and the two studies report positive correlations between DOF –identified problem behaviors and teacher's ratings of problem behaviors and negative correlations between DOF-identified problem behaviors and school performance and adaptive functions.

Convergent Validity

Judd et al. (1991) define convergent validity as an "overlap between alternative measures that are intended to tap the same construct but have different sources of irrelevant, undesired variation (p. 54-55)." Stage et al. (2002) examined the convergent validity of the Teacher Functional Behavior Checklist. Convergent validity was assessed by examining the agreement between the items on the Teacher Functional Behavior Checklist and a sequential time-lag analysis for co-occurring problem behaviors during in-class structured activities. Each student received a TFBC at the beginning of six weeks. If students demonstrated disruptive behavior outside of normal classroom boundaries, teachers completed a TFBC. Students with three or more TFBCs during the six-week observation period were observed with peer comparisons. The researchers wanted to examine whether students with numerous TFBCs were more likely to demonstrate patterns of disruptive behavior, and they reported overall agreement of 63% (kappa = 0.41) between the TFBC identification or problem behaviors and the observation of problem behaviors within observed classrooms. In sum, teachers' ratings of problem behavior within their classrooms were consistent with the sequential time-lag analysis.

Flanagan et al. (1996) examine the convergent validity of the Behavior Assessment System for Children (BASC) and the Social Skills Ratings System (SSRS), two instruments that categorize children's social skills and emotional and behavioral disorders within forms that are distributed to both parents and teachers. Fifty-three New York City kindergarten students participated in the study. Correlations for the Social Skills scales of both instruments are 0.58 ($p < 0.001$) for parents and are 0.23 ($p > 0.05$) for teachers with significant correlations noted for the differences between the correlations at the $p < 0.03$ level. Correlations between the BASC's Adaptability subscales and the SSRS's Social Skills scale were moderate for teachers (0.44 at $p < 0.001$) and were higher for parents (0.54 at $p < 0.001$). Correlations between the BASC's Adaptive Skills Composite and the SSRS's Social Skills scale also were moderate for teachers (0.37 at $p < 0.01$) and were higher for parents (0.62 at $p < 0.001$). Low correlations were found, however, for the BASC Internalizing scale and the SSRS Problem Behaviors Scale for parents (0.26 at $p > 0.05$) and for the BASC Anxiety subscale and the SSRS Problem Behaviors scale for parents (0.03 at $p > 0.05$).

Application of the Literature to the VaNTH Observation System

In summary, all studies within the validity literature review occurred within K-12 classrooms. From previous classroom observation research, information can be determined about specific ways in which the validity of the VaNTH Observation System can be examined. Suggestions for validating this instrument are outlined below.

Content Validity

Although content validity usually is examined prior to the development of a classroom instrument, content validity may be used within this research to examine the extent to which HPL operational definitions used by VOS observers within the "HOW" category (i.e., knowledge-centered, learner-centered, assessment-centered, community-centered, and organization) of the Classroom Interaction Observation are congruent with definitions of the HPL framework as defined by Bransford, Brown, and Cocking (1999). Two of the four VOS components, the Classroom Interaction Observation and the Global Ratings, contain HPL terms and language and were developed to capture HPL-oriented behaviors during an observation. To examine content validity of these components, experts familiar with the HPL framework can be asked to evaluate the extent to which the Classroom Interaction Observation and the Global Ratings capture HPL elements as defined by Branford, Brown, and Cocking (1999).

Concurrent Validity

Although concurrent validity explores "the degree to which scores on an instrument are related to scores on other instruments measuring the same dimensions (Doherty et al., 2002, p. 81)," there is a limitation in examining the concurrent validity of the Classroom Interaction Observation portion of the VOS: no other direct observation instruments are available. Although survey data has been collected about HPL dimensions within bioengineering classrooms (Pion & Cordray, 2001; Cordray et al. 2003), these surveys have not been distributed to students in enough of the courses that were observed using the VOS. Moreover, the surveys were sent to samples of students in courses.

Convergent Validity

Alternative methods of recording interactions using the CIO can be undertaken as a partial assessment of the convergent validity of in-class method of data gathering. That is, each classroom observation could be coded in two ways: (1) the present manner (i.e., cyclic observations of the Classroom Interaction Observation, the Student Engagement

Observation, and the Narrative Notes followed by a one-time Global Ratings (see Figure 2-5) in actual classrooms, and (2) continuously coding of interactions (via the Classroom Interaction Observation) using videotaped classroom observations that correspond with the real-time VOS observations. This assessment would determine if the two methods agree on the HPL-content of the class sessions. Product moment correlations could be used to index the degree of agreement.

In addition, to assess the convergent validity of the Classroom Interaction Observation portion of the VOS, alternative methods of scaling "HPLness" using the Classroom Interaction Observation data can be undertaken. For each observation in the sample, the percent of individual HPL dimensions that are present can be derived (and summated into an index of "HPLness"). In addition, the percent of HPL-oriented instructional pedagogy can be derived using CIO code strings.

<u>Criterion Validity</u>

As reported earlier, there is some evidence that pedagogical styles differ between courses that are known to be HPL-based and those that are known to be based on traditional teaching methods. By contrasting "HPLness" scores (based on the CIO), a form of criterion validity could be undertaken. This type of validation process is also referred to as a criterion contrast. Here, it would be hypothesized that bioengineering courses that are designated to be HPL-oriented will have higher percentages of total HPL instruction in them, and bioengineering courses that are designated to be traditional will have lower percentages of total HPL instruction.

CHAPTER III

RESEARCH METHODOLOGY

Objectives

This chapter presents the research methodology for each of the five validity studies that will be conducted on the CIO and Global Rating portions of the VaNTH Observation System (VOS). Studies 1 and 2 examine the content domain (Carmines & Zeller, 1991) the CIO and GR portions of the VOS, respectively. Study 3 examines the convergent validity of alternative indices of the amount of HPL-based pedagogy that is present in classes. Study 4 examines the extent to which results converge when they are derived from alternative data gathering methods (i.e., sample of real-time coding vs. videotaped class sessions). Finally, Study 5 examines whether an index of "HPLness" discriminates between courses that are known to use HPL-based versus traditional pedagogy. This study provides evidence of the criterion validity of a newly developed HPL Index (from Study 3).

Study 1: Do Experts Agree with the VOS CIO HPL Dimensions?

Classroom Interaction Observation Content Validity Overview

The purpose of this study is to assess the extent to which experts agree with the use of the "HOW" category of the Classroom Interaction Observation in representing the "HPLness" of a course. During each three-minute CIO coding session, the "HOW" category notes the presence or absence of each HPL dimension and organization.[4] More specifically, VOS observers record observed classroom activities to be knowledge-centered (K), learner-centered (L), assessment-centered (A), community-centered (C), or organization (O). Within the "HOW" category, HPL dimensions and organization are regarded as mutually exclusive.

Having documented high inter-observer agreement for the "HOW" category of the CIO, attention can be directed at the content validity of the "HPLness" category resulting from the CIO.[5] The content validity of the "HOW" category of the CIO will be examined by examining the agreement between ratings (classifications) of trained VOS observers' use of the "HOW" category for twenty vignettes with the ratings of external experts, individuals who are familiar with the HPL framework of Bransford, Brown, and Cocking (1999). Comparisons of ratings across content experts will be examined as well as comparisons of ratings across vignettes. If HPL dimensions and organization are being coded accurately by VOS observers within classrooms, it is hypothesized that, across the twenty vignettes, there will be high agreement between VOS observers' and content experts' ratings of the HPL classifications.

Research Questions

There are two main questions of interest when examining the content validity of the CIO. First, how do VOS observers' classification of the presence of the four HPL

---

[4] In addition, the CIO makes provisions to record whether the instructor is engaging in behaviors associated with the organization or management of the class session.

[5] Agreement among trained VOS observers ranges from 95% to 100% for written vignettes and ranges from 87% to 95% for videotaped vignettes (VaNTH Annual Report, 2002).

dimensions (and organization) agree with those of content experts? That is, using the VOS observers' ratings as the 'gold standard' (i.e., whether an HPL dimension or organization is present or absent) do content expert agree? Second, because the VOS system does not specify the extent to which individual HPL dimensions are present within observed vignettes, the rating scheme that is being used allows for degrees of agreement. For this reason, it is expected that as the degree to which an HPL is present increases (e.g., from 2 or "only a little" to 4 or "to a great extent") that the rates of agreement will decline.

In addition, two sub-questions will be addressed to assess factors that influence agreement. First, looking at ratings across experts, it is possible that vignettes or types of vignettes will be more or less difficult for experts to agree upon. Here, there will be examination of the reasons for differences in average agreement, across vignettes. Second, because experts have different levels of experience with the HPL framework, it is expected that ratings of the vignettes will differ across the experts (e.g., professors, postdocs, graduate students, etc.). Again, the reasons for these differences will be investigated, if possible.

Sample

Eleven content experts familiar with the HPL framework were recruited for this study. Two experts are from Vanderbilt University (Nashville, Tennessee), two experts are from Northwestern University (Evanston, Illinois), five experts are from the University of Illinois (Chicago, Illinois), and two experts are from the University of

Texas (Austin, Texas). With the exception of the experts from the University of Illinois, content experts are associated with the VaNTH Engineering Research Center[6].

Methodology

To assess the extent to which the "HOW" category of the Classroom Interaction Observation portion of the VOS accurately captures the four dimensions of the HPL framework as defined by Bransford, Brown, and Cocking (1999), a survey containing twenty vignettes was distributed to each expert. Each expert rated the extent to which the four HPL dimensions (and organization) were present in the appropriate portion of the vignette. The survey instrument and supporting material are provided in Appendix A. Similar to research conducted by Kettle et al. (1998), this study sought content experts' views of theoretical concepts by asking the experts to categorize given classroom behaviors based upon their understanding of theoretical concepts.

To assure that the experts were using the same definitions for the HPL framework definitions, they were given a summary sheet that provided brief definitions of the major elements of the HPL framework and examples of four dimensions, as well as organization (Appendix A). After verbally discussing the given definitions and classroom examples with the author, content experts rated three orienting vignettes that were similar to actual Study 1 vignettes. They then rated the extent to which a highlighted portion of twenty one- to two-minute vignettes contained or did not contain HPL dimensions and organization as defined on the HPL summary sheet (Appendix A).

---

[6] Content experts included Sean Brophy, Karen Carney, Susan Goldman, Greg Light, Cherie McCullough, Banu Oney, Bob Plants, Jim Pelligrino, Anthony Petrosino, Joan Walker, and Bugra Yalvac.

Content for the vignettes was transcribed from videos of three undergraduate biomedical engineering classes at Vanderbilt University. One class was a Special Topics class taught by a female Research Assistant Professor, and another class was a Systems Physiology class taught by a female Associate Professor. The final class was a Biomechanics class taught by a male Full Professor. All of the classes utilized HPL-oriented materials during the semester, and the students in the vignettes were actual biomedical engineering students registered in the classes during the semester that the vignettes were transcribed.

Using a four-point Likert scale, content experts rated the extent to which organization, knowledge-centeredness, learner-centeredness, assessment-centeredness, and community-centeredness were present within the highlighted portion of each of the twenty vignettes. Figure 3-1 shows one of the actual vignettes given to content experts. The VOS observer defined "gold standard" concludes that knowledge-centeredness is present and learner-centeredness, assessment-centeredness, community-centeredness, and organization are absent. Content expert agreement with this "gold standard" will be calculated across the eleven content experts and across the twenty vignettes.

8) (The professor is talking about pressures in the heart.)
PROF: I want to focus today in particular on what's happening with the pressure.
PROF: So that's this middle, yellow band (refers to projected graphic).
PROF: But of course it's very closely- in fact, inescapably linked to what's happening in the very top band, and that's the electrocardiogram.
PROF: But again, and down here, what goes on down here (gestures to lower part of image) is also closely related to the volume issues here (gestures to middle part of image).
PROF: I want to look here at the pressures.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

Figure 3-1. Sample Assessment for the CIO Content Validity Study

Data Analysis

The percent agreement between VOS observers' CIO ratings of the highlighted portion of vignettes and content experts' CIO ratings of the same highlighted portions will be calculated for each HPL dimension, organization, and for HPL combinations across vignettes. For each of the 20 vignettes, Table 3-1 indicates how the VOS observers characterized the presence (noted with an "X") or absence (noted with a Blank) of each of the four HPL dimensions, as well as organization. For example, in vignette number 1, if experts agree with the VOS observers (the "gold standard"), they will indicate that only the knowledge dimension is present, at least to some extent. They also will indicate that learner, assessment and community are not present. As such, the experts agree with the

VOS "gold standard" if they correctly state that knowledge is present and they correctly say that the other three dimensions are absent. For the combined HPL dimensions, to be in agreement, the experts would have to correctly identify all the dimensions marked with an "X" and code the others as absent. This is a relatively stringent criterion for agreement.

Table 3-1. VOS Observers' HPL Combination Ratings ("Gold Standard")

Vignette Number	**HPL Dimensions**				**Organization**
	Knowledge	**Learner**	**Assessment**	**Community**	
1	X				
2				X	X
3	X	X	X	X	
4	X	X	X		
5	X	X	X		
6	X				
7	X	X	X		
8	X				
9				X	X
10	X	X	X	X	
11	X	X	X		
12	X	X	X		
13	X	X	X		
14	X	X	X		
15	X		X		
16	X		X		
17	X	X	X	X	
18	X		X		
19	X	X	X		
20	X	X	X		

The percent agreement between HPL content experts' ratings of the highlighted portion of each vignette and trained VOS observers' ratings of the same highlighted portion of each vignette across vignettes and across experts will be analyzed at three levels (ratings of 2 through 4 or "a little" through "a great deal") for each HPL dimension, organization, and for the HPL combinations. The degree to which an HPL dimension (or organization) is present can be examined by recoding the responses. The most liberal criterion for agreement is that any level of the dimension (2= a little, 3= some, 4=a great deal) is counted as agreement. By regarding agreement as including ratings of 2, 3, or 4, the most liberal degree of agreement implies that *at least* a little of the dimension is present. Constraining the agreement to ratings of 3 or higher means that at least some (3= some or 4= a great deal) dimension is present. The most stringent degree of agreement only counts responses of 4 (a great deal).[7] Naturally, as the inclusion criteria moves from liberal (2, 3 or 4) to stringent (only 4), we expect the degree of agreement on dimensions that are present to decline.

Study 2: How Well Does the Global Ratings Portion of the VOS Capture the HPL Dimensions?

Content Validity of the Global Rating: An Overview

The purpose of this study is to assess the extent to which the seventeen Global Ratings items used within the VOS represent the four HPL dimensions (Figure 2-4). These items are classified into one of the following categories: (1) signaling with cognitive organizers, (2) assessing students' understanding, or (3) maintaining lesson

---

[7] At the most liberal degree of analysis, original ratings of "1" will be recoded to a value of "0", and ratings of "2," "3," or "4" will be recoded as present with a value of "1." At the middle degree of analysis, original ratings of "1" or "2" will be recoded with a "0" to represent the absence of the dimensions or organization, and original ratings of "3" or "4" will be recoded as present with a value of "1." At the most stringent degree of analysis, original ratings of "1," "2," or "3" will be recoded with a "0" to represent the absence of the dimensions and organization, and original ratings of "4" will be recoded as present with a value of "1."

engagement. VOS observers use the Global Ratings items to rate the overall behaviors of the professors and their interactions with the class over the entire class session. To date, however, no one has rated the extent to which knowledge-centeredness, learner-centeredness, assessment-centeredness, and community-centeredness are captured by each of the Global Rating indicators. For this reason, content experts will be asked to assess the extent to the which VOS Global Rating indicators represent classroom organization and the four HPL dimensions as defined by Bransford, Brown, & Cocking (1999).

Because the Global Ratings indicators were designed to represent effective classroom pedagogical behaviors, it is hypothesized that the majority of the indicators reflect the principles of the HPL framework. Based upon experts' ratings of these indicators, an HPL scale (or subscales) will be created, assessed for reliability, and used to analyze observations associated with Studies 3 and 5.

Research Questions

Five research questions will be addressed in Study 2. First, to what extent does the Global Ratings (GR) portion of the VOS accurately capture the four dimensions of the HPL framework as defined by Bransford, Brown, and Cocking (1999)? Also, what is the percent agreement across content experts for each indicator, and what is the percent agreement among content experts across the indicators? Second, can GR indicators be grouped into subscales that represent HPL dimensions? Third, can GR subscales be used to create a Global Ratings HPL index that can be used to analyze current VOS data across semesters? Fourth, are certain GR indicators within this study problematic or difficult for experts to rate along the HPL dimensions and/or organization, and if so, why? Finally, are there differences in ratings of indicators across the eleven experts (e.g., professors, postdocs, graduate students, etc.), and if so, what are these differences?

Sample

The experts for Study 2 are the same content experts (11) used for Study 1.

Methodology

To assess the extent to which the Global Ratings portion of the VOS accurately captures the four dimensions of the HPL framework as defined by Bransford, Brown, and Cocking (1999), HPL content experts completed a protocol that was similar to the one used in Study 1. The protocol is reproduced as Appendix A. This protocol was completed by each expert after they rated the vignettes in Study 1. Again, they were asked to rate the extent to which knowledge-, learner-, assessment-, and community-centeredness (along with organization) were embodied (or represented) within each of the seventeen Global Ratings indicators. Similar to the CIO content validity study, experts used a "1" to note whether HPL dimensions and organization are present 'not at all,' a "2" to note whether HPL dimensions and organization are present 'only a little,' a "3" to note whether HPL dimensions and organization are present 'some,' and '4' to note whether HPL dimensions and organization are present 'a great deal.' Space was provided for experts to write comments about each indicator and the applicability of the HPL dimensions (Figure 3-2).

(1.) **“The professor provides a chronological outline of the steps of the lesson.”**

Given what you know about HPL, which label(s) best categorizes item #1?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

Figure 3-2. Example of a Global Indicator and Rating Scheme for the HPL Dimensions and Organization

Data Analysis

Data from this study will be analyzed in several ways. Since VOS observers have not classified Global Ratings indicators using the HPL dimensions and organization, there is no VOS observer “gold standard” for this study. Rather, comparisons of ratings across experts and across Global Ratings indicators will be examined to determine the consensus on how each indicator corresponds to the HPL dimensions at three levels. At the most liberal degree of analysis, original ratings of “1” for the indicators will be recoded to a value of “0”, and ratings of “2,” “3,” or “4” will be recoded as present with a value of “1.” At the middle degree of analysis, original ratings of “1” or “2” will be recoded with a “0” to represent the absence of indicators, and original ratings of “3” or “4” will be recoded as present with a value of “1.” At the most stringent degree of analysis, original ratings of “1,” “2,” or “3” will be recoded with a “0” to represent the absence of indicators, and original ratings of “4” will be recoded as present with a value of “1.” Across the cuts, for each indicator where an HPL dimension or organization is considered to be present, values will be summed across experts and across indicators to represent the percent agreement across experts and across indicators.

Study 3: Validity of the HPL Index from the “HOW” Portion of the CIO

Convergent Validity Overview

This portion of the research examines the convergent validity of two assessment methods that were created to analyze CIO data. The first method analyzes the HPL content distribution of the “HOW” category (i.e., the amount of knowledge-, learner-, assessment-, and community-centeredness) of the CIO for each class session (Norris et al., 2004). The sum of the observed instances for the dimensions is greater than 100% because some dimensions are not mutually exclusive. The second method is a newly-created HPL Index that uses entire CIO codes strings (all CIO categories) to analyze the percent of HPL-oriented instruction that occurs within each class session. The HPL-oriented instruction percent represents the interdependencies of the CIO, is a portion of an overall sum that equals 100%, and represents the total amount of HPL instruction within each class session.

Creation of the HPL Index

To examine the convergent validity of the CIO portion of the VOS an HPL Index was created. Since the existing CIO assessment method does not consider the interdependencies of all CIO categories in assessing the amount of “HPLness” within a class session, the HPL Index was developed to address the shortcomings of the first assessment method. In addition to looking at the interdependencies of the CIO code strings as a measure of “HPLness,” the second assessment method categorizes all non-HPL code strings as either traditional instruction or as classroom organization. The sum of all code strings equals 100% of the activity within the class session.

To create the HPL Index, members of the VOS assessment team classified over eighty current CIO code strings as representations of either HPL-oriented instruction (Table 3-2), traditional instruction (Table 3-3), or organization, which is represented by any code string in which the organization dimension is used. After the code strings were categorized and rubrics were created to classify all possible codes, a computer code was written and saved as an SPSS syntax file. With this SPSS file, clean CIO data files for each class could be analyzed quickly and consistently. Once the syntax was run for each class session file, the percent of individual instructional categories was calculated. Additional information about both the classification of the code strings and the SPSS syntax used to analyze CIO data is located in Appendix B.

Within the HPL Index, the total percent of HPL instruction can be further represented by eleven sub-categories. These sub-categories include higher-order questioning by the instructor, higher-order questioning by the class, guidance by the instructor, HPL-oriented lecture, HPL-oriented comments, HPL-oriented praise, HPL-oriented monitoring, HPL-oriented question and response, HPL-oriented correction, use of a Personal Response System, and no response in an HPL-oriented environment. An example of an HPL-oriented activity is the professor using the computer as he asks a higher order question to the entire class. He is also applying knowledge-centered, learner-centered, and assessment-centered principles.

Table 3-2. CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification (HPL Index Category)**	**Possible Interactions**
1	Prof asks student(s) or visitor a higher order question.	Higher order questioning is a part of HPL-oriented instruction. *(Higher order questioning by the instructor)*	(a) Prof asks the entire class a higher order question. (b) Prof asks an initial student a higher order question. (c) Prof asks the same student a higher order question. (d) Prof asks a small subgroup of students a higher order question. (e) Prof asks a large subgroup of students a higher order question. (f) Prof asks a visitor a higher order question.
2	Student(s) or a visitor initiates a higher order question.	Higher order questioning is a part of HPL-oriented instruction. *(Higher order questioning by the class)*	(a) An initial student asks the prof a higher order question. (b) An initial student asks another student a higher order question. (c) The same student asks the prof a higher order question. (d) A small subgroup of students asks the prof a higher order question. (e) A large subgroup of students asks the prof a higher order question. (f) A visitor asks the prof a higher order question.
3	Prof guides student(s) or visitor to a correct answer.	Guiding students to answers is a part of HPL-oriented instruction. *(Guidance by the instructor)*	(a) Prof guides the entire class to a correct answer. (b) Prof guides an initial student to a correct answer. (c) Prof guides the same student to a correct answer. (d) Prof guides a small subgroup of students to a correct answer. (e) Prof guides a large subgroup of students to a correct answer. (f) Prof guides a visitor to a correct answer.
4	Media presents information related to academic content to students as they use the Personal Response System (PRS).	The PRS provides formative feedback to students, so this is an HPL activity. *(Use of a Personal Response System)*	(a) Media provides instruction to the entire class. (b) Media presents activity-related information to the entire class.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
5	Media presents information related to academic content to students as they use the Personal Response System (PRS). This information also draws on students' preconceptions, skills, prior experience, knowledge, and/or beliefs.	The PRS provides formative feedback to students as they engage in learner-centered activities, so this is an HPL activity. *(Use of a Personal Response System)*	(a) Media provides instruction to the entire class. (b) Media presents activity-related information to the entire class.
6	Media presents information related to academic content to students as they use the Personal Response System (PRS). This information also draws on students' preconceptions, skills, prior experience, knowledge, and/or beliefs as they work in collaborative groups.	The PRS provides formative feedback to students as they engage in learner-centered activities. Students are also working in groups, so this is an HPL activity. *(Use of a Personal Response System)*	(a) Media provides instruction to the entire class. (b) Media presents activity-related information to the entire class.
7	The prof asks a group of students a lower-level fact question about academic content.	Students are working in collaborative groups, so this is HPL-oriented behavior. *(HPL-oriented question and answer)*	(a) Prof asks a small subgroup of students a fact question. (b) Prof asks a large subgroup of students a fact question.
8	The prof responds to a group of students' questions about academic content.	The prof responds to students as they work in collaborative groups, so this is an HPL-oriented activity. *(HPL-oriented question and answer)*	(a) Prof responds to a question asked by a small subgroup of students. (b) Prof responds to a question asked by a large subgroup of students.
9	One student asks another student a lower-level fact question about academic content.	Since students are interacting with one another in class, this is very community-centered. For this reason, this is HPL-oriented. *(HPL-oriented question and answer)*	(a) An initial student asks another student a fact question.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
10	A student responds to another student about academic content.	Since students are interacting with one another in class, this is very community-centered. For this reason, this is HPL-oriented. *(HPL-oriented question and answer)*	(a) An initial student responds to another student's fact question.
11	A group of students ask the professor a lower-level fact question about academic content.	Students are working in groups, so even though the question's lower-level, HPL activities are still occurring. *(HPL-oriented question and answer)*	(a) A small subgroup of students asks the prof a fact question. (b) A large subgroup of students asks the prof a fact question.
12	A group of students respond to a professor's question about academic content.	Students are working in collaborative groups. This is an HPL-oriented activity. *(HPL-oriented question and answer)*	(a) A small subgroup of students responds to a question asked by the prof. (b) A large subgroup of students responds to a question asked by the prof.
13	Professor asks students/visitor a lower-level question about academic concepts. A question draws on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	Since this question is a learner-centered question, it is HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof asks the entire class a fact question. (b) Prof asks an initial student a fact question. (c) Prof asks the same student a fact question. (d) Prof asks a visitor a fact question.
14	Professor asks students/visitor a lower-level fact question about academic concepts as they work in collaborative groups.	Students are working in collaborative groups, so this is HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof asks a small subgroup of students a fact question. (b) Prof asks a large subgroup of students a fact question.
15	Professor asks a group of students a lower-level fact question about academic concepts. This question draws on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	Although this question is lower-level, it draws upon students' backgrounds. I think that it is HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof asks a small subgroup of students a fact question. (b) Prof asks a large subgroup of students a fact question.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
16	Professor responds to students' or a visitor's question about academic concepts. The original question drew on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	Formative assessment is occurring and learner-centered elements are seen. This is mainly HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof responds to a question asked by the entire class. (b) Prof responds to a question asked by an initial student. (c) Prof responds to a question asked by a same student. (d) Prof responds to a question asked by a visitor.
17	Professor responds to students' questions about academic concepts as they work in collaborative groups.	Prof is giving feedback to students as they work in groups. This is HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof responds to a question asked by a small subgroup of students. (b) Prof responds to a question asked by a large subgroup of students.
18	Professor responds to students' questions about academic concepts. The original question drew on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	Prof is giving feedback about learner-centered elements as students work in groups. This is HPL-oriented. *(HPL-oriented question and answer)*	(a) Prof responds to a question asked by a small subgroup of students. (b) Prof responds to a question asked by a large subgroup of students.
19	Students or a visitor ask a lower-level fact question to the prof about academic concepts. The original question drew on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	Since a student or visitor is asking a question that is learner-centered, it is primarily HPL-oriented. *(HPL-oriented question and answer)*	(a) An initial student asks the prof a fact question. (b) The same student asks the prof a fact question. (c) A visitor asks the prof a fact question.
20	A group of students ask the professor a lower-level fact question about academic concepts. Students are working in collaborative groups.	Students are working in collaborative groups, so this is HPL-oriented. *(HPL-oriented question and answer)*	(a) A small subgroup of students asks the prof a fact question. (b) A large subgroup of students asks the prof a fact question.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
21	A group of students ask a lower-level question to the prof about academic concepts. The question drew on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	Students are working in collaborative groups and are using learner-centered elements. This is an HPL-oriented activity. *(HPL-oriented question and answer)*	(a) A small subgroup of students asks the prof a fact question. (b) A large subgroup of students asks the prof a fact question.
22	Students respond to the prof's question about academic content. The question draws on students' preconceptions, skills, prior experiences, etc.	Students are giving feedback to the professor and are using learner-centered elements. This is HPL-oriented. *(HPL-oriented question and answer)*	(a) The entire class responds to a question asked by the prof … (b) An initial student responds to a question asked by the prof. (c) A same student responds to a question asked by a prof. (d) A visitor responds to a question asked by the prof.
23	A group of students respond to the prof's questions about academic concepts as they work in collaborative groups.	Students are working in groups, so this is HPL-oriented. *(HPL-oriented question and answer)*	(a) A small subgroup of students responds to the prof's question. (b) A large subgroup of students responds to the prof's question.
24	A group of students respond to the prof's questions about academic concepts. This question draws on students' preconceptions, skills, etc. as they work in collaborative groups.	This gives information about the nature of the question, which is learner-centered. Students are also working in groups. This is HPL-oriented. *(HPL-oriented question and answer)*	(a) A small subgroup of students responds to the prof's question. (b) A large subgroup of students responds to the prof's question.
25	One student asks another student a lower-level fact question about academic concepts. This question also draws on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	Students are interacting as a community during group work. The question draws in learner-centered elements as well, so this is HPL-oriented. *(HPL-oriented question and answer)*	(a) An initial student asks another student a fact question.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
26	One student responds to another student about academic concepts. This question also draws on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	A student is giving feedback to another student using learner-centered elements and involves the community of students. This is HPL-oriented. *(HPL-oriented question and answer)*	(a) An initial student responds to another student's question
27	The professor lectures to a group of students about academic content.	This is an HPL-oriented activity, since students are working in groups. *(HPL-oriented lecture)*	(a) Prof lectures content to a small subgroup of students… (b) Prof lectures content to a large subgroup of students
28	The professor lectures to students about academic content while drawing on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	This is a lecture using learner-centered elements. This is an HPL-oriented activity. *(HPL-oriented lecture)*	(a) Prof lectures content to the entire group… (b) Prof lectures content to an initial student… (c) Prof lectures content to the same student…
29	The professor lectures to students about academic content while students work in collaborative groups.	Students are working in collaborative groups, so this in an HPL-oriented activity. *(HPL-oriented lecture)*	(a) Prof lectures content to a small subgroup of students… (b) Prof lectures content to a large subgroup of students…
30	The professor lectures to students about academic content while drawing on students' preconceptions, skills, prior experiences, knowledge, and/or beliefs. Students are working in collaborative groups.	Prof is lecturing using learner-centered elements. Students are also working in groups as lecture occurs. This is HPL-oriented. *(HPL-oriented lecture)*	(a) Prof lectures content to a small subgroup of students… (b) Prof lectures content to a large subgroup of students…
31	Professor makes a comment that is tangentially related to academic content to a group of students.	A professor makes a comment as students work in groups. This is HPL-oriented behavior. *(HPL-oriented comment)*	(a) Prof makes a related comment to a small subgroup of students… (b) Prof makes a related comment to a large subgroup of students…

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
32	A group of students make a comment tangentially related to academic content to the professor.	Students' working in groups illustrates HPL-oriented behavior. *(HPL-oriented comment)*	(a) A small subgroup of students makes a related comment to the prof. (b) A large subgroup of students makes a related comment to the prof.
33	One student makes a comment tangentially related to academic content to another student.	Students are engaged with each other within the community of the classroom, so this is an HPL-oriented activity. *(HPL-oriented comment)*	(a) An initial student makes a related comment to another student.
34	Professor makes a comment tangentially related to academic content to students or a visitor. The comment draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The comment contains learner-centered elements, so this is HPL-oriented. *(HPL-oriented comment)*	(a) Prof makes a related comment to an entire group of students. (b) Prof makes a related comment to an initial student. (c) Prof makes a related comment to same student. (d) Prof makes a related comment to a visitor.
36	Professor makes a comment tangentially related to academic content to students as they work in collaborative groups.	Students are working in groups so this is considered to be HPL-oriented. *(HPL-oriented comment)*	(a) Prof makes a related comment to a small subgroup of students. (b) Prof makes a related comment to a large subgroup of students.
37	Professor makes a comment tangentially related to academic content while giving feedback to students. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The feedback is learner-centered so this represents HPL activities. *(HPL-oriented comment)*	(a) Prof makes a related comment to an entire group of students. (b) Prof makes a related comment to an initial student. (c) Prof makes a related comment to same student. (d) Prof makes a related comment to a visitor.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
38	Professor makes a comment tangentially related to academic content while giving feedback to students. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, etc. Students are working in collaborative groups.	All HPL elements are present so this is clearly HPL-oriented. *(HPL-oriented comment)*	(a) Prof makes a related comment to a small subgroup of students. (b) Prof makes a related comment to a large subgroup of students.
39	Students or a visitor makes a comment tangentially related to academic content. The feedback draws upon students' preconceptions, skills, prior experiences, etc.	The comment contains learner-centered elements, so this is HPL-oriented. *(HPL-oriented comment)*	(a) An initial student makes a related comment to the prof. (b) The same student makes a related comment to the prof. (c) A visitor makes a related comment to the prof.
40	A group of students make a comment tangentially related to academic content. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs. Students are working in collaborative groups.	This contains multiple HPL elements. *(HPL-oriented comment)*	(a) A small subgroup of students makes a related comment to the prof. (b) A large subgroup of students makes a related comment to the prof.
41	Students make a comment tangentially related to academic content to the professor as they work in collaborative groups.	Students are working in groups, so this is an HPL-oriented activity. *(HPL-oriented comment)*	(a) A small subgroup of students makes a related comment to the prof. (b) A large subgroup of students makes a related comment to the prof.
42	Students provide feedback to the professor about activities that are related to academic content. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	This contains multiple HPL elements. *(HPL-oriented comment)*	(a) An initial student makes a related comment to the prof. (b) The same student makes a related comment to the prof. (c) A visitor makes a related comment to the prof.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
43	Students provide formative or summative feedback to the professor about activities that are related to academic content. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs. Students are working in collaborative groups.	This contains all HPL elements. *(HPL-oriented comment)*	(a) A small subgroup of students makes a related comment to the prof. (b) A large subgroup of students makes a related comment to the prof.
44	A student provides feedback to another student about activities that are related tangentially to academic content.	Students are interacting in the community of the classroom, so this is an HPL-oriented activity. *(HPL-oriented comment)*	(a) An initial student makes a related comment to another student…
45	A student makes a comment tangentially related to academic content to another student. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	Since the comments are learner-centered and allow students to interact with one another, this is HPL-oriented. *(HPL-oriented comment)*	(a) An initial student makes a related comment to another student.
46	A student provides feedback to another student about activities that are related tangentially to academic content. The feedback draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	Multiple HPL elements are seen here. *(HPL-oriented comment)*	(a) An initial student makes a related comment to another student.
47	The professor praises/ acknowledges a group of students during assessment of academic content.	Students are working in groups, so this is an HPL-oriented activity. *(HPL-oriented praise)*	(a) Prof praises a small subgroup of students. (b) Prof praises a large subgroup of students.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
48	The professor praises/ acknowledges students assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The professor praises/acknowledges and gives feedback to students about their learner-centered questions or comments. This is HPL-oriented. *(HPL-oriented praise)*	(a) Prof praises the entire group. (b) Prof praises an initial student. (c) Prof praises the same student. (d) Prof praises a visitor.
49	The professor praises/ acknowledges a group of students during assessment of academic content as they work in collaborative groups.	Students are working in groups, so this is an HPL-oriented activity. *(HPL-oriented praise)*	(a) Prof praises a small subgroup of students. (b) Prof praises a large subgroup of students.
50	The professor praises/ acknowledges students assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	This contains all of the HPL elements. *(HPL-oriented praise)*	(a) Prof praises a small subgroup of students. (b) Prof praises a large subgroup of students.
51	A group of students does not respond to a question presented by the professor during assessment of academic content.	Students are working in groups, so this is an HPL-oriented activity. *(No response in an HPL-oriented environment)*	(a) A small subgroup of students does not respond to the professor's question. (b) A large subgroup of students does not respond to the professor's question.
52	The professor monitors groups of students from the front of the room during assessment of academic content.	Students are working in groups, so this is an HPL-oriented activity. *(HPL-oriented monitoring)*	(a) Professor passively monitors a small subgroup of students.
53	The professor monitors students from the front of the room during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The prof is monitoring students as they are assessed on learner-centered elements. This is HPL-oriented. *(HPL-oriented monitoring)*	(a) Professor monitors the entire class.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
54	The professor monitors students from the front of the room during assessment of academic content as students work in collaborative groups.	Students are engaged in assessment as they work in collaborative groups. This is HPL-oriented. *(HPL-oriented monitoring)*	(a) Professor monitors the entire class. (b) Professor monitors a small subgroup of students.
55	The professor monitors students from the front of the room during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	All HPL elements are being used. *(HPL-oriented monitoring)*	(a) Professor monitors a small subgroup of students.
56	The professor walks among students during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The prof is walking among students as they are assessed on learner-centered elements. This is HPL-oriented. *(HPL-oriented monitoring)*	(a) Professor monitors the entire class.
57	The professor walks among students during assessment of academic content as students work in collaborative groups.	Students are engaged in assessment as they work in collaborative groups. This is HPL-oriented. *(HPL-oriented monitoring)*	(a) Professor monitors a small subgroup of students.
58	The professor walks among students during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as they work in collaborative groups.	All HPL elements are being used. *(HPL-oriented monitoring)*	(a) Professor monitors a small subgroup of students.
59	The professor corrects a group of students or a visitor during assessment of academic content.	Students are working in groups, so this is HPL-oriented behavior. *(HPL-oriented monitoring)*	(a) Prof corrects a small subgroup of students. (b) Prof corrects a large subgroup of students.

Table 3-2 (continued). CIO Code Strings That Represent HPL-Oriented Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
60	The professor corrects students or a visitor during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs.	The professor is correcting students' views of concepts. Learner-centered elements are used. This is HPL-oriented. *(HPL-oriented correction)*	(a) Prof corrects the entire group of students. (b) Prof corrects an initial student. (c) Prof corrects the same student. (d) Prof corrects a visitor.
61	The professor corrects students during assessment of academic content as students work in collaborative groups.	Professor is correcting students' views of concepts as they work in groups. This is HPL-oriented. *(HPL-oriented monitoring)*	(a) Prof corrects a small subgroup of students. (b) Prof corrects a large subgroup of students.
62	The professor corrects students during assessment of academic content. The question draws upon students' preconceptions, skills, prior experiences, knowledge, and/or beliefs as students work in collaborative groups.	All HPL elements are being used. *(HPL-oriented monitoring)*	(a) Prof corrects a small subgroup of students. (b) Prof corrects a large subgroup of students.
63	Professor, students, or a visitor uses the Personal Response System (PRS).	The PRS provides formative feedback to students and professors, so this is an HPL-oriented activity. *(Use of a Personal Response System)*	(a) Prof uses the PRS. (b) An initial student uses the PRS. (d) The same student uses the PRS. (e) A small subgroup of students uses the PRS. (f) A large subgroups of students uses the PRS. (e) A visitor uses the PRS.
64	The Personal Response System (PRS) provides information about academic content to students or to the professor.	The PRS provides formative feedback to students and professors, so this is an HPL-oriented activity. *(Use of a Personal Response System)*	(a) Media (PRS) gives information to the entire class.

Within the HPL Index, the total percent of traditional instruction is represented by eight sub-categories. These categories include the following: instruction by media, traditional question and response, traditional lecture, traditional comments, no response in a traditional manner, traditional monitoring, traditional praise, and traditional correction. An example of a traditional classroom activity is the professor lecturing to all students using no media. The professor is focused on content knowledge, but she is using traditional pedagogy to deliver the material.

Table 3-3. CIO Code Strings That Represent Traditional Instruction

Item #	**Classroom Activity**	**Justification for Classification**	**Possible Interactions**
1	Media provides instruction or presents information related to academic content to students.	Media provides general information to students but does not require that students engage deeply in the instruction. This is traditional behavior. *(Instruction by media)*	(a) Media provides instruction to the entire class. (b) Media presents activity-related information to the entire class.
2	The prof asks student(s) or a visitor a lower-level fact question about academic content.	Lower-level questioning does not require that students generate deep answers to questions. This is a traditional classroom behavior. *(Traditional question and answer)*	(a) Prof asks the entire class a fact question. (b) Prof asks an initial student a fact question. (c) Prof asks the same student a fact question. (d) Prof asks a visitor a fact question.
3	The prof responds to students' or visitor's questions about academic content.	Responding to students' questions about academic content is an expected, traditional classroom activity. *(Traditional question and answer)*	(a) Prof responds to a question asked by the entire class. (b) Prof responds to a question asked by an initial student. (c) Prof responds to a question asked by a same student. (d) Prof responds to a question asked by a visitor.
4	Student(s) or visitor responds to a professor's question about academic content.	Responding to a question about academic content is an expected, traditional classroom activity. *(Traditional question and answer)*	(a) The entire class responds to a question asked by the prof. (b) An initial student responds to a question asked by the prof. (c) A same student responds to a question asked by a prof. (d) A visitor responds to a question asked by the prof.

Table 3-3 (continued). CIO Code Strings That Represent Traditional Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
5	Student(s) or visitor asks the prof a lower-level fact question about academic content.	Lower-level questioning does not require that students generate deep answers to questions. This question might even be a clarification question. This is a traditional classroom behavior. *(Traditional question and answer)*	(a) An initial student asks the prof a fact question. (b) The same student asks the prof a fact question. (c) A visitor asks the prof a fact question.
6	Multiple students respond to a professor's question about academic content.	Students aren't working in groups, and multiple students respond to the question. Responding to a question about academic content is a traditional classroom activity. *(Traditional question and answer)*	(a) A small group of students respond to the prof's question. (b) A large group of students respond to the prof's question.
7	The professor lectures to students about academic content.	This is a traditional classroom activity. *(Traditional lecture)*	(a) Prof lectures to the entire group. (b) Prof lectures content to an initial student. (c) Prof lectures content to the same student.
8	Professor makes a comment that is tangentially related to academic content to students or to a visitor.	This is a traditional classroom behavior. *(Traditional comment)*	(a) Prof makes a related comment to the entire group. (b) Prof makes a related comment to an initial student. (c) Prof makes a related comment to the same student. (d) Prof makes a related comment to a visitor.
9	Students or a visitor makes a comment tangentially related to academic content to the professor.	This is a traditional classroom behavior. *(Traditional comment)*	(a) An initial student makes a related comment to the prof. (b) The same student makes a related comment to the prof. (c) A visitor makes a related comment to the prof.
10	Professor makes a comment tangentially related to academic content while giving feedback to students.	This is a traditional classroom activity. *(Traditional comment)*	(a) Prof makes a related comment to an entire group of students. (b) Prof makes a related comment to an initial student. (c) Prof makes a related comment to same student. (d) Prof makes a related comment to a visitor.

Table 3-3 (continued). CIO Code Strings That Represent Traditional Instruction

Item #	Classroom Activity	Justification for Classification	Possible Interactions
11	Students provide feedback to the professor about activities that are tangentially related to academic content.	Providing feedback is typical. The quality of the feedback is not noted, so this represents a traditional classroom activity. *(Traditional comment)*	(a) An initial student makes a related comment to the prof. (b) The same student makes a related comment to the prof. (c) A visitor makes a related comment to the prof.
12	The professor praises/ acknowledges students or a visitor during assessment of academic content.	This is typical classroom behavior. *(Traditional praise)*	(a) Prof praises the entire group. (b) Prof praises an initial student. (c) Prof praises the same student. (d) Prof praises a visitor.
13	Students or a visitor do not respond to a question presented by the professor during assessment of academic content.	Students' not responding to the professor is a traditional classroom behavior. *(Traditional no response)*	(a) The entire class does not respond to the professor's question. (b) An initial student does not respond to the professor's question. (c) The same student does not respond to the professor's question. (d) A visitor does not respond to the professor's question.
14	The professor monitors students from the front of the room during assessment of academic content.	Monitoring is a passive behavior that is a traditional classroom activity. *(Traditional monitoring)*	(a) Professor passively monitors the entire class.
15	The professor walks among students during assessment of academic content.	Professors are walking among the class as they complete seatwork. This is traditional. *(Traditional monitoring)*	(a) Professor monitors the entire class.
16	The professor corrects students during assessment of academic content.	This is typical classroom behavior. *(Traditional correction)*	(a) Prof corrects the entire group of students. (b) Prof corrects an initial student. (c) Prof corrects the same student. (d) Prof corrects a visitor.

Research Question

The prior research using the VOS has characterized the "HPLness" of a class session or course as the percent of class time devoted to knowledge-, learner-, assessment- or community-centeredness as derived from the "HOW" category within the CIO portion of the VOS. Since Bransford, Brown, and Cocking's HPL framework focuses upon the interdependencies of the HPL dimensions, however, an HPL Index that reflects these interdependencies is introduced in this research. Therefore, the research question for Study 3 asks, “To what extent does this newly-created HPL Index accurately reflect the prevalence of HPL-based pedagogy in a class or course?”

Sample

For this portion of the study, data collected by trained VOS observers during five semesters (spring 2002, fall 2002, spring 2003, fall 2003, and spring 2004) will be used. As of May 2004, observers had taken 182 classroom observations in twenty-eight (28) biomedical engineering-related courses. Table 3-4 lists the courses observed each semester along with the number of classes observed within that course.

Table 3-4. Biomedical Engineering Courses and the Number of Classes Observed Using the VaNTH Observation System

Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004
HPL Courses Biomedical Optics (8) Biotechnology (8) Biomechanics (5)	**HPL Courses** Biomedical Optics (4) Freshman Seminar-Electrocardiogram (5) Freshman Seminar-Optics (4) Systems Physiology (9)	**HPL Courses** Biomechanics (6) Biopharmaceuticals (10)	**HPL Courses** Freshman Seminar-Electrocardiogram (2) Biomechanics (4) Transport (7)	**HPL Courses** Bioethics (7) Biotechnology (13) Biomedical Optics (8) Biomechanics (8) Medical Imaging (5)
Non-HPL Courses Biopharmaceuticals (7)	**Non-HPL Courses** Systems Physiology (8) Freshman Seminar-Electrocardiogram (3) Biomechanics (10)	**Non-HPL Courses** Biotechnology (5) Systems Physiology (7)	**Non-HPL Courses** Senior Design (7) Freshman Seminar-Electrocardiogram (2) Transport (5)	**Non-HPL Courses** Section 1-Bioinstrumentation (5) Section 2-Bioinstrumentation (10)

Methodology

Similar to Stage et al.'s (2000) convergent validity study, this study will examine the agreement between two different ways of defining the same construct. Specifically, correlations between HPL dimension values using the current CIO assessment method (Norris et al, 2005) and between the HPL instruction scores within the HPL Index will be calculated.

Data Analysis

Microsoft Excel CIO data files for each class in the sample will be imported into SPSS and will be analyzed using the two assessment methods. For the current assessment method, this means that for each observation, the percent of knowledge-, learner-, assessment-, and community-centeredness will be calculated using the using data from the "HOW" category within the CIO. For the HPL Index, sets of code strings representing organization, HPL-oriented instruction, and traditional instruction will be combined. The percentage of class time devoted to organization, HPL instruction, and traditional instruction will be calculated. The correlations will be used to assess the extent to which these two indices produce comparable data.

Study 4: Convergent Validity of Alternative Data Gathering Methods for the CIO Portion of the VOS

Convergent Validity Overview

This study examines the convergent validity of two alternative methods of gathering data for the Classroom Interaction Observation portion of the VOS. The first scheme represents the current data collection method. For this study, twenty separate course sessions are rated using the full VOS. Recall that within the CIO portion of the VOS, data is gathered in real-time, within the cycle of a three-minute Classroom Interaction Observation, followed by a thirty- to sixty-second Student Engagement Observation, followed by one- to two-minute Narrative Notes. At the conclusion of the class session, a set of Global Ratings are taken (see Study 2). The alternate scheme collects data via videotape in the same twenty classes. An alternate VOS coding scheme collects CIO data continuously throughout the observation. The HPL Index created within Study 3 will be used to contrast the results from the two schemes (sample of real-time coding versus videotape). It is hypothesized that if the current, sample of real-time coding of classes (using the CIO portion of the VOS) is accurately recording classroom activities, there will be a positive correspondence between CIO data coded using the current VOS scheme within "live" classrooms and CIO data coded using the alternate VOS scheme within videotaped classrooms.

Research Question

One research question will be addressed within Study 4. Namely, when comparing relative data gathering from a continuous videotaped version of a class session, does the current CIO/VOS data collection method (cycles of time-sampled behaviors) accurately represent what occurs during an entire class?

Sample

The research participants in this study are faculty and students within select Vanderbilt University biomedical engineering classes taught in the spring semester of 2004. Students and the five faculty members were given information about the VaNTH ERC, the VOS, and the purpose of this study prior to data collection and video recording.

Twenty (20) class sessions were observed and recorded during the spring 2004 semester. The five courses included (1) an HPL-oriented Biomechanics class taught by a Full Professor, (2) a non-HPL-oriented Bioinstrumentation class taught by an Assistant Professor, (3) an HPL-oriented Medical Imaging class taught by an Associate Professor, (4) an HPL-oriented Biotechnology class taught by an Associate Professor, and (5) an HPL-oriented Bioethics taught by a Research Associate Professor. Five observations were taken in the Biomechanics class, five observations were taken in the Bioinstrumentation class, one observation was taken in the Medical Imaging class, six observations were taken in the Biotechnology class, and three observations were taken in the Bioethics class. The professors of both the Bioinstrumentation and the Bioethics classes taught their classes for the first time during the semester that the observations were taken.

Methodology

Similar to validity studies conducted by Han, Marvin and Walden (2003), Hyson et al. (1990), and La Greca et al. (1998), this study examines the convergent validity of two "instruments" that measure the same constructs. Since the VOS is the only known direct observation instrument that has been developed specifically to record the presence of HPL dimensions within classrooms, the relationship between two VOS coding schemes will be examined across twenty class sessions. From the two VOS data recording schemes (sample of real-time coding versus recording based on continuous videotape), the primary focus of analysis for both schemes will be the CIO since each CIO code string (pertaining to 4-6 seconds of behavior) is intended to record information about the HPL dimensions and HPL-oriented classroom behaviors that are present and absent during an observation period.

Using real-time sampling observation methods, the first VOS coding scheme collected classroom data for the sample of classes using all components of the VOS and its original data collection strategies. This means that for each observed class session, the VOS observer continuously coded a three-minute Classroom Interaction Observation (CIO), followed by a 30 to 60 second Student Engagement Observation (SEO), followed by one- to two- minute Narrative Notes, and concluded with a one-time end-of-class Global Ratings assessment. Within a fifty-minute class, between 300 and 450 CIO code strings could be recorded.

The second VOS coding scheme collected classroom data for the sample of classes using two components (the CIO and GR) of the VOS and an alternate VOS data collection scheme (videotape). That is, while the regular VOS observations were being undertaken, the session was also videotaped. The CIO and GR coding procedures were then applied to the entire videotaped course. The VOS observer continuously coded an ongoing CIO concluded with a one-time end-of-class Global Ratings assessment. Using the second coding scheme within a fifty-minute class, between 500 and 750 CIO code strings could be recorded. This means that about 200 to 300 more CIO codes will be recorded by the alternate VOS scheme versus the original VOS scheme.

Data Analysis

The CIO data files for the twenty classes coded real-time and the CIO data files for the same twenty classes coded from videotape will be transferred from Microsoft Excel files into SPSS files. The HPL Index developed within Study 3 will be used to calculate the percent of HPL instruction for the classes using the alternate coding schemes. CIO data for a class currently lists the original date of the observation, the observed professor's name, a time stamp for each CIO code string, the CIO cycle number, and the presence or absence of items within the CIO *who, to whom*, *what*, *how*, and *media* categories.

For each set of CIO data, the SPSS syntax created to assess the CIO data will be run. The percent of total class time spent in organizational activities, HPL-oriented instruction, and traditional instruction will be reported for the twenty classes. Values for both the sample of real-time CIO data and for the videotaped CIO data will be analyzed, and correlations and profiles for two coding schemes will be presented. These results should show whether CIO data collected using the current, sampled VOS data collection method accurately represents what occurs during an entire class, along with the extent to which an entire class session is not captured by time-sampled CIO data.

Study 5: Criterion Validity of the HPL Index

Criterion Validity Overview

This study examines the criterion validity of the HPL Index (see Study 3) derived from the Classroom Interaction Observation portion of the VOS. As seen in Table 3-2, within the Biomedical Engineering Program at Vanderbilt University there are courses that are known to be using the HPL framework; observations have also been take in courses that are known to follow traditional pedagogical practices. If the HPL index derived in Study 3 adequately captures true HPL practices, it should be sensitive enough to register pedagogical differences in these two types of courses. Being able to distinguish between two contrasting groups yields evidence of criterion validity of the index. It is hypothesized that higher HPL instructional scores (on average) will be found within HPL courses and that lower HPL instructional scores (on average) will be found within traditional courses.

Research Question

The main question for this study is “Is the HPL Index derived in Study 3 sensitive enough to capture HPL-related differences in courses that are known to employ HPL or traditional pedagogy?”

Sample

The same twenty-eight courses used in Study 3 are analyzed in this study.

Methodology/ Data Analysis

Data will be grouped based upon the classification of courses as either HPL-oriented or traditional courses. The HPL Index (based on the Classroom Interaction Observation) will calculate the percent of HPL instruction, traditional instruction, and organization for all courses. Comparisons for fifteen known HPL courses versus thirteen courses that entail traditional pedagogy will be made.

CHAPTER IV

RESULTS

Classroom Interaction Observation Overview

The validity of the CIO portion of the VOS is necessary, since it provides the majority of quantitative information about the presence and absence of HPL dimensions within classrooms. VOS observers attend intensive, multi-day training sessions prior to collecting CIO data in actual classrooms. Before collecting data with a handheld Personal Data Assistant (PDA), observers code written classroom vignettes using pencil and paper. The content of the vignettes is coded into Classroom Interaction Observation code strings every four to six seconds at the speed of speech. These code string gather information about who is initiating an action in the classroom (e.g., professor or visitor), to whom the first person is responding (e.g., the entire class or a small group of students), the type of interaction this is occurring (e.g., lecture or higher order questioning), the HPL dimensions that are present at that time (i.e., knowledge-centered, learner-centered, assessment-centered, or community-centered), and any media that is being used (e.g., computer, video, or simulation) (Figure 2-1). After three minutes of CIO coding, observers collect data using two other parts of the VOS. This cycle continues until the end of the class session.

Results for Study 1: Content Validity of the Classroom Interaction Observation Portion of the VOS

Classroom Interaction Observation Content Validity Overview

Currently, the "HPLness" of an observed class session is captured within the Classroom Interaction Observation portion of the VOS. More specifically, one part of a CIO code string, the "HOW" category, reports the HPL dimensions and/or organization that VOS observers observe within each CIO code string. Prior to asking the content experts to rate the vignettes, VOS observers had defined the HPL dimensions and organization elements that they thought were and were not present within each vignette (Table 3-1). VOS observers' ratings therefore are considered to be the "gold standard," or the criteria by which HPL dimensions and/or organization are present or absent within the vignettes.

Agreement across Individual HPL Dimensions and Organization (Twenty Vignettes)

Table 4-1 reports the average percentage of agreement between the 11 experts and the ratings given to each vignette by the VOS team (the gold standard) at the least stringent level of agreement. Results are reported at this level since VOS observers have rated HPL dimensions as present or absent and have not rated the extent (i.e., "only a little," "some," or "a great deal") to which the HPL dimensions are present. As can be seen, when agreement is defined as ratings of "a little" or more (or codes 2, 3, or 4) the average percentage agreement ranges from 68.2% to 78.6% for the four HPL dimensions, with and average across the four dimensions of 71.4%. For the correct combinations of HPL dimensions ascribed by the VOS team, the average agreement is only 24.6%. Table

4-1 reveals that requiring the presence of a dimension to be greater for agreement (i.e., 3 or some, 4 or a great deal) reduces the average agreements rates rather substantial. For this reason, the remainder of the discussion in this section will focus on the most liberal definition of agreement (i.e., the dimension is present *at least a little*). Appendix C (Tables 1, 2, and 3) provides detailed accounting of the rates of agreement, by expert and vignette for each of the three definitions of agreement.

Table 4-1. Percent Agreement for Different Degrees of Strength of HPL Dimensions, Organization, and Combinations of HPL Dimensions

Degree to Which Dimension is Present	HPL Dimensions					Organi-zation	Combi-nation
	Know-ledge	Learner	Assess-ment	Com-munity	Average Agree-ment		
A Little or More	78.6%	66.2%	79.1%	69.1%	73.3%	71.4%	24.6%
Some or More	58.2	61.0	69.6	65.5	64.8	64.8	16.4
A Great Deal	36.8	42.0	41.8	55.5	48.6	48.6	7.7

Using the liberal definition of agreement (the presence of HPL dimensions is noted by overall ratings of 2, 3, or 4 or “a little” or more), agreement varies across the individual HPL dimensions and organization (Table 4-1). For the knowledge-centered dimension, average agreement across vignettes and across experts is 78.64% with total agreement across experts ranging from 60% to 95% and with total agreement across vignettes ranging from 27% to 100% (see Appendix C, Table 4). For the learner-centered dimension, average agreement across vignettes and across experts is 66.2% with total agreement across experts ranging from 55% to 75% and with total agreement across vignettes ranging from 9% to 100% (see Appendix C, Table 5). For the assessment-centered dimension, average agreement across vignettes and across experts is 79.1% with total agreement across experts ranging from 55% to 95% and with total agreement across vignettes ranging from 18% to 100% (see Appendix C, Table 6). For the community-centered dimension, average agreement across vignettes and across experts is 69.1% with total agreement across experts ranging from 25% to 100% and with average agreement across vignettes ranging from 36% to 100% (see Appendix C, Table 7). Finally, for organization, average agreement across vignettes and across experts is 71.4% with total agreement across experts ranging from 30% to 95% and with total agreement across vignettes ranging from 0% to 90.91% (see Appendix C, Table 8).

Table 4-2. Percent Agreement for HPL Dimensions, Organization, & Combinations across Twenty Vignettes for Individual Experts and Across Eleven Experts (Ratings of "2" or Greater)

Expert ID	**Knowledge-Centered**	**Learner-Centered**	**Assessment-Centered**	**Community-Centered**	**Organization**	**VOS Combina-tions**
9051	90	75	85	55	65	35
9763	90	75	55	80	85	25
3641	70	70	85	25	40	5
2855	75	70	80	80	90	45
0001	60	60	85	100	90	30
0021	65	65	60	100	75	15
3191	80	60	80	45	50	15
3476	75	70	90	60	75	25
5522	90	75	95	80	30	15
7673	95	75	85	90	90	50
7028	75	55	70	45	95	10
Avg. %	**78.6**	**66.2**	**79.1**	**69.1**	**71.4**	**24.6**

The individual HPL dimensions with the lowest total percent agreement across all vignettes and across all experts are the learner-centered dimension and the community-centered dimension, and the individual HPL dimensions with the highest total percent agreement across all vignettes and across all experts are the knowledge-centered and assessment-centered dimensions (Table 4-2).

HPL Combination Agreement

Although individual HPL dimensions have been defined extensively, at the heart of the HPL framework is the idea that the four dimensions are interdependent. For this reason, agreement between experts and observers about the presence of the HPL dimension combinations within the highlighted portion of each vignette represents the strongest test of content validity. As such, agreement was calculated across vignettes and across content experts across three cuts of the data. These three cuts note combinations of ratings where content experts rate HPL dimensions and/or organization to be present "not at all" (rating of 1), "only a little" (rating of 2), "some" (rating of 3), or "a great deal" (rating of 4).

Using the most liberal definition of agreement for the HPL combinations (the presence of HPL dimensions are noted by overall ratings of "2," "3," or "4"), average agreement across vignettes and across experts is 24.6% (Table 4-2). This number represents the extent to which content experts and VOS observers identically identify the presence and absence of multiple HPL dimensions within the vignettes. Individual content expert agreement for all vignettes at this level ranges from 5% to 50%, and individual vignette agreement across experts ranges from 0% to 63.64% (see Appendix C, Table 1).

At the middle level of analysis for the HPL combinations (the presence of HPL dimensions is noted by overall ratings of “3” or “4”), average agreement across vignettes and across experts is 16.4% (Table 4-1). Individual content expert agreement for all vignettes at this level ranges from 0% to 45%, and individual vignette agreement across experts ranges from 0% to 54.55% (see Appendix C, Table 2).

Finally, at the most stringent level of analysis for the HPL combinations (the presence of HPL dimensions is noted by overall ratings of “4”), average agreement across vignettes and across experts is 7.7% (Table 4-1). Individual content expert agreement for all vignettes at this level ranges from 0% to 35%, and individual vignette agreement across experts ranges from 0% to 36.4% (see Appendix C, Table 3). Comments that might explain this variance are located in Appendix D.

Results for Study 2: Content Validity of the Global Ratings Portion of the VOS

Global Ratings Content Validity Overview

This portion of the research examines the extent to which the Global Ratings portion of the VOS represents the four HPL dimensions. Content experts used a similar method of rating as was undertaken in Study 1 to rate the seventeen Global Ratings indicators. The total percent agreement, across content experts, is calculated. From here, Global Ratings HPL subscales are created, and the reliability of the subscales are calculated using Cronbach’s alpha (1951).

Content Experts' Agreement across Global Ratings Indicators

Eleven content experts rated the extent to which each of the seventeen Global Ratings indicators used by VOS observers at the end of an observation represent knowledge-, learner-, assessment-, and community-centeredness. They also rated whether the indicator referred to class management (i.e., organization). For each indicator, items that initially were rated with values of "2" (HPL dimension or organization is present 'only a little'), "3" (HPL dimension or organization is present 'some'), or "4" (HPL dimension or organization is present 'a great deal'), were identified and recoded with a value of "1" to represent a liberal definition of the presence of HPL dimensions or organization. The recoded ratings indicate the dimension is *at least a little* present or implied by the indicator. Items that initially were rated with a "1" (HPL dimension or organization is present 'not at all') were recoded with a value of "0" to represent the absence of HPL dimensions or organization. The seventeen indicators along with the percent agreement across content expert for the seventeen indicators are reported in Table 4-3. A dimension is considered to be present within an indicator if agreement across experts is 80% or greater.

Table 4-3 also shows that, across the four HPL dimensions and organization, the coverage of HPL dimensions is variable. Experts rated 10 items as knowledge-centered (α = 0.669), 12 items as learner-centered (α = 0.842), and 8 items as reflecting assessment-centeredness (α = 0.766). One item (Indicator 17) represented community-centeredness but was also classified as representing learner-centeredness. Only one item represented organization (Indicator 1).

Table 4-3. Percent Agreement across Global Ratings Indicators and Content Experts (Presence of HPL Rated with Values of “2,” “3,” or “4”)

Global Rating Indicator	**Knowledge-Centered**	**Learner-Centered**	**Assessment-Centered**	**Community-Centered**	**Organization**
1. Professor presents a chronological outline.	45.2%	18.2%	9.1%	9.1%	**100%**
2. Professor provides lesson objectives to students.	**100**	54.6	54.6	18.2	63.6
3. Professor signals the lesson’s unfolding and linkages.	**90.9**	45.4	9.1	18.2	54.6
4. Professor presents an HPL challenge.	**100**	**100**	72.7	54.6	45.5
5. Professor makes connections to students’ prior learning.	**81.8**	**100**	18.2	27.3	18.2
6. Professor checks students’ understanding of a concept before a lesson.	72.73	**90.9**	**100**	36.4	27.3
7. Professor checks students’ understanding of a concept during the lesson.	**81.8**	**90.9**	**100**	45.5	18.2
8. Professor seeks student assessment of what they learned and/or do not understand after a lesson.	63.6	**100**	**100**	45.5	36.4
9. Students ask clarifying questions.	**81.8**	**81.8**	**81.8**	45.5	0
10. Students ask extending questions.	**90.9**	**100**	**81.8**	36.4	9.1
11. Professor makes eye contact with students.	0	45.5	18.2	27.3	36.4
12. Professor moves among students.	0	18.2	36.4	54.5	45.5
13. Professor uses appropriate visual aids to explain the lesson.	**90.9**	**90.9**	9.1	9.1	36.4
14. Professor encourages/ accepts student questions.	63.6	**100**	**81.8**	54.5	27.3
15. Professor asks clarifying questions to students.	**81.8**	**90.9**	**100**	36.4	27.3
16. Professor asks hypothetical questions to students.	**81.8**	**90.9**	**90.9**	63.6	9.1
17. Students collaborate in in-class problem solving.	63.6	**90.9**	63.6	**100**	27.3
Number of Items	10	11	8	1	1
Cronbach’s Alpha	**0.669**	**0.842**	**0.766**	**None**	**None**

Of the seventeen indicators, content experts agree that three indicators (i.e., Indicators 1, 11, and 12) do not appear to represent aspects of the HPL dimensions, and only one indicator (Indicator 17) represents community-centered activities. More specifically, content experts report that professors' providing a chronological outline of the steps of the lesson primarily represents classroom organization. Experts report that professors' making periodic eye contact with all parts of the class and moving among students represent neither the HPL framework nor organization.

Content experts agree that the remaining thirteen indicators clearly represent one of four subscales-- (1) knowledge-centeredness only, (2) knowledge- and learner-centeredness, (3) learner- and assessment-centeredness, and (4) knowledge-, learner-, and assessment-centeredness (Table 4-4). Consistent with the notion that HPL-dimensions are overlapping (or that they co-occur), Table 4-4 also shows that experts generally viewed the items as reflecting more than one HPL dimension (or organization). For example, experts agree that item 4 (Professor presents an HPL challenge) reflected at least a little knowledge and learner-centeredness. Item 9 (Students ask clarifying questions) was seen as representing three of the four HPL dimensions; namely, knowledge-, learner- and assessment-centeredness.

Experts think that communicating a lesson's chronological order and signaling a lesson's unfolding/linkages primarily represent the knowledge-centered dimension. The experts report that providing an HPL challenge, making connections to prior learning, and using appropriate visual aids to illustrate a lesson represent both the knowledge-centered and learner-centered dimensions. In addition, content experts think that ongoing assessment of students' understanding during a lesson, students' asking questions for additional clarification, students' asking extending questions, the professor asking clarifying questions, and the professor asking hypothetical questions primarily represent knowledge-, learner-, and assessment-centered dimensions. Finally, content experts think that pre-assessment of students' understanding of a concept, post-assessment of students' understanding after a lesson, and encouraging/accepting student questions comprise learner- and assessment-centered dimensions.

Table 4-4. Classification of Global Ratings Indicators into Subscales

Global Rating Indicator	**Dominant HPL Dimensions (80% or Greater Agreement)**
1- Communicating the lesson's chronological order	Organization
2- Communicating the lesson's behavioral objectives	Knowledge-Centered
3- Signaling the lesson's unfolding/linkages	Knowledge-Centered
4- Providing an HPL challenge	Knowledge- & Learner-Centered
5- Making connections to prior learning	Knowledge- & Learner-Centered
6- Pre-assessment of students' understanding of a concept	Learner-, & Assessment-Centered
7- Ongoing assessment of students' understanding during a lesson	Knowledge-, Learner-, & Assessment-Centered
8- Post-assessment of students' understanding after a lesson	Learner-, & Assessment-Centered
9- Students' asking questions for additional clarification	Knowledge-, Learner-, & Assessment-Centered
10- Students' asking extending questions (e.g., What if?)	Knowledge-, Learner-, & Assessment-Centered
11- Making eye contact with students	No Dimensions Present
12- Moving among students	No Dimensions Present
13- Using appropriate visual aids to explain the lesson	Knowledge- & Learner-Centered
14- Encouraging/accepting student questions	Learner-, & Assessment-Centered
15- Professor asking clarifying questions	Knowledge-, Learner-, & Assessment-Centered
16- Professor asking hypothetical questions	Knowledge-, Learner-, & Assessment-Centered
17- Students collaborating with others in in-class problem solving	Community-Centered

Global Ratings Subscale Reliability

Content experts' original ratings ("1" means that an HPL dimension or organization are not present; "2," "3," or "4" means that an HPL dimension or organization are present) for the Global Ratings indicators were used to calculate Cronbach's alpha for the four final subscales below (Table 4-5). The highest correlation is found for the knowledge-, learner-, and assessment centered subscale (α=0.91). Correlations are also high for the knowledge- and learner-centered subscale (α=0.75) and for the learner- and assessment-centered subscale (α=0.74). The lowest correlations are found for the knowledge-centered subscale (α=0.59).

Table 4-5. Cronbach's Alpha Values for Global Ratings Subscales

Global Ratings Subscale	**Cronbach's Alpha for Subscales**
Knowledge-Centered (Items 2, 3)	**0.59**
Knowledge- and Learner-Centered (Items 4, 5, 13)	**0.75**
Knowledge-, Learner-, and Assessment-Centered (Items 7, 9, 10, 15, 16)	**0.91**
Learner- and Assessment-Centered (Items 6, 8, 14)	**0.74**

Agreement across Experts

The average agreement across experts was 91.5% where the presence of HPL dimension(s) or organization are noted by content experts' ratings of "2" (present "only a little"), "3" (present "some"), or "4" (present "a great deal"). The criterion of 80% agreement or higher across the indicators was used to declare that a dimension was represented by an indicator. When looking at differences in agreement across the eleven content experts, it is found that the lowest total percent agreement across experts is found for a researcher and for a tenure-track faculty member (Table 4-6). Experts with about 90% agreement across indicators are two doctoral students and a researcher. Experts with 100% agreement across indicators include three researchers and three tenure-track faculty. In summary, there is no distinguishing difference between content experts with less professional educational experience and content experts with more professional educational experience.

Table 4-6. Total Percent Agreement across Experts for the Global Ratings Indicators

Expert ID	Job Title	Percent Agreement with other Experts (Ratings of “2,” “3,” or “4”)
9051	Postdoctoral Research Assistant	**89.7%**
9763	Doctoral Student	**89.7**
3641	Research Associate	**100.0**
2855	Full Professor	**75.9**
0001	Doctoral Student	**89.7**
0021	Research Associate	**62.1**
3191	Full Professor	**100.0**
3476	Associate Professor	**100.0**
5522	Associate Professor	**100.0**
7673	Postdoctoral Research Assistant	**100.0**
7028	Assistant Research Professor	**100.0**

Problematic Global Ratings Indicators

Content experts do not see the relationship between the four HPL dimensions and three Global Ratings indicators- (1) a professor’s providing a chronological outline of the steps of a lesson, (2) a professor’s making periodic eye contact with students, and (3) a professor’s moving among students. First, all content experts agree that a professor’s use of a chronological outline is an organizational activity, not an HPL-oriented activity. For this indicator, one expert wrote that a “chronological outline is not theoretical” in nature.

Second, all content experts rate the HPL dimensions and organization to be absent when professors make eye contact and move among students during in-class activities. One expert wonders if the professor's eye contact with students is supposed to engage students in the activity, and another expert thinks that the periodic eye contact might be used to monitor students' attention during class and to engage students in interpersonal contact with the professor. The latter expert also thinks that a professor's movement among students "might be to promote interpersonal connections and/or community or to monitor engagement." In sum, the majority of the experts state that since they do not know *why* the professor is making eye contact and moving among students, they did not think that these indicators explicitly relate to the four HPL dimensions.

Results for Study 3: Convergent Validity of the CIO Portion of the VOS

Convergent Validity Overview

This portion of the research examines the convergent validity of the Classroom Interaction Observation portion of the VOS. Two assessment methods were used to analyze CIO data within 182 class sessions. The first assessment method represents the "HOW" category of the CIO portion of the VOS by analyzing the total percent of individual HPL dimensions (i.e., knowledge-centeredness, learner-centeredness, assessment-centeredness, and community-centeredness) that are present within each session's CIO data. The second assessment method, also known as the HPL Index, represents the interdependencies of all CIO categories within the VOS and analyzes the total percent of integrated HPL dimensions that are present within each session's CIO data. Correlations and differences between the two assessment methods are reported.

Correlations between Two CIO Assessment Methods

Table 4-7 reports the correlations of 182 class sessions in which CIO data were analyzed using the two CIO assessment methods that represent the amount of "HPLness" within observed sessions. The left column lists individual HPL dimensions and HPL dimension combinations that were of interest within the first assessment method. The second column displays the correlations between portions of the first assessment method and the scores within the HPL Index.

The correlations offer some insight into the weaknesses and strengths of the two assessment methods. The low correlation (r = -0.16) between the knowledge-centered dimension within the first assessment method and between the HPL Index score implies that there are differences in the types of knowledge that is reported within the two assessment methods. The correlations between the HPL Index scores and the remaining individual HPL dimensions and HPL combinations within the first assessment method are high, however, and are positively correlated as the individual HPL dimensions are combined within the first assessment method. The correlations between the HPL dimension combination scores and the HPL Index scores imply that both assessment methods represent the same underlying HPL constructs, although the knowledge-centered dimension is a constant when combined with other HPL dimensions. The high correlation between the HPL Index score and the sum of the knowledge-, learner-, assessment-, and community dimension within the first assessment method shows that the HPL Index considers the interdependencies among the HPL dimensions.

Table 4-7. Correlations between Two CIO Assessment Methods

Direct Classification of HPLness (Using Individual HPL Dimensions)	**New HPL Index (HPL Instructional Sum Using Code Strings)**
Knowledge-Centered (Knowledge %)	**-0.16**
Learner-Centered (Learner %)	**0.78**
Assessment-Centered (Assessment %)	**0.66**
Community-Centered (Community %)	**0.49**
Learner-Centered + Community-Centered (Learner % + Community %)	**0.80**
Learner-Centered + Assessment-Centered + Community-Centered (Learner % +Assessment % + Community %)	**0.87**
Knowledge-Centered + Learner-Centered + Assessment-Centered + Community-Centered (Knowledge % + Learner % + Assessment % + Community %)	**0.79**

Results for Study 4: Alternative Methods of Gathering CIO Data

Convergent Validity Overview

Since the newly-created HPL Index represents the interdependencies of the HPL dimension as seen within the previous convergent validity study, it will be used examine the convergent validity of the CIO by analyzing CIO data collected using two alternative data gathering schemes. The first scheme uses the current, real-time, VOS data gathering scheme (cycle of a three-minute Classroom Interaction Observation, followed by a thirty- to sixty-second Student Engagement Observation, followed by one- to two-minute Narrative Notes, and concluded with a one-time Global Ratings assessment at the end of class) within twenty actual class sessions. The second data gathering scheme uses an alternate VOS data gathering scheme, namely, a continuous videotape of the class session that is then coded using the Classroom Interaction Observation portion of the VOS. The author is a trained VOS observer and coded all classroom session within the sample. It is hypothesized that if the current CIO portion of the VOS is accurately recording classroom activities, there will be a positive correspondence between CIO data collected as a sample of the real-time class and CIO data collected via videotape.

Sample of Real-Time Versus Videotaped Class Sessions: Convergence of Two Methods

The correlations between the two methods of data gathering were substantial for the organization sub-category ($r = 0.95$), for the HPL-instruction sub-category ($r= 0.85$), and for the traditional instruction sub-category ($r = 0.89$) of the newly developed HPL Index. Given the sizable correlations between the HPL sub-categories for the sample of real-time and videotaped methods of data gathering, it appears that the current method of data collection underlying the CIO portion of the VOS accurately represents what occurs during an entire class session. Figure 4-1 shows the total average percent of organization, HPL-oriented instruction, and traditional instruction that is present across the twenty classes within the sample. The profiles are similar for both the sample of real-time data and the videotaped CIO data. Figure 4-2 shows that the sub-categories of the HPL-oriented activities are also similar for both data gathering methods.

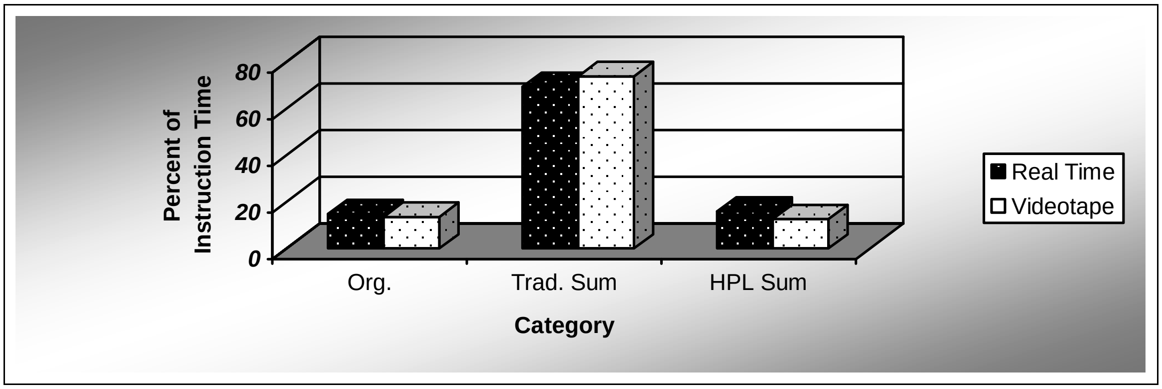

Figure 4-1. Profiles across Code String Categories

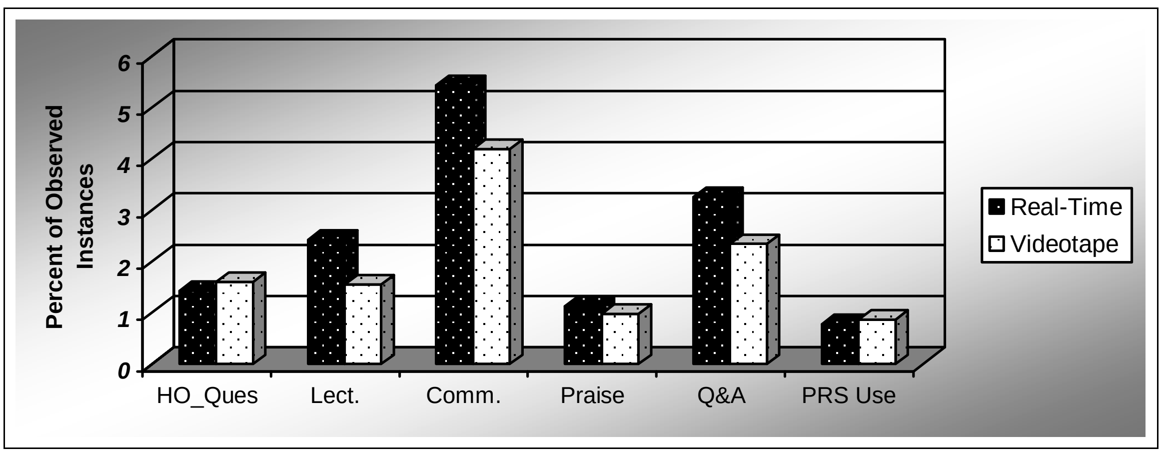

Figure 4-2. Profiles across Sub-Categories of HPL-Based Instruction

Results for Study 5: Criterion Validity of the New HPL Index

Criterion Validity Overview

To further examine the HPL Index's ability to capture the amount of "HPLness" of observed classes, the criterion validity of the Index is examined. This is done by examining whether the newly developed HPL Index distinguishes between courses that are known to follow HPL-oriented or traditional pedagogical styles. The comparison or criterion contrast is based on twenty-eight bioengineering courses—seventeen that primarily use HPL-oriented pedagogical practices and eleven that primarily use traditional engineering practices. Five semesters (spring 2002 to spring 2004) of VOS data were used for this study, and 182 class session observations were taken. Using CIO data from these 182 class sessions, this research used the HPL Index to calculate the average percent of HPL instruction that is present within classes that are designated as HPL-oriented and traditional classes by year. It is hypothesized that on average, known HPL-based courses will reveal higher average levels of HPL instruction than traditionally-taught courses.

Comparisons across Traditional and HPL-Oriented Courses

Classes within the sample were classified as HPL-oriented or traditional for each of the five semesters by VaNTH ERC researchers. CIO data for each of the twenty-eight courses were analyzed using the newly developed HPL Index that classifies entire CIO code strings as either organization, HPL-oriented, or traditional. Average HPL Index scores across the semesters for both types of classes are reported in Figure 4-3.

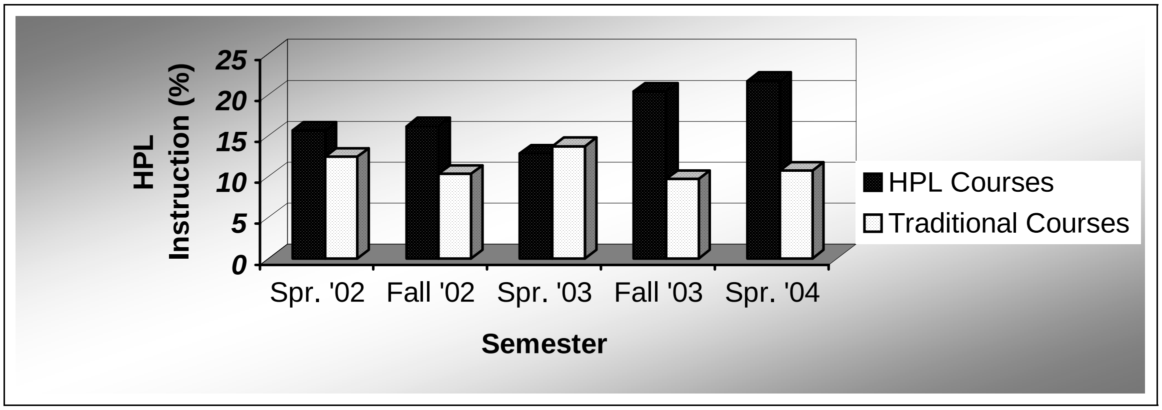

Figure 4-3. HPL Instruction Score Comparisons across HPL-Oriented and Traditional Bioengineering Courses

Distinct differences are noted between courses that are designated as HPL courses and between courses that are designated as traditional courses. For every semester except the spring 2003 semester, the HPL-designated courses report a higher percent of HPL instruction than traditional courses. During spring 2002, the average HPL instruction sum across the three HPL-oriented courses is 15.6%, and the average HPL instruction sum for the traditional course is 12.5%. Similarly, for fall 2002, the average HPL instruction sum across the four HPL-oriented courses is 16.2%, and the average HPL instruction score across the three traditional courses is 10.4%. During spring 2003, however, the average HPL instruction sum for the traditional courses is 13.8%, although the average HPL instruction sum for both HPL-oriented courses is 12.8%. During fall 2003, the average HPL instruction sum for the three HPL-designated courses jumps considerably to 20.5%, and the HPL instruction sum for the three traditional courses drops to 9.7%. In the final semester of observation, the HPL instruction sum for the HPL-designated courses is 21.7%, and the HPL instruction sum for the two traditional courses is 10.7%.

A closer look at the data may offer some explanations about the HPL trends across the semesters. First, during spring 2003, one of the HPL professors in the sample taught using HPL pedagogical practices for the first time. His inexperience using HPL-oriented materials may have resulted in his lower than average total HPL instruction score of 2.95%. During that same semester, however, a professor teaching a traditional course did not use HPL materials but incorporated several HPL-like practices within his course, therefore resulting in a relatively high HPL instruction sum of 18.1% when compared to his traditional counterparts. Instances such as this led to a separation of the courses in three ways: (1) traditional courses, (2) HPL courses taught by "seasoned" professors-- professors who have taught using HPL-oriented materials for more than one semester, or (3) HPL courses taught by "novice" professors—professors who are teaching using HPL-oriented materials for the first time.

Comparisons across Traditional, HPL "Seasoned," and HPL "Novice" Courses

Dividing the HPL courses into those taught by "novice" HPL professors and those taught by "seasoned" HPL professors provides an even more detailed view of differences between HPL-oriented and traditional courses. Figure 4-4 shows comparisons across the three groups for four of the most dominant HPL instruction categories—lecture, comments, monitoring, and question and response. The results present averages across courses and semesters for faculty who teach within one of the three course types. Ten courses (i.e., Biotechnology (2), Biomechanics (3), Freshman Seminar, Transport, Optics, Bioethics, and Medical Imaging) are included in the HPL "seasoned" course category. Seven courses (i.e., Optics (2), Freshman Seminar (2), Physiology, Biomechanics, and

Biopharmaceuticals) are included in the HPL “novice” course category. Eleven courses (i.e., Biopharmaceuticals, Physiology (2), Freshman Seminar (2), Biomechanics, Biotechnology, Transport, Senior Design, and Bioinstrumentation (2)) are included in the traditional course category.

Figure 4-4 shows comparisons across four HPL categories-- lecture, comments, monitoring, and question/answer. The average percent of HPL instruction across semesters for the HPL “seasoned” course, the HPL “novice” course, and the traditional course are 22.11%, 12.3%, and 11.05%, respectively. HPL “seasoned” courses report higher percentages of HPL-oriented lecture, comments, monitoring, and question/answer than both HPL “novice” courses and traditional courses. The graph also shows that on average, HPL “novice” courses have slightly higher percentages of HPL-oriented comments and question/answer than traditional courses, although traditional courses report higher percentages of HPL-oriented lecture and monitoring than HPL “novice” courses.

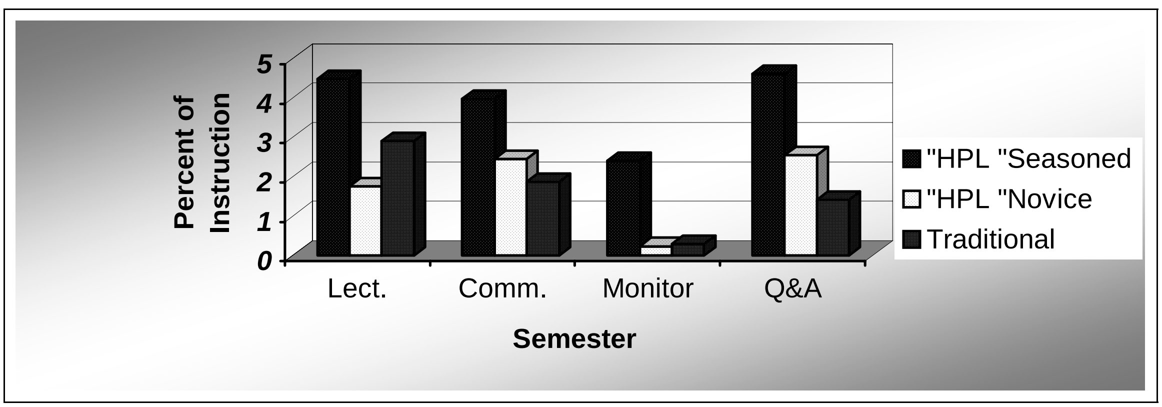

Figure 4-4. HPL Instruction Category Comparisons across HPL and Traditional Courses

CHAPTER V

SUMMARY AND IMPLICATIONS

Validity Summaries

Classroom Interaction Observation Content Validity Summary

The first research question within this study focuses upon the extent to which content experts familiar with the HPL framework agree with VOS observers' current operationalization of the HPL framework within classrooms. Across vignettes, it is found that content experts achieve approximately 25% total agreement with the VOS observers' "gold standard" for the HPL combination ratings. Total agreement is higher, however, when the total percent agreement is calculated for the knowledge-, learner-, assessment-, and community-centered dimensions. This means that content experts primarily agree upon the presence of the individual HPL dimension and organizations within the vignettes but do not agree upon the interactions of these dimensions and organization across the vignettes. For this reason, this portion of the study justifies the creation of a CIO HPL index or assessment method that not only looks at one part of a CIO category, the "HOW" category (i.e., knowledge-centeredness, learner-centeredness, assessment-centeredness, community-centeredness, and organization), but uses an entire Classroom Interaction Observation code string category to determine the amount of "HPLness" that is present within a class session.

Relative to the content validity of the CIO portion of the VOS, on average, content experts do not agree with VOS observers' ratings of the HPL combinations and agree with VOS observers' ratings of the individual HPL dimensions at an average percent agreement. Several factors may have contributed to this low agreement. First, although the vignettes described class activities before and after the target behavior to be rated by the experts, they made their ratings on less information than did the VOS observers. In this sense, the full context was not available to the content experts. As such, their ratings were more likely to differ from VOS observers who rated the vignettes in context. Second, the eleven content experts differed in their levels of expertise. This is seen in the variance of the total percent agreement across experts for each vignette. Third, since the HPL framework does not explicitly define all possible HPL dimension combinations, experts did not have enough experience to qualify certain HPL combinations as present.

Because agreement across content experts for the "HOW" category is relatively low even at the least stringent level of analysis, classifying the amount of "HPLness" within classrooms using only the "HOW" category may be problematic. For this reason, the creation of a new CIO assessment method that uses more than one CIO category to represent "HPLness" within classes is justified.

Global Ratings Content Validity Summary

The second research question within this study examines the extent to which content experts familiar with the HPL framework agree that summative indicators within the Global Ratings portion of the VOS represent the HPL framework. Overall, content experts strongly agree upon the classification of the Global Ratings indicators into HPL dimensions. Although correlations are high on average for the four HPL subscales, content experts agree that VOS Global Ratings indicators primarily represent the knowledge-centered, learner-centered, and assessment-centered dimensions and minimally represent the community-centered dimension. In other words, the Global Ratings portion of the VOS currently does not represent all HPL dimension interdependencies as defined by Bransford, Brown, and Cocking (1999) and cannot be expected to provide comprehensive information about all of the possible HPL-oriented activities that may occur within a class session. For this reason, the content coverage of the Global Ratings portion of the VOS is incomplete and needs to be revised if it is to be used as a comprehensive measure of “HPLness” within classrooms.

Despite the needed revisions for the Global Ratings portion of the VOS, this study significantly contributes to the literature on the HPL framework. Although Bransford, Brown, and Cocking (1999) report that learning is maximized as multiple HPL dimensions are implemented within classrooms, direct observational assessment of the interplay among the HPL dimensions has not been undertaken. As a result of the GR content validity study, specific classroom behaviors that relate to three HPL combinations, (1) knowledge- centered and learner-centered, (2) knowledge-centered, learner-centered, and assessment-centered, and (3) learner-centered and assessment-centered, are verified.

Convergent Validity Summary

The third research question notes the correlations between data collected using two assessment methods that measure the amount of HPL-oriented activities that occur within observed classrooms. As expected, high correlations between both assessment methods used to analyze CIO data exist. This is important since the newly-created, HPL Index considers the interdependencies of the entire CIO code string, not just one part of the CIO. Now, VOS researchers can use CIO data to not only identify individual percentages of knowledge-centeredness, learner-centeredness, assessment-centeredness, and community-centeredness but can examine the total percent of organization, HPL-oriented instruction, and traditional instruction within an entire class session. Therefore, this portion of the research supports the convergent validity of the CIO portion of the VOS.

The fourth research question compares twenty sets of CIO data collected within actual classrooms using the current VOS coding scheme to twenty sets of CIO data collected within videotaped versions of the real-time classrooms using a modified version of the VOS coding scheme. Results show that whether CIO data is collected within three-minute cycles or is collected continuously over the course of a class session, average classroom profiles are similar across the twenty classroom sessions. In sum, this portion of the research supports the convergent validity of the CIO portion of the VOS.

Criterion Validity Summary

The final research question notes the relationship between the calculated amount of HPL-oriented instruction within courses to the courses' classification as either an

HPL-oriented or traditionally-taught bioengineering course. The average amount of HPL instruction was calculated using the newly-developed HPL Index that categorizes an entire CIO code string as either organization, HPL-instruction, or traditional instruction. The average HPL instruction sums for all courses within the sample were calculated. Results show that on average, for four of the five semesters in which data were collected, HPL-oriented courses had higher average HPL instruction scores than traditional courses. A further examination of the HPL courses noted differences between two types of HPL courses- “seasoned” courses that are taught by faculty who have implemented HPL methods for more than one semester, and “novice” courses that are taught by faculty who are implementing HPL methods for the first time. This separation of the HPL course data showed that HPL “novice” course scores are similar to traditional scores, therefore implying that additional training and time may be needed for faculty to become proficient users of HPL-oriented materials. Overall, this portion of the study supports the criterion validity of the CIO portion of the VOS.

Major Contributions of the Research

The results within this dissertation offer significant contributions to learning science, to classroom assessment and evaluation, and to engineering education. In addition to the contributions mentioned throughout this chapter, an HPL index that calculates the percent of HPL-based instructions within classrooms was created and validated. This HPL Index helps in the creation of pedagogical profiles that show engineering faculty how much HPL-oriented instruction is present within their courses.

Development of an HPL Index

Although the previous CIO assessment method calculated the percent of the individual HPL dimensions that were present within the observed class sessions, this method did not provide information about other activities that were being captured within the CIO portion of the VOS and how HPL-oriented instruction relates to traditional classroom instruction and organizational activities. The HPL Index, however, that was developed as a second way to assess CIO data, calculates the percent of CIO code strings that are present within observed class sessions. More specifically, professors can see the percent of total class time that they spend engaged in organizational activities, HPL-oriented activities (e.g., higher-order questioning by the class, higher-order questioning by students, the use of a Personal Response System, and HPL-oriented lecture), and traditional activities (e.g., traditional lecture and traditional questioning). The sum of the three major categories equals 100%, thereby presenting HPL-oriented instruction relative to traditional activities that are occur within classrooms.

Pedagogical Profiles for Engineering Faculty

Current CIO data can be imported into SPSS statistical software package easily, thereby displaying the percent of time that engineering faculty implement classroom organization, eleven HPL-oriented activities, and eight traditional classroom activities. With this information, faculty can begin to monitor their teaching patterns over time and can see how in-class interventions can affect their profiles.

Implications for Scholarly Understanding

This study raises questions about how to operationalize the dimensions of the HPL framework within postsecondary engineering classrooms. Although Bransford, Brown, and Cocking (1999) created a diagram to represent the interactions of the four dimensions (Figure 1-1), the results of this research imply that HPL dimension interactions may be more difficult to operationalize within actual classroom settings. In fact, although Bransford, Brown, and Cocking have provided detailed examples about how individual knowledge-centered, learner-centered, assessment-centered, and community-centered dimensions are represented within K-12 classes, they do not report how all possible HPL dimension combinations are represented within these same classes. Future research could examine the operationalization of HPL dimension combinations at different educational levels (i.e., K-12 and postsecondary), across disciplines (e.g., engineering, medicine, and education), and within disciplines (e.g., bioengineering, industrial engineering, and mechanical engineering).

The Global Ratings content validity study provides some insight into the classroom activities that represent specific HPL dimension combinations within classrooms. Content experts agree at a level of 80% or greater that the current Global Ratings portion of the VOS contain three HPL subscales representing the following combinations: (1) knowledge-, learner-, and assessment-centered, (2) learner- and assessment-centered, and (3) knowledge- and learner-centered. These subscale combinations, however, dispute Bransford, Brown, and Cocking’s HPL framework diagram, which places community-centeredness within all possible HPL dimension combinations. Using the present Global Ratings content validity study as a guide, additional GR indicators can be created and classified into subscales. The reliability of these additional subscales can then be calculated and the feasibility of additional HPL dimension combinations can be reported. From here, various indicators can be observed relative to student outcomes such as persistence and achievement.

Rethinking the HPL Framework

The content validity study results bring attention to current HPL dimension interactions. Although the HPL framework is not an actual theory, information about the HPL dimension combinations is needed so that non-learning science faculty can understand the aspects of the framework. Until research pinpoints what each HPL combination looks like, the current HPL framework diagram must provide pictorially represent the interactions of the dimensions.

The convergent and criterion validity study results place HPL instruction in the context of total classroom instruction and classroom organization. The results show that although courses use HPL-oriented materials, on average, the majority of the class time is not spent in HPL-oriented instruction. Because of this, researchers must realign their expectations about HPL-oriented classes. In fact, future studies might focus upon the quality of the HPL instruction within HPL-oriented classes in an effort to understand the impact of HPL-oriented course materials and teaching techniques.

Implications for Professional Practice

Although researchers report that student collaboration, faculty-student interactions, faculty guidance to correct answers, and the presence of higher order questioning increase students' learning and engagement within engineering classrooms, it has been difficult to measure good teaching performance (Schuster and Zingheim, 1992). For this reason, the majority of engineering faculty are not given consistent quantitative feedback about their pedagogical patterns within the classroom. The validated HPL Index developed within this study, however, can provide pedagogical profiles to faculty about the percent of overall class time that they spend organizing, using HPL-oriented techniques, and using traditional techniques. These profiles may be especially beneficial to new faculty, who, on average, welcome feedback about their job performance and their teaching skills (Sorcinelli, 1988; Menges, 1999).

As members of a high consensus academic discipline, engineering faculty demonstrate an affinity for research and spend less time in teacher preparation than their non-engineering counterparts (Braxton & Hargens, 1996; Neumann, 2001). One reason for this attraction to research may be engineering faculty's affinity for engineering, not their affinity for educational pedagogy (Ruscio, 1987). Despite their lack of pedagogical training, however, engineering faculty are expected to demonstrate elements of the "scholarship of teaching" by transferring their knowledge of engineering to students who will become future engineers and active, lifelong learners (Boyer, 1990).

The final validity study supports the idea that engineering faculty who are not formally trained in pedagogy and are expected to implement new pedagogical techniques within their classrooms need training to understand what these profiles mean relative to student engagement and learning. To help interpret these results, engineering faculty may collaborate with on-campus teaching and learning centers and education departments. In addition, engineering departments and colleges can sponsor forums and workshops that help engineering faculty understand effective ways to implement effective pedagogical practices within their classrooms.

APPENDIX A

CONTENT VALIDITY QUESTIONNAIRES

Sample Content Validity Request Letter

Date

Dear Participant:

You are being asked to participate in a study to help VaNTH Engineering Research Center researchers assess the validity of the VaNTH Observation System (VOS), a classroom observation instrument currently used to collect data within postsecondary bioengineering classrooms. The purpose of this study is to assess the extent to which the VOS accurately captures knowledge-, learner-, assessment-, and community-centered dimensions of the "How People Learn" (HPL) framework as well as classroom organization within the Classroom Interaction Observation and Global Ratings portions of the VOS.

You have been identified by one of the members of our research team as an individual with interest or knowledge of the HPL framework as defined by Bransford, Brown, & Cocking (1999). We would like for you to complete two assessments that will rate the extent to which written vignettes of biomedical engineering classes and selected indicators of effective teaching accurately capture classroom organization and the four dimensions of the HPL framework. A quantitative survey with a section for qualitative input will be used for both assessments. Prior to the assessment, you will be asked to review an HPL framework summary sheet that defines knowledge-centered, learner-centered, assessment-centered, and community-centered dimensions as well as organization. The sheet will also give examples of the HPL dimensions and organization within classrooms. Both assessments will be used to help researchers assess the validity of the Classroom Interaction Observation and Global Ratings portions of the VaNTH Observation System.

A member of the research staff will contact you to set up a time to distribute both assessments and to collect your responses to the assessments. The assessments will be given in the spring of 2005 and will last approximately one hour per expert. The research team will cover all expenses associated with this study. The original assessment sheets will be stored in a file cabinet in a private office of one of our research team members.

The only risk that may be associated with this research will be the inconvenience that is typically associated with completing assessments. The interviewer will attempt to eliminate this problem by negotiating suitable dates and times for you to complete the assessment around your existing schedule. If you choose to participate in this study, you will be compensated with a $25 bookstore gift certificate.

The potential benefits to science and humankind that may result from this study are that data collected from experts will help in the revision of a postsecondary classroom observation instrument that can be disseminated to engineering colleges and universities across the nation. The potential benefits to you from this study are that you can help to evaluate one of the first observation instruments developed to capture information about the HPL framework within engineering classrooms.

At any time during this study, you are welcome to withdraw. Please note, however, that you will not be compensated financially for your time if you withdraw prior to the completion of the assessment.

Please indicate below whether or not you agree to participate in this study. Then, sign the attached consent form and return it to the selected member of our research team. A second copy of the consent letter has been included for your records.

Thank you for your consideration. If you should have any questions about this research study or possibly injury, please feel free to contact **Monica F. Cox** at **(615) 337-2700** or at monica.cox@vanderbilt.edu. Additional information about this study may also be obtained by contacting the Institutional Review Board at (615) 322-2918, fax: (615) 343-2648, or e-mail: irb@mcmail.vanderbilt.edu.

CONSENT FOR COLLECTION OF ASSESSMENT DATA FROM LEARNING SCIENCE, EDUCATION, AND ENGINEERING PROFESSIONALS

I have read this informed consent document, and the material contained in it has been explained to me verbally. All of my questions have been answered, and I freely and voluntarily choose to participate.

Signature____

Date____

Consent obtained by:

____________________ ____

Date Signature

____

Printed Name and Title

"How People Learn" [1] Framework Summary Sheet

The "How People Learn" (HPL) framework says that learning can be enhanced if the learning environments are grounded in four basic principles. Although optimal learning environments are *learner-centered*, *knowledge-centered*, *assessment-centered*, and *community-centered*, various combinations of the dimensions may be observed in varying degrees. For this reason, each dimension is defined separately below. In addition to HPL activities, administrative behaviors that are not related to instruction occur. These activities relate to *organization*. Definitions for the HPL dimensions and organization are listed below.

<u>Knowledge-Centered Environment</u>

- Promotes *learning with understanding* by organizing the knowledge around "key concepts" of the subject domain area and an understanding of the conditions under which it is applicable
  - ➢ *Example:* Professor uses a simulation that demonstrates the concepts and principles that are being taught.

<u>Learner-Centered Environment</u>

- Takes into account the knowledge, skills, beliefs, preconceptions, misconceptions, and learning styles of the students
  - ➢ *Example #1- Problem-Oriented Statement:* "Think about the muscles that you would use to pick up a child."
  - ➢ *Example #2- Prediction:* "What do you think would happen if we increased the amount of substrate in the model?"

<u>Assessment-Centered Environment</u>

- Provides opportunities for students and faculty to obtain feedback on understanding so that it can be refined as needed
- Uses formative and summative assessment techniques
  - o Formative assessment gives students and faculty immediate feedback about in-class teaching and learning and is usually not graded.
  - o Summative assessment is associated with grades and measures student learning. An example of summative assessment includes professor-created exams or graded projects covering course content.
  - ➢ *Example:* Use of a Personal Response System (PRS)* during formative assessment

*A technology-based assessment-centered approach might include a professor asking students to use a Classroom Communications System such as a Personal Response Systems (PRS) to answer in-class questions. For example, a Biomechanics professor may begin a lecture about free body diagrams. To test students' understanding of this concept, four free body diagrams are shown on a screen. Students are asked to select the correct free body diagram for the remainder of a woman's body if her leg is removing and if the weight of the leg is neglected. Students then use PRSs to beam their answers to the system. A graph displaying the distribution of students' answers is displayed on the computer screen, giving both the professor and students immediate feedback about whether the question was delivered appropriately and if the students understood the class material. By compiling and sorting students' responses, the PRS can pinpoint course concepts that need further discussion (Roselli & Brophy, 2002).

Community-Centered Environment

- Promotes a learning environment such that students, teachers, and other interested participants (1) share norms that value learning and high standards, (2) interact, (3) receive feedback, and (4) learn.
- Includes the community of the classroom, the school, and the connections between the school and the larger community, including the home
- The degree to which students, teachers, and administers feel connected to the larger community of homes, businesses, states, the nation, and even the world
  - *Example #1:* Involves students working together in class
  - *Example #2:* Student and professor interactions via chat rooms, listservs, web servers

Organization[2]

- Organizational statements or behaviors that relate to classroom procedures, what is to be done, how it is to be done, and the chronological order of the doing
  - *Example:* Professor asks students to pass in their homework assignments.

In summary, HPL…

- Emphasizes student learning
- Probes students misconceptions
- Guides students to correct answers
- Focuses on in-class assessment in an effort to assess students' "deep understanding" and "higher order thinking"
- Encourages in-class student collaboration
- Focuses upon a transfer of learning from students' previous learning and experiences

[1]Bransford, J., Brown, A.L., & Cocking, R.R. (Eds.) (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

[2] Harris, A.H. (2003). *VOS: A manual for the VaNTH Observation System.*. Nashville, TN: Vanderbilt University.

ID #________

Study 1: Content Validity of the Classroom Interaction Observation Portion of the VOS

The purpose of this study is to assess the extent to which the VaNTH Observation System (VOS) accurately captures the four dimensions of the HPL framework as defined by Bransford, Brown, and Cocking (1999).

Before beginning the actual assessment, I want to take a few minutes to go through the steps that you will take to assess classroom vignettes. You are going to (1) read each vignette, (2) focus upon the highlighted portion of each written vignette, and (3) assess the extent to which the highlighted portion of the vignette accurately captures HPL dimensions as they are summarized on the "How People Learn" Summary Sheet.

<u>Orienting Vignette #1</u>

- Read the vignette below, paying close attention to the highlighted portion.
- Rate the extent to which the highlighted portion is "Knowledge-Centered", "Learner-Centered," "Assessment-Centered," "Community-Centered," and "Organization."
- Please feel free to write comments about the applicability of the indicators to the HPL framework and/or about your reasons for rating the indicators as you rated them.

P3-2 (The professor is setting up a Personal Response System (PRS) question.)
PROF: If the voltage-gated potassium gates involved in an action potential are slower than usual to close, what would you expect V memb to do after the peak of an action potential?
PROF: So we've started an action potential, hit the peak--what's going to happen afterwards if the voltage-gated potassium gates are slower than usual to close?
PROF: All right, let me go ahead and open this up. I know those are long, wordy answers.
(Prof works with computer and takes a drink from her water bottle.)
(Some students begin to beam in answers.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

- Use the steps for Orienting Vignette #1 to assess Orienting Vignette #2 for Professor R's class.

Orienting Vignette #2

R10-1 (The professor is introducing the Iron Cross Module.)

PROF: Alright. Today, what I would like for us to do is go over the module called the Iron Cross Module.

PROF: Basically, the major challenge here is, and we won't be able to get through this entire module in this session.

PROF: It will be available to you on the web in a slightly different form where you can actually fill in some of the questions, some of the answers to questions, etc.

PROF: But this is kind of the classroom version of that one and the major challenge is "how strong is strong." So…

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

- Use the steps for Orienting Vignette #1 to assess Orienting Vignette #3 for Professor K's class.

Orienting Vignette #3

K17-1

PROF: Do you remember what the grand challenge question, way ever so long ago,—do you remember what the grand challenge question was?

STUDENT A: What did the teacher have? What did the EKG reflect that the teacher had?

PROF: Yeah, that's exactly right.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

In the same way that you rated the three vignettes above, I would like for you to assess the extent to which each of the following twenty vignettes represents the HPL framework as defined by Bransford, Brown, and Cocking (1999). Unlike the orienting vignettes, however, the vignettes below do not have accompanying video clips. In this way, you can flow quickly and easily through this part of the assessment. Feel free to qualify your ratings for each vignette by writing comments about the applicability of the indicators to the HPL framework and/or about your reasons for rating the indicators as you rated them.

1) (The professor is talking about students' Personal Response System responses.)
PROF: First of all, by the way, I will say that I am happy to see that three is the most popular answer. That is the correct answer, so congratulations to those of you who picked that.
PROF: Number one: "Vmemb will decline monotonically from the peak to about minus eighty-six millivolts and stay at that potential until the next action potential."
PROF: We just looked at the Goldman-Hodkin-Katz equation that shows us how different ions can influence membrane potential and how the permeabilities weight the influence of that ion.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

2)
PROF: Okay, you know this about muscles; you know a few other things about muscles. I'm going to ask you now to do a little bit of an activity.
PROF: I've been training for a marathon, my first ever. So- then speaking about myself in the third person- one morning she finds that her muscles are quite tight, yet she fails to stretch them before beginning to run.
PROF: She notices that she is unable to run particularly well.
PROF: Given what you know about muscle physiology, what two phenomena could explain her difficulty in running?
PROF: So, I'm going to give you – uh, let's see – about a minute and a half to think about this yourself.
PROF: And then I want you to pair up with one other person or two others depending on how you're seated and whatever works out to be convenient.

To what extent are the following elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

3) (The professor asks students to answer a question.)
PROF: Okay. I want you now to find a partner – one or two partners – and see if you can't decide what phenomena would explain my difficulty in running.
PROF: If you disagree about those, I want you to try to convince each other. Alright? Please go ahead.
(Students get with partners.)
(Students begin to discuss ideas.)
(Prof watches from the podium area as students discuss.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

4) (The professor asks students to report their Personal Response System answers.)
PROF: Okay. Let's see. Can I get a volunteer?
(A student raises his hand.)
PROF: Yes, sir, what are your ideas?
STUDENT A: Well, you have the golgi tendons, which, since they're sensing this tension in your muscles, they're exciting the interneuron which is inhibiting the alpha motor neuron—
STUDENT A: -- and therefore causing the muscles not to contract as much when you try to get up and move. I can't explain that.
PROF: Okay…
(P begins to key in student's response, and it is delayed on the screen.)
PROF: They're exciting these inhibitor interneurons…
STUDENT A: that um…
PROF: -that, to be redundant here, inhibit…
STUDENT A: …the alpha motor neurons.
(P continues to key in response.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

5) (The professor asks students to report their answers to the Personal Response System question.)
PROF: Alright. Does someone else have another idea?
(A student raises her hand.)
PROF: Yes, ma'am?
STUDENT B: We said that if her muscles are tight, their base length is shorter than, like, they are on average, so when it contracts, the myosin heads are overlapping and not leading to optimal myosin contraction strength.
(Professor keys in the student's response.)
PROF: Myosin heads are overlapping and thus leading to – I'm sorry, could you say it for me?
STUDENT B: Like, reduces strength of contraction. It's not as effective.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

6)
PROF: So the last thing I wanted to work on in this class was to review the events of the cardiac cycle.
PROF: And I'm going to switch over here to friend Elmo…
(Prof sets up opaque overhead projector and displays a graphic.)
(Prof continues working with projector.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

7) (The professor is reviewing events of the cardiac cycle.)
PROF: That top blue line is aortic pressure.
PROF: The red line is ventricular pressure. And the green line is left atrial pressure.
PROF: We would see the exact same plot for the right side of the heart, although the actual pressures here in millimeters of mercury would be a little bit lower.
PROF: Actually, the pressures generated on the right side of the heart are lower than those generated on the left side of the heart.
PROF: Why do you think that is a reasonable design?
STUDENT A: Because the left side has to pump out to the entire body.
PROF: The left side has to pump out to the entire body- to the entire systemic circulation rather than to the pulmonic circulation.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

8) (The professor is talking about pressures in the heart.)
PROF: I want to focus today in particular on what's happening with the pressure.
PROF: So that's this middle, yellow band (refers to projected graphic).
PROF: But of course it's very closely- in fact, inescapably linked to what's happening in the very top band, and that's the electrocardiogram.
PROF: But again, and down here, what goes on down here (gestures to lower part of image) is also closely related to the volume issues here (gestures to middle part of image).
PROF: I want to look here at the pressures.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

9) (The professor is asking students challenge questions.)
PROF: So, that's the challenge…
PROF: … and what I would like you to do just for a couple of minutes is to generate some ideas about number one—what additional information are we going to need in order to answer that question? (This question is displayed on the computer screen.)
PROF: What muscles do you think are the most susceptible to injury and why, (This question is displayed on the computer screen.)
PROF: … and then, what is meant by muscle strength? (This question is displayed on the computer screen.)
PROF: Ok, so if you'll take a couple of minutes, talk among yourselves; um, see if we can't answer those three questions.
PROF: And I would focus primarily on the first and the third, and we'll talk more about the second a little bit later on.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

10) (Students are working in groups to answer challenge questions.)
(The professor stands at the front of the room, looking out over the class while they are in small groups, discussing possible answers to three questions the professor has asked.)
(Prof walks to the back of room to talk to a group.)
(A student in a group asks the professor something about the question they have been discussing.)
(The professor responds to that group.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

11) (Students are reporting their answers from group work.)
PROF: Let's try to answer the first question first. What additional information do you think we're going to need?
STUDENT A: The weight of the athlete.
PROF: The weight of the athlete is going to be a really important thing.
STUDENT B: Height.
PROF: The height of the athlete.
PROF: Uh, what other information?
STUDENT C: The anthropometric measurements.
PROF: Real measurements, I'd say, in this case, not just from the tables.
PROF: You really need to go in there and actually make some measurements, because many of these athletes obviously have much more muscle bulk etcetera.
PROF: And so the standard anthropometric tables are probably not going to be all that appropriate for these things, right?

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

12) (Students are still reporting their answers from group work.)
PROF: What is meant by--what do you think we're talking about when we talk about muscle strength?
STUDENT F: I'm thinking more of cumulative muscle strength—not just one muscle.
PROF: Okay, so what you're saying is that there could be more than one muscle active at the same time.
STUDENT F: Lot of muscles.
PROF: (nodding) Lot of muscles active.
PROF: The more muscles active, presumably, the greater will be the-- what?
SEVERAL STUDENTS: Force.
PROF: Force generated (nods), okay, 'cause, uh, the muscle is generating a force per unit area.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

13) (The professor is discussing diagrams after a Personal Response System question.)
PROF: This is the one that people are saying is the correct one. (Prof points to one of four free body diagrams displayed on the screen as possible answers to a Personal Response System (PRS) question.)
PROF: Why not this one? What's wrong with this one? (Prof is pointing at one of four possible free body diagrams displayed on the projector screen.)
SEVERAL STUDENTS: The muscle's pushing.
PROF: The muscle's pushing, right? Muscles don't push.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

14) (The professor is still discussing diagrams after a Personal Response System question.)
PROF: Now, why this one instead of that one? Let's look at this one.
(Prof points at the appropriate free body diagrams on the screen.)
STUDENT A: (calls out a response not caught well on tape)
STUDENT B: (calls out a response not caught well on tape)
PROF: (nodding) Ok.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

15) (The professor is giving students additional information before a Personal Response System question.)
PROF: Let's say we have, that we know, we go and we measure electrical activity in the muscles themselves, and we measure that only two of those adductor muscles are actually active during this activity.
PROF: That's a hypothesis. But let's say we can make that measurement…
PROF: -- And here we are, this one, the latissimus dorsi muscle (Prof points to screen), and the pectoralis major muscle, are the two muscles that we know are active.
PROF: Can we determine what the force would be in each one of those? That's the question.
PROF: Can we determine how much of the force is taken by the pectoralis major- how much of it is taken by the latissimus dorsi?
PROF: To help answer that, draw a free body diagram of this case.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

16) (The class is looking at Personal Response System responses.)
PROF: Ok, for those of you who said that there were four, what are they? Give me one at a time.
STUDENT A: Tension.
PROF: Tension.
PROF (to same student): Where?
STUDENT A: In the rope.
PROF: In the rope, okay.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

17)
PROF: How can I find out what the maximum torque that particular muscle can provide at the shoulder when we're holding that iron cross position? (Prof makes iron cross gesture.)
PROF: What is it? Ok, that's the question. How can you find that out?
PROF: So, talk about that and see if you can't come up with the correct approach.
(Some students begin to move together.)
(Some, but not all students talk among themselves.)

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

18) (The professor is reviewing information for the final exam.)
PROF: I'm not talking anatomy. I'm talking function. What might I have in mind from that?
STUDENT A: Electrical currents.
PROF: We did talk about electrical currents, and we talked about the SA node and Perkenji.
PROF: I'm also thinking of pressures of the heart.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

19) (The professor engages students in a question and answer session.)
PROF: Remember Q is your first ventricular deflection. Sometimes it shows up, and sometimes it really doesn't. R is always your positive peak, and S is negative. (The professor refers to the board.)
PROF: What does a P wave represent in your heartbeat? What's happening when the P wave occurs?
A FEW STUDENTS: Atrial contraction.
PROF: How about Q or S?
A FEW STUDENTS: Ventricular depolarization.
PROF: Ventricular depolarization.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

20) (The professor asks students to recall information taught earlier.)
PROF: Thinking about the articles, do you remember what we pulled out of them at the time and, in retrospect, why they were relevant to the course?
(Professor turns through pages in notebook.)
PROF: We had one that was called "The Hidden Unity of Hearts," and we had a second one called "And the Beat Goes On." The Hidden Unity of Hearts" kind of showed us some similarities genetically between hearts even from the fruit fly and things.
PROF: Then "And the Beat Goes On" looked at sort of the evolution of vertebrate hearts.
PROF: Matt?
STUDENT A: "The Beat Goes On" helped us understand where the heart came from and tried us to see how our hearts relate to others and how the electric potentials are the same but just more complex.
PROF: Uh Hmm.

To what extent are the following HPL elements present in the highlighted segment?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

ID #________

Study 2: Content Validity of the Global Ratings Portion of the VOS

Similar to the previous assessment, I would like for you to assess the extent to which each of the seventeen indicators below represents the HPL framework as defined by Bransford, Brown, and Cocking (1999). After rating each indicator, feel free to qualify your ratings by writing comments about the applicability of the indicators to the HPL framework and/or about your reasons for rating the indicators as you rated them.

(1) "The professor provides a chronological outline of the steps of the lesson."

Given what you know about HPL, which label(s) best categorizes item #1?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(2) "The professor provides lesson objectives in terms of what students will know and/or be able to do at the end of the lesson."

Given what you know about HPL, which label(s) best categorizes item #2?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(3) "The professor signals the lesson's unfolding/ linkages- that is, makes overt connections between/ among parts of the day's lesson."

Given what you know about HPL, which label(s) best categorizes item #3?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(4) "The professor presents a 'How People Learn' challenge when new materials/ concepts are introduced to engage students in the coming academic content."

Given what you know about HPL, which label(s) best categorizes item #4?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(5) "The professor makes connections to students' prior learning, including past courses and/or previous experiences in or out of class."

Given what you know about HPL, which label(s) best categorizes item #5?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(6) "The professor checks students' understanding of a concept before beginning the lesson."

Given what you know about HPL, which label(s) best categorizes item #6?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(7) "The professor checks students' understanding of a concept during the lesson."

Given what you know about HPL, which label(s) best categorizes item #7?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(8) "After the lesson, the professor seeks student assessment of what they learned and/or do not understand."

Given what you know about HPL, which label(s) best categorizes item #8?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(9) "Students ask questions for additional clarification."

Given what you know about HPL, which label(s) best categorizes item #9?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(10) "Students ask questions to extend their knowledge (e.g., 'What if…?')."

Given what you know about HPL, which label(s) best categorizes item #10?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(11) "The professor makes periodic eye contact with all parts of the class."

Given what you know about HPL, which label(s) best categorizes item #11?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(12) "The professor moves among students."

Given what you know about HPL, which label(s) best categorizes item #12?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(13) "The professor uses appropriate visual aids—including diagrams, illustrations, web sites, transparencies, etc.—to illustrate/explain the lesson."

Given what you know about HPL, which label(s) best categorizes item #13?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(14) "The professor encourages/ accepts student questions."

Given what you know about HPL, which label(s) best categorizes item #14?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(15) "The professor asks clarifying questions that reveal students' reasoning/ thinking."

Given what you know about HPL, which label(s) best categorizes item #15?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(16) "The professor asks hypothetical questions ('What if…?'; 'But suppose…')."

Given what you know about HPL, which label(s) best categorizes item #16?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

(17) "Students collaborate with others in in-class problem solving."

Given what you know about HPL, which label(s) best categorizes item #17?

	Not at All	Only a Little	Some	A Great Deal
Knowledge-Centered	1	2	3	4
Learner-Centered	1	2	3	4
Assessment-Centered	1	2	3	4
Community-Centered	1	2	3	4
Organization	1	2	3	4

Comment(s)____

APPENDIX B

HPL INDEX MATERIALS

SPSS Syntax to Analyze Code Strings

```
COMPUTE HO_ques_P = 0.
IF (WHO=1 OR WHO=8) AND WHAT = 2 AND HOWO=0 AND TECH <> 7 HO_ques_P = 1.
EXECUTE.

COMPUTE HO_ques_C = 0.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=5 OR WHO=6) AND WHAT = 2 AND HOWO=0 AND
TECH <> 7 HO_ques_C = 1.
EXECUTE.

COMPUTE P_guide = 0.
IF WHAT = 8 AND HOWO=0 AND TECH <> 7 P_guide = 1.
EXECUTE.

COMPUTE media_instruction = 0.
IF WHO=7 AND TW=2 AND HOWO=0 AND TECH <> 7 media_instruction=1.
EXECUTE.

COMPUTE PRS_use = 0.
IF TECH = 7 AND HOWO=0 PRS_use=1.
EXECUTE.

COMPUTE lecture_trad  = 0.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4) AND WHAT=4 AND (HOWK=1 AND
HOWL=0 AND HOWA=0 AND HOWC=0 AND HOWO=0) AND TECH <>7 lecture_trad=1.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4) AND WHAT=4 AND (HOWK=1 AND
HOWL=0 AND HOWA=1 AND HOWC=0 AND HOWO=0) AND TECH <>7 lecture_trad=1.
EXECUTE.

COMPUTE ques_response_hpl = 0.
IF (WHO=1 OR WHO=8 OR WHO=5 OR WHO=6) AND (TW=1 OR TW=5 OR TW=6 OR WHO=8)
AND (WHAT=1 OR WHAT=3) AND HOWO=0 AND TECH <> 7 ques_response_hpl=1.
IF (WHO=3 OR WHO=4) AND (TW=2 OR TW=3 OR TW=4) AND (WHAT=1 OR WHAT=3) AND
HOWO=0 AND TECH <> 7 ques_response_hpl=1.
IF (WHO=1 OR WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (WHAT=1 OR WHAT=3) AND
HOWK=1 AND HOWA=1 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <> 7
ques_response_hpl=1.
IF (WHO=5 OR WHO=6) AND (TW=2 OR TW=3 OR TW=4) AND (WHAT=1 OR WHAT=3) AND
HOWO=0 AND TECH <>7 ques_response_hpl=1.
EXECUTE.

COMPUTE ques_response_trad = 0.
IF (WHO=2 OR WHO=3 OR WHO=4) AND (TW=1 OR TW=8) AND (WHAT=1 OR WHAT=3) AND
HOWK=1 AND HOWA=1 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <> 7
ques_response_trad=1.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4) AND (WHAT=1 OR WHAT=3) AND
HOWO=0 AND TECH <> 7 AND ques_response_hpl=0 ques_response_trad=1.
EXECUTE.

COMPUTE lecture_hpl  = 0.
IF (WHO=1 OR WHO=8) AND (TW=5 OR TW=6) AND WHAT=4 AND HOWO=0 AND TECH <>7
lecture_hpl=1.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4) AND WHAT=4 AND HOWK AND
(HOWL=1 OR HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7 lecture_hpl=1.
```

```
IF( WHO=3 OR WHO=4) AND (TW=2) AND WHAT=4 AND HOWO=0 AND TECH <>7
lecture_hpl=1.
IF (WHO=5 OR WHO=6) AND (TW=1 OR TW=2) AND WHAT=4 AND HOWO=0 AND TECH <>7
lecture_hpl=1.
EXECUTE.

COMPUTE comments_trad  = 0.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=0 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
comments_trad=1.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=6 AND
(HOWK=1 AND HOWA=1) AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
comments_trad=1.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW = 1 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=0 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
comments_trad=1.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW = 1 OR TW=8) AND WHAT=6 AND
(HOWK=1 AND HOWA=1) AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
comments_trad=1.
EXECUTE.

COMPUTE comments_hpl  = 0.
IF (WHO=1 OR WHO=5 OR WHO=6) AND (TW=1 OR TW=5 OR TW=6) AND WHAT=6 AND
HOWO=0 AND TECH <> 7 comments_hpl=1.
IF (WHO=5 OR WHO=6) AND (TW=2) AND WHAT=6 AND HOWO=0 AND TECH <> 7
comments_hpl=1.
IF (WHO=3 OR WHO=4) AND (TW=2 OR TW=3 OR TW=4) AND WHAT=6 AND HOWO=0 AND
TECH <> 7 comments_hpl=1.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=1 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
comments_hpl=1.
IF (WHO=1 OR WHO=8) AND (TW = 2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=0 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
comments_hpl=1.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW=1 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=1 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
comments_hpl=1.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW=1 OR TW=8) AND WHAT=6 AND
HOWK=1 AND HOWA=0 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
comments_hpl=1.
EXECUTE.

COMPUTE praise_trad = 0.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=7 AND
(HOWK=1 AND HOWA=1) AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
praise_trad=1.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=7 AND
HOWK=1 AND HOWA=0 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
praise_trad=1.
EXECUTE.

COMPUTE praise_hpl = 0.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=5 OR TW=6 OR TW=7) AND
WHAT=7 AND HOWK=1 AND HOWA=1 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND
TECH <>7 praise_hpl=1.
```

```
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=5 OR TW=6 OR TW=7) AND
WHAT=7 AND HOWK=1 AND HOWA=1 AND HOWC=1 AND HOWO=0 AND TECH <>7
praise_hpl=1.
IF (WHO=1 OR WHO=8) AND (TW=5 OR TW=6) AND WHAT=7 AND HOWO=0 AND TECH <>7
praise_hpl=1.
EXECUTE.

COMPUTE no_response = 0.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW=1 OR TW=8) AND WHAT=10 AND
(HOWK=1 AND HOWA=1) AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
no_response=1.
EXECUTE.

COMPUTE no_response_hpl = 0.
IF (WHO=5 OR WHO=6) AND (TW=1 OR TW=8) AND WHAT=10 AND HOWO=0 AND TECH <>7
no_response_hpl=1.
IF (WHO=2 OR WHO=3 OR WHO=4 OR WHO=8) AND (TW=1 OR TW=8) AND WHAT=10 AND
(HOWK=1 AND HOWA=1) AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
no_response_hpl=1.
EXECUTE.

COMPUTE monitor_trad = 0.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4) AND (WHAT=11 OR WHAT=12)  AND
HOWK=1 AND HOWA=1 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
monitor_trad=1.
IF (WHO=1 OR WHO=8) AND TW=2 AND (WHAT=11 OR WHAT=12) AND HOWK=1 AND
HOWA=0 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <> 7 monitor_trad=1.
EXECUTE.

COMPUTE monitor_hpl=0.
IF (WHO=1 OR WHO=8) AND (TW=5 OR TW=6) AND (WHAT=11 OR WHAT=12) AND HOWO=0
AND TECH <>7 monitor_hpl=1.
IF WHO=1 AND (TW=2 OR TW=3) AND (WHAT=11 OR WHAT=12) AND (HOWK=1 AND
HOWA=1) AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7 monitor_hpl=1.
IF WHO=1 AND (TW=2 OR TW=3) AND (WHAT=11 OR WHAT=12) AND HOWK=1 AND HOWA=1
AND HOWC=1 AND HOWL=0 AND HOWO=0 AND TECH <>7 monitor_hpl=1.
EXECUTE.

COMPUTE correct_trad = 0.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=9 AND
HOWK=1 AND HOWA=0 AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
correct_trad=1.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=9 AND
(HOWK=1 AND HOWA=1) AND HOWL=0 AND HOWC=0 AND HOWO=0 AND TECH <>7
correct_trad=1.
EXECUTE.

COMPUTE correct_hpl= 0.
IF (WHO=1 OR WHO=8) AND (TW=5 OR TW=6) AND WHAT=9 AND HOWO=0 AND TECH <>7
correct_hpl=1.
IF (WHO=1 OR WHO=8) AND (TW=2 OR TW=3 OR TW=4 OR TW=8) AND WHAT=9 AND
HOWK=1 AND HOWA=1 AND (HOWL=1 OR HOWC=1) AND HOWO=0 AND TECH <>7
correct_hpl=1.
EXECUTE.

FREQUENCIES
```

```
 VARIABLES=  HOWO TECH HO_ques_P HO_ques_C P_guide media_instruction PRS_use lecture_trad
lecture_hpl ques_response_trad ques_response_hpl comments_trad comments_hpl praise_trad praise_hpl
no_response no_response_hpl monitor_trad monitor_hpl correct_trad correct_hpl.
 EXECUTE.
```

APPENDIX C

CLASSROOM INTERACTION OBSERVATION CONTENT VALIDITY RESULTS

Table 1- VOS HPL Combination Agreement across Vignettes and Content Experts
(The Presence of Combinations Are Noted by Ratings of “2,” “3,” or “4”*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	0	1	1	1	0	0	1	1	0	0
9763	0	0	0	0	0	0	1	1	0	0
3641	0	0	0	0	0	0	0	1	0	0
2855	1	1	0	0	0	0	1	1	0	0
1	0	1	0	1	1	0	0	0	0	0
21	0	0	0	1	0	0	0	0	0	0
3191	0	0	1	0	0	0	0	1	0	0
3476	0	0	1	0	0	0	1	0	0	1
5522	0	1	0	0	0	0	0	0	0	0
7673	0	1	1	1	1	0	1	1	0	1
7028	1	0	0	0	0	0	0	1	0	0
Total %	**18.18**	**45.45**	**36.36**	**36.36**	**18.18**	**0**	**45.45**	**63.64**	**0**	**18.18**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	0	0	0	0	0	0	0	1	1	0
9763	0	1	1	1	0	0	0	0	0	0
3641	0	0	0	0	0	0	0	0	0	0
2855	0	1	1	1	1	0	0	1	0	0
1	0	0	1	1	0	0	0	0	1	0
21	0	1	1	0	0	0	0	0	0	0
3191	0	0	0	0	0	0	0	1	0	0
3476	0	0	1	0	0	0	0	0	1	0
5522	0	0	0	0	0	0	0	0	1	1
7673	1	1	0	0	0	0	0	0	0	1
7028	0	0	0	0	0	0	0	0	0	0
Total %	**9.09**	**36.36**	**45.45**	**27.27**	**9.09**	**0**	**0**	**27.27**	**36.36**	**18.18**

*****Original values of “2,” “3,” or “4” are recoded with a value of 1, and original values of “1” are recorded with a value of 0.
**Vignettes are represented with a “V” followed by the vignette number (For example, Vignette 1 is abbreviated as “V1.”)

Content Expert ID	Percent Agreement with VOS Observers
9051	35
9763	25
3641	5
2855	45
1	30
21	15
3191	15
3476	25
5522	15
7673	50
7028	10
Average Agreement	**24.55**

Average Agreement across vignettes is 24.55% also.

Table 2- VOS HPL Combination Agreement across Vignettes and Content Experts
(The Presence of Combinations Are Noted by Ratings of “3” or “4”*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	0	0	0	1	0	0	0	1	0	0
9763	0	0	0	0	0	0	1	1	0	0
3641	0	0	0	0	0	0	0	1	0	0
2855	1	1	0	0	0	0	0	1	0	0
1	0	1	0	1	1	0	0	0	0	0
21	0	0	0	1	0	0	0	0	0	0
3191	0	0	0	0	0	0	0	1	0	0
3476	0	0	0	0	0	0	0	0	0	1
5522	0	0	0	0	0	0	0	0	0	0
7673	0	1	1	1	1	0	0	1	0	1
7028	1	0	0	0	0	0	0	0	0	0
Total %	**18.18**	**27.27**	**9.09**	**36.36**	**18.18**	**0**	**9.09**	**54.55**	**0**	**18.18**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	0	0	0	0	0	0	0	0	0	0
9763	0	1	1	1	0	0	0	0	0	0
3641	0	0	0	0	0	0	0	0	0	0
2855	0	1	1	1	1	0	0	1	0	0
1	0	0	1	1	0	0	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
3191	0	0	0	0	0	0	0	0	0	0
3476	0	0	1	0	0	0	0	0	0	0
5522	0	0	0	0	0	0	0	0	0	0
7673	1	1	0	0	0	0	0	0	0	1
7028	0	0	0	0	0	0	0	0	0	0
Total %	**9.09**	**27.27**	**36.36**	**27.27**	**9.09**	**0**	**0**	**9.09**	**9.09**	**9.09**

***Original values of “3” or “4” are recoded with a value of 1, and original values of “1” are recorded with a value of 0.
**Vignettes are represented with a “V” followed by the vignette number (For example, Vignette 1 is abbreviated as “V1.”)

Content Expert ID	Percent Agreement with VOS Observers
9051	10
9763	25
3641	5
2855	40
1	30
21	5
3191	5
3476	10
5522	0
7673	45
7028	5
Average Agreement	**16.36**

Average Agreement across vignettes is 16.36%.

Table 3- VOS HPL Combination Agreement across Vignettes and Content Experts
(The Presence of Combinations Are Noted by Ratings of "4"*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	0	0	0	0	0	0	0	0	0	0
9763	0	0	0	0	0	0	0	1	0	0
3641	0	0	0	0	0	0	0	1	0	0
2855	1	0	0	0	0	0	0	1	0	0
1	0	1	0	1	1	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
3191	0	0	0	0	0	0	0	0	0	0
3476	0	0	0	0	0	0	0	0	0	0
5522	0	0	0	0	0	0	0	0	0	0
7673	0	1	1	1	1	0	0	1	0	1
7028	0	0	0	0	0	0	0	0	0	0
Total %	**9.09**	**18.18**	**9.09**	**18.18**	**18.18**	**0**	**0**	**36.36**	**0**	**9.09**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	0	0	0	0	0	0	0	0	0	0
9763	0	0	0	0	0	0	0	0	0	0
3641	0	0	0	0	0	0	0	0	0	0
2855	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	0	0	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
3191	0	0	0	0	0	0	0	0	0	0
3476	0	0	0	0	0	0	0	0	0	0
5522	0	0	0	0	0	0	0	0	0	0
7673	0	1	0	0	0	0	0	0	0	0
7028	0	0	0	0	0	0	0	0	0	0
Total %	**0**	**9.09**	**9.09**	**9.09**	**0**	**0**	**0**	**0**	**9.09**	**0**

*****Original values of "4" are recoded with a value of 1, and original values of "1" are recorded with a value of 0.
**Vignettes are represented with a "V" followed by the vignette number (For example, Vignette 1 is abbreviated as "V1.")

Content Expert ID	Percent Agreement with VOS Observers
9051	0
9763	5
3641	5
2855	10
1	30
21	0
3191	0
3476	0
5522	0
7673	35
7028	0
Average Agreement	**7.73**

Table 4- Agreement on Knowledge-Centeredness across Vignettes and Content Experts (The Presence of Combinations Are Noted by Ratings of "2," "3," or "4"*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	1	1	1	1	1	1	1	1	1	0
9763	1	0	1	1	1	1	1	1	0	1
3641	1	1	0	0	1	1	1	1	1	0
2855	1	1	0	0	1	1	1	1	1	0
1	1	1	0	1	1	1	0	1	1	0
21	1	0	1	1	1	0	1	1	0	0
3191	1	0	1	1	1	1	1	1	1	0
3476	1	1	1	0	1	1	1	1	1	1
5522	1	1	1	1	1	1	1	1	0	0
7673	1	1	1	1	1	1	1	1	0	1
7028	1	1	0	1	1	0	1	1	0	0
Total %	**100**	**72.73**	**63.64**	**72.73**	**100**	**81.82**	**90.91**	**100**	**54.55**	**27.27**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	1	1	1	0	1	1	1	1	1	1
9763	1	1	1	1	1	1	1	1	1	1
3641	0	1	1	1	1	0	0	1	1	1
2855	1	1	1	1	1	1	0	1	1	0
1	0	0	1	1	1	0	0	1	1	0
21	0	1	1	0	1	0	1	1	1	1
3191	0	1	1	1	1	1	0	1	1	1
3476	0	1	1	1	1	1	0	0	1	0
5522	1	1	1	1	1	1	1	1	1	1
7673	1	1	1	1	1	1	1	1	1	1
7028	1	1	1	1	1	1	0	1	1	1
Total %	**54.55**	**90.91**	**100**	**81.82**	**100**	**72.73**	**45.45**	**90.91**	**100**	**72.73**

*Original values of "2," "3," or "4" are recoded with a value of 1, and original values of "1" are recorded with a value of 0. **Vignettes are represented with a "V" followed by the vignette number (For example, Vignette 1 is abbreviated as "V1.")

Content Expert ID	Knowledge-Centered Agreement (Absence)	Knowledge-Centered Agreement (Presence)	Total Percent Agreement
9051	10	80	90
9763	0	90	90
3641	10	60	70
2855	10	65	75
1	10	50	60
21	0	65	65
3191	5	75	80
3476	10	65	75
5522	5	85	90
7673	5	90	95
7028	5	70	75
Average % Agreement	**6.36**	**72.27**	**78.64**

VOS observers report that 10% of vignettes do not contain the knowledge-centered dimension, and 90% of the vignettes contain the knowledge-centered dimension.

Table 5- Agreement on Learner-Centeredness across Vignettes and Content Experts
(The Presence of Combinations Are Noted by Ratings of “2,” “3,” or “4”*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	1	1	1	1	1	1	1	1	0	0
9763	0	0	1	1	1	1	1	1	0	1
3641	0	1	1	1	1	1	1	1	0	1
2855	1	1	0	1	1	1	1	1	1	0
1	0	1	1	1	1	0	1	0	0	0
21	1	0	1	1	0	1	0	1	0	1
3191	0	0	1	1	1	1	1	1	0	0
3476	1	0	1	1	1	1	1	0	0	1
5522	1	1	1	1	1	1	1	0	0	0
7673	0	1	1	1	1	1	1	1	0	1
7028	1	1	0	1	0	1	1	1	0	0
Total %	**54.55**	**63.64**	**81.82**	**100**	**81.82**	**90.91**	**90.91**	**72.73**	**9.09**	**45.45**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	1	1	1	1	0	0	0	1	1	1
9763	1	1	1	1	0	0	1	1	1	1
3641	1	1	1	1	0	0	0	0	1	1
2855	0	1	1	1	1	0	0	1	0	1
1	1	1	1	1	0	0	1	0	1	1
21	1	1	1	0	1	1	1	1	0	0
3191	1	1	1	1	0	0	0	1	0	1
3476	1	1	1	1	0	0	1	0	1	1
5522	1	1	1	1	1	0	1	0	1	1
7673	1	1	1	1	0	0	1	0	1	1
7028	1	0	1	0	1	0	0	0	1	1
Total %	**90.91**	**90.91**	**100**	**81.82**	**36.36**	**9.09**	**54.55**	**45.45**	**72.73**	**90.91**

*Original values of “2,” “3,” or “4” are recoded with a value of 1, and original values of “1” are recorded with a value of 0.
**Vignettes are represented with a “V” followed by the vignette number (For example, Vignette 1 is abbreviated as “V1.”)

Content Expert ID	Learner-Centered Agreement (Absence)	Learner-Centered Agreement (Presence)	Total Percent Agreement
9051	25	50	75
9763	15	60	75
3641	15	55	70
2855	35	35	70
1	5	55	60
21	30	35	65
3191	15	45	60
3476	10	60	70
5522	20	55	75
7673	15	60	75
7028	25	30	55
Average % Agreement	**19.09**	**49.09**	**66.18**

VOS observers report that 40% of vignettes do not contain the learner-centered dimension, and 60% of the vignettes contain the learner-centered dimension.

Table 6- Agreement on Assessment-Centeredness across Vignettes and Content Experts (The Presence of Combinations Are Noted by Ratings of “2,” “3,” or “4”*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	1	1	1	1	1	0	1	1	0	0
9763	0	1	0	1	1	1	1	1	0	0
3641	0	1	1	1	1	1	1	1	0	1
2855	1	1	1	1	1	1	1	1	0	0
1	1	1	0	1	1	1	1	1	0	1
21	0	1	0	1	1	1	1	0	1	1
3191	0	0	1	1	1	1	1	1	0	0
3476	1	1	1	1	1	0	1	1	0	1
5522	1	1	1	1	1	1	1	1	1	0
7673	0	1	1	1	1	1	1	1	0	1
7028	1	1	1	1	0	1	1	1	0	1
Total %	**54.55**	**90.91**	**63.64**	**100**	**90.91**	**81.82**	**100**	**90.91**	**18.18**	**54.55**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	1	1	1	1	1	1	1	1	1	1
9763	0	1	1	1	0	1	0	0	1	0
3641	1	1	1	1	1	1	0	1	1	1
2855	0	1	1	1	1	1	0	1	1	1
1	1	1	1	1	1	1	0	1	1	1
21	1	1	1	0	0	1	0	0	1	0
3191	1	1	1	1	1	1	1	1	1	1
3476	1	1	1	1	1	1	1	1	1	1
5522	1	1	1	1	1	1	1	1	1	1
7673	1	1	1	1	1	1	0	1	1	1
7028	1	1	1	0	0	1	0	1	1	1
Total %	**81.82**	**100**	**100**	**81.82**	**72.73**	**100**	**36.36**	**81.82**	**100**	**81.82**

*Original values of “2,” “3,” or “4” are recoded with a value of 1, and original values of “1” are recorded with a value of 0.
**Vignettes are represented with a “V” followed by the vignette number (For example, Vignette 1 is abbreviated as “V1.”)

Content Expert ID	Assessment-Centered Agreement (Absence)	Assessment-Centered Agreement (Presence)	Total Percent Agreement
9051	15	70	85
9763	15	40	55
3641	15	70	85
2855	20	60	80
1	20	65	85
21	15	45	60
3191	10	70	80
3476	15	75	90
5522	25	70	95
7673	15	70	85
7028	20	50	70
Average % Agreement	**16.82**	**62.27**	**79.09**

VOS observers report that 25% of vignettes do not contain the assessment-centered dimension, and 75% of the vignettes contain the assessment-centered dimension.

Table 7- Agreement on Community-Centeredness across Vignettes and Content Experts (The Presence of Combinations Are Noted by Ratings of "2," "3," or "4"*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	1	1	1	1	0	1	1	1	1	0
9763	1	1	1	0	0	1	1	1	1	1
3641	0	0	1	0	0	1	0	1	1	1
2855	1	1	1	0	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1
3191	0	1	1	0	0	1	0	1	1	0
3476	0	1	1	0	0	1	1	1	1	1
5522	1	1	1	1	0	1	1	1	1	1
7673	1	1	1	1	1	1	1	1	1	1
7028	1	0	1	0	1	1	0	1	1	0
Total %	**72.73**	**81.82**	**100**	**45.45**	**36.36**	**100**	**72.73**	**100**	**100**	**72.73**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	0	0	0	0	0	0	1	1	1	0
9763	1	1	1	1	1	0	1	1	0	1
3641	0	0	0	0	0	0	0	0	0	0
2855	0	1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1
3191	0	0	0	0	0	0	1	1	1	1
3476	0	0	1	0	1	0	0	1	1	1
5522	0	1	0	0	1	1	1	1	1	1
7673	1	1	0	1	1	1	1	1	-	1
7028	0	0	0	1	1	0	1	0	0	0
Total %	**36.36**	**54.55**	**45.45**	**54.55**	**72.73**	**45.45**	**81.82**	**81.82**	**54.55**	**72.73**

*Original values of "2," "3," or "4" are recoded with a value of 1, and original values of "1" are recorded with a value of 0.
**Vignettes are represented with a "V" followed by the vignette number (For example, Vignette 1 is abbreviated as "V1.")

Content Expert ID	Community-Centered Agreement (Absence)	Community-Centered Agreement (Presence)	Total Percent Agreement
9051	35	20	55
9763	55	25	80
3641	10	15	25
2855	55	25	80
1	75	25	100
21	75	25	100
3191	25	20	45
3476	40	20	60
5522	55	25	80
7673	65	25	90
7028	30	15	45
Average % Agreement	**47.27**	**21.82**	**69.09**

VOS observers report that 75% of vignettes do not contain the community-centered dimension, and 25% of the vignettes contain the community-centered dimension.

Table 8- Agreement on Organization Ratings across Vignettes and Content Experts
(The Presence of Combinations Are Noted by Ratings of "2," "3," or "4"*)

ID	V1**	V2	V3	V4	V5	V6	V7	V8	V9	V10
9051	0	1	1	1	1	0	1	1	1	1
9763	1	0	1	1	1	0	1	1	0	1
3641	0	1	1	1	1	0	0	1	0	0
2855	1	1	1	1	1	0	1	1	1	1
1	1	1	1	1	1	0	1	1	0	1
21	1	1	0	1	1	0	1	1	1	1
3191	0	1	1	0	0	0	1	1	1	0
3476	1	1	1	1	1	0	1	1	1	1
5522	0	1	0	0	0	0	0	0	1	0
7673	1	1	1	1	1	0	1	1	1	1
7028	1	1	1	1	1	0	1	1	1	1
Total %	**63.64**	**90.91**	**81.82**	**81.82**	**81.82**	**0**	**81.82**	**90.91**	**72.73**	**72.73**

ID	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
9051	0	1	1	0	-	0	1	1	1	0
9763	1	1	1	1	1	1	1	1	1	1
3641	1	0	1	0	0	0	1	0	0	0
2855	0	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
21	0	1	1	1	0	1	0	1	1	1
3191	0	1	0	0	1	0	1	1	1	0
3476	0	1	0	1	1	0	0	1	1	1
5522	0	0	0	0	0	1	0	1	1	1
7673	1	1	1	0	1	1	1	1	1	1
7028	1	1	1	1	1	1	1	1	1	1
Total %	**45.45**	**81.82**	**72.73**	**54.55**	**63.64**	**63.64**	**72.73**	**90.91**	**90.91**	**72.73**

*Original values of "2," "3," or "4" are recoded with a value of 1, and original values of "1" are recorded with a value of 0. **Vignettes are represented with a "V" followed by the vignette number (For example, Vignette 1 is abbreviated as "V1.")

Content Expert ID	Organization Agreement (Absence)	Organization Agreement (Presence)	Total Percent Agreement
9051	55	10	65
9763	85	0	85
3641	35	5	40
2855	80	10	90
1	85	5	90
21	65	10	75
3191	40	10	50
3476	65	10	75
5522	20	10	30
7673	80	10	90
7028	85	10	95
Average % Agreement	**63.18**	**8.18**	**71.36**

VOS observers report that 90% of vignettes do not contain organization, and 10% of the vignettes contain organization.

APPENDIX D

CONTENT EXPERTS' COMMENTS

Content Experts' Comments and Classification of Comments

(1) Content experts don't know the content of the conversation. • Vig. 3- If student's conversation is focused on concepts, this is knowledge-centered. *(9051)* • Vig. 3- Hard for expert to tell the quality of the discussion, although something is going on. *(5522)* • Vig. 10- Expert can't tell without knowing the content of the conversation. *(9763)* • Vig. 17- Expert doesn't know what the students are talking about, so it is hard to evaluate the assessment- and knowledge-centered piece. *(9051)* • Vig. 17- There is no information about what students are talking about. *(3641)* • Vig. 17- Expert assumes students are talking about the lesson, but there is no detail. *(5522)* • GR Indicator 14- Depends of what the question is; expert assumes the question is about knowledge. *(9051)* • GR Indicator 14- Expert is unsure about the questions that are used for assessment. *(9763)*
(2) Experts think that the content is primarily focused on facts. • Vig. 5- Statement appears to be focused on facts describing the muscle- would be rated higher if it was more conceptual. *(7028)* • Vig. 8- This could be modeling but is not really knowledge-centered since the professor fails to draw a relationship among the concepts represented by the lines. (*21*) • Vig. 8- Straight description of an ECG. *(7028)* • Vig. 16- Seems to be asking about factual knowledge. (*5522*) • Vig. 16- This is knowledge-centered, because it's more factual. *(7028)*
(3) Experts think that "we" implies a community- or knowledge-centered dimension. • Vig. 1- Is "we" an indication of community? *(3476)* • Vig. 5- "We said" makes this knowledge-centered. *(9051)* • Vig. 20- "We" makes this community. *(9051)*
(4) Experts think that a statement is preceding or is setting up in-class assessment or lecture. • Vig. 2- Assessment if likely to come but has not occurred. *(21)* • Vig. 3- Too early in the teaching process to determine assessment. *(21)* • Vig. 6- Seems like the professor is about to lecture. *(5522)* • Vig. 9- Could be used for assessment *(9763)* • Vig. 11- Higher potential for assessment. *(3476)* • GR Indicator 4- Imagine formative assessment will come but isn't here explicitly *(9763)* • GR Indicator 9- Prof could use questions for assessment. *(9763)*
(5) Experts think that there is a connection to prior learning or past courses and/or concepts. • Vig. 20- This is a review about previous material, not conceptions and/or constructions. *(9763)* • GR Indicator 5- Past courses means some knowledge is here, too *(9763)*
(6) Experts think this is community-centered but not because students are working in groups. • Vig. 4- A little community, because student ideas are at the forefront. *(9763)* • GR Indicator 12- Learner-centered because a community is about learners, but it is a stretch. *(9763)*
(7) Experts think that students are synthesizing knowledge • Vig. 7- Asks for synthesis. *(9763)* • GR Indicator 10- More knowledge because they're synthesizing here. *(9763)*
(8) Experts are not sure or are making assumptions or are providing explanation(s) about professor's purpose for doing an activity. • Vig. 10- He's just "looking"- not sure what (if anything) he's processing about this. *(5522)* • Vig. 10- Monitoring activity could be an assessment of students on task or assessing group dynamics. *(7028)* • GR Indicator 11- Professor is monitoring attention and engaging in interpersonal contact. *(9051)*. • GR Indicator 11- Are the students engaged? *(1)* • GR Indicator 12- Might be to promote interpersonal connection/ community or to monitor engagement. *(9051)*
(9) Experts think that questions are asked, but no definite answer is given. • Vig. 14- Ask question but does not take in any information; therefore, these is no score on other dimensions *(7028)* • GR Indicator 9- Students have an opportunity to ask questions, which suggest a learner-centered

interaction but is not explicitly learner-centered. *(9051)*.
(10) Experts think that this is primarily related to organization, not deep understanding or knowledge. • Vig. 1- Seems to be summarizing the activity *(5522)* • Vig. 2- Procedure *(1)* • Vig. 6- Reacting to time constraints? *(9763)* • Vig. 20- Knowledge is not indicated, because professor is asking a question that has no content area within it. *(1)* • GR Indicator 1- Chronological is not theoretical. *(5522)* • GR Indicator 6- Sequence is organized, but there's no explicit reference to the professor's awareness of the sequence. *(9051)*
(11) Experts are not sure about how much of an HPL dimension/activity or about which HPL dimensions are being demonstrated. • Vig. 3- Not sure how much community is being formed, although students are working together. *(9763)* • Vig. 4- Self-assessment could be present if other students evaluate their responses in light of Student A. *(21)* • Vig. 11- Hard to differentiate knowledge-centered, learner-centered, and assessment-centered. *(5522)* • Vig. 12- Rating community low, because it is the professor to the whole class; would rate high if engagement was more deliberate (e.g., follow-up question, probing question). *(7028)* • GR Indicator 12- Indeterminate. Could be assessment-centered or learner-centered depending on the purpose of moving around. *(2855)* • GR Indicator 13- Does appropriate mean "good"? *(3476)*

REFERENCES

Abikoff, H. (1977). Validation of a classroom observation code for hyperactive children. Journal of Consulting and Clinical Psychology, 45, 5, 772-782.

Adolf, J.W. (1983). An examination of Stallings' implementation and child effects of teaching practices in Follow Through classrooms. ERIC Ascension Number ED234907.

Bell, J.S., Cox, M.F., & Harris, A.H. (2003, October). Teaching Methods and Student Engagement in Bioengineering Classrooms. Poster presented at the 2003 Biomedical Engineering Society Annual Meeting, Nashville, TN.

Biglan, A. (1973). Relationships between subject matter characteristics and the structure and output of university departments. Journal of Applied Psychology, 57, 3, 204-213.

Boyer, E.L. (1990). Scholarship reconsidered: Priorities of the professoriate. Princeton, New Jersey: The Carnegie Foundation for the Advancement of Teaching.

Brown, R.M., & Wells, N. (1988). Research and policy in evaluating initially certified teachers in North Carolina. ERIC Ascension Number ED301575.

Bransford, J.D., Brown, A.L., & Cocking, R.R. (1999). How people learn: Brain, mind, experience, and school. Washington, DC: National Academy Press.

Braxton, J.M., & Hargens, L.L. (1996). Variation among academic disciplines : Analytical frameworks and research. In Higher Education: Handbook of Theory and Research, 11. New York: Agathon Press.

Braxton, J.M., Bray, N.J., & Berger, J.B. (2000). Faculty teaching skills and their influence on the college student departure process. Journal of College Student Development, 41, 2, 215-227.

Bredekamp, S. (1986). The reliability and validity of the Early Childhood Classroom Observation Scale for accrediting early childhood programs. Early Childhood Research Quarterly, 1, 103-118.

Caboni, T.C., Mundy, M.E., & Duesterhaus, M.B. (2002). The implications of the norms of undergraduate college students for faculty enactment of principles of good practice in undergraduate education. Peabody Journal of Education, 77, 3, 125-137.

Cabrera, A.F., Colbeck, C.L., & Terenzini, P.T. Developing performance indicators for assessing classroom teaching practices and student learning: The case of engineering. Research in Higher Education, 42, 3, 327-352.

Carmines, E. G. & Zeller, R.A. (1991). Reliability and validity assessment. Newbury Park: Sage Publications.

Chauvin, S.W. (1991). Development and validation of a comprehensive assessment system for teaching and learning. (ERIC Document ID ED335410) (Available at http://www.eric.ed.gov.)

Chiu, L. (1997). Development and validation of the School Achievement Motivation Rating Scale. Educational and Psychological Measurement, 57, 2, 292-305.

Cloud-Silva, C., & Denton, J. (1989). The development and validation of a low-inference observation instrument to assess instructional performance of teaching candidates. Journal of Classroom Interaction, 25, 2, 7-14.

Cooper, J., & Robinson, P. (1998). Small-group instruction in science, mathematics, engineering, and Technology (SMET) disciplines: A status report and an agenda for the future," Journal of College Student Teaching, 27, 6, 383-388.

Cordray, D.S., Pion, G.M., Harris, A., & Norris, P. (2003). The value of the VaNTH Engineering Research Center. IEEE Engineering in Medicine and Biology Magazine, 22, 4, 47-54.

Cox, M.F. (2003). An examination of "How People Learn" elements within traditional bioengineering classrooms and non-traditional bioengineering classrooms. Poster presented at the 2003 Association for the Study of Higher Education Annual Conference, Portland, OR.

Cox, M.F., & Harris, A.H. (2004). A comparison of bioengineering faculty members' teaching patterns at one research university. Proceedings of the American Society for Engineering Education.

Cudd, T.A., & Wasser, J.S. (1999). Biomedical device design discovery team approach to teaching physiology to undergraduate bioengineering students. American Journal of Physiology, 277, 22, S29-S41.

Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16, 297-334.

Doherty, R.W., Hillberg, R.S., Epaloose, G., & Tharp, R.G. (2002). Standards performance continuum: Development and validation of measure of effective pedagogy. The Journal of Educational Research , 96, 2, 78-91.

Elett, C.D., Loup, K.S., & Chauvin, S.W. (1991). Development, validity and reliability of a new generation of assessments of effective teaching and learning: Future directions for the study of learning environments. Journal of Classroom Interaction, 26, 2, 25-39.

Evertson, C.M. (1985). Training teachers in classroom management: An experimental study in secondary school classrooms. The Journal of Educational Research, 79, 1, 51-58.

Fish, M.C., & Dane, E. (2000). The Classroom Systems Observation Scale: Development of an instrument to assess classrooms using a systems perspective. Learning Environments Research, 3, 67-92.

Flanagan, D.P., Alfonso, V.C., Primavera, L.H., Povall, L, & Higgins, D. (1996). Convergent validity of the BASC and SSRS: Implications for social skills assessment. Psychology in the Schools, 33, 13-23.

Flanders, N. (1970). Analyzing teacher behavior. Addison Wesley: Reading, MA.

Friedman, D.L. (1987). Direct observation of classroom quality for learning: Reliability and validity. ERIC Ascension Number ED296538.

Han, K., Marvin, C., & Walden, A. (2003). Searching for an alternate way to identify young creative minds: A classroom-based observation approach. Assessment for Effective Intervention, 28, 2, 1-16.

Harris, A.H. (2003). VaNTH Observation System Manual. Nashville, TN: Peabody College at Vanderbilt University.

Harris, A.H., Cordray, D.S., & Harris, T.R. (2002). Measuring what is happening in bioengineering classrooms—An observation system to analyze teaching in traditional versus innovative classrooms. Proceedings of the Second Joint EMBS-BMES Conference. (CD-ROM, Omnipress): 2618-2619.

Harris, T.R., Bransford, J.D., & Brophy, S.P. (2002). Roles for learning sciences and learning technologies in biomedical engineering education: A review of recent advances. Annual Review of Biomedical Engineering, 4, 29-48.

Haynes, S.N., & Kerns, R.D. (1979). Validation of a behavioral observation system. Journal of Consulting and Clinical Psychology, 47, 2, 397-400.

Hativa, N., & Marincovich, M. (Eds.). (1996). Disciplinary Differences in Teaching and Learning: Implications for Practice. (Vol. 64). San Francisco: Jossey-Bass.

Herkert, J.R. (1999). ABET's Engineering Criteria 2000 and engineering ethics: Where do we go from here? Presentation at the Online Ethics Center International Conference on Ethics in Engineering and Computer Science, March 1999.

Hyson, M.C., Hirsh-Pasek, K., & Rescorla, L. (1990). The Classroom Practices Inventory: An observation instrument based on NAEYC's guidelines for developmentally appropriate practices for 4- and 5-year old children. Early Childhood Research Quarterly, 5, 475-494.

Jansen, E.D., Brophy, S.P., McKenna, A., Mahdevan-Jansen, A., & Walsh, Jr., J.T. (2003). Implementation and assessment of challenge-based instruction in a biomedical optics course. Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition.

Judd, C.M., Smith, E.R., & Kidder, L.H. (1991). Research methods in social relations. (Sixth Edition). Fort Worth, TX: Harcourt Brace Javanovich College Publishers.

Kettle, K.E., Renzulli, J.S., & Rizza, M.G. (1998). Products of mind: Exploring students' preferences for product development using *My Way…An Expression Style Instrument.* Gifted Child Quarterly, 42, 1, 48-57.

Keyton, J. (1985). A field study using SYMLOG dynamics as indicators of conflict, self-concept, and decision making. Unpublished master's thesis, Ohio State University, Columbus, OH.

Keyton, J. (1987). An examination of the compatibility and effectiveness of self-selected small task groups. Unpublished doctoral dissertation, Ohio State University, Columbus, OH.

Knight, S.L. (2001). Using technology to update traditional classroom observation instruments. Paper Presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Le Greca, A.M., Dandes, S.K., Wick, P., Shaw, K., & Stone, W.L. (1988). Development of the Social Anxiety Scale for children: Reliability and concurrent validity. Journal of Clinical Child Psychology, 17, 1, 84-91.

Lett, N.J., & Kamphaus, R.W. (1992). Validation of the BASC Teacher Rating Scale by the BASC Student Observation Scale. Paper presented at the Annual Meeting of the American Psychological Association, Washington, DC.

Lodahl, J.B., & Gordon, G.G. (1972). The structure of scientific fields and the functioning of university graduate departments. American Sociological Review, 37, 1, 57-72.

Menges, R.J. et al. (1999). Faculty in New Jobs. San Francisco: Jossey-Bass.

Miller, M.L., Fee, V.E., & Jones, C.J. (2004). Psychometric properties of ADHD rating scales among children with mental retardation II: Validity. Research in Developmental Disabilities, 25, 5, 477-492.

Milton, O., et al. (1978). On college teaching: A guide to contemporary practices. San Francisco: Jossey-Bass.

National Science Foundation. (2004). Science and engineering indicators 2004. Arlington, VA. (NSB 4-01).National Science Board, National Science Foundation, Division of Science Resources Statistics.

Neumann, R. (2001). Disciplinary differences and university teaching. Studies in Higher Education, 26, 2, 135-146.

Neumann, R., Parry, S., & Becher, T. (2002). Teaching and learning in their disciplinary contexts: A conceptual analysis. Studies in Higher Education, 27, 4, 405-417.

Norris, P.R., Harris, A.H., and Washington, C. (2004). The VOS data manager: Providing immediate feedback on teaching effectiveness. Proceedings of the American Society for Engineering Education Session 1793: 8 pages.

Peterson, D., Micceri, T., & Smith, B.O. (1985). Measurement of teacher performance: A study of instrument development. Teaching and Teacher Education, 1, 1, 63-77.

Pion, G.M., & Cordray, D.S. (2001). "Experiences and benefits of courses: Description of a course-based survey." Unpublished manuscript, Vanderbilt University, Nashville, TN.

Quinlan, K.M. (1998). Promoting faculty learning about collaborative teaching. College Teaching, 46, 2, 43-47.

Reed, M.L., & Edelbrock, C. (1983). Reliability and validity of the Direct Observation Form of the Child Behavior Checklist. Journal of Abnormal Child Psychology, 11, 4, 521-530.

Roberson, T. (1998). Classroom observation: Issues regarding validity and reliability. Paper presented at the 27th Annual Meeting of the Mid-South Educational Research Association (New Orleans, LA, November 4-6, 1998).

Roselli, R.J., & Brophy, S.P. (2001). Movement from a taxonomy-driven strategy of instruction to a challenge-driven strategy in teaching introductory biomechanics. Proceedings of the American Society for Engineering Education Annual Conference & Exposition, Session 1309, 10 pp.

----------------------------------(2002). Exploring an electronic polling system for the assessment of student progress in two biomedical engineering courses. Proceedings of the American Society for Engineering Education Annual Conference & Exposition.

----------------------------------(2003). Redesigning a biomechanics course using challenge-based instruction. IEEE Engineering in Medicine and Biology Magazine, 22, 4, 66-70.

Ross, S. (1976). Children's interactions in traditional and nontraditional classrooms. ERIC Ascension Number ED174306.

Ruscio, K.P. (1987). Many sectors, many professions. In The Academic Profession. (Burton R. Clark, Editor), 331-368.

Rymarchy, G.K. (2004). "Validity." The Web Center for Social Research Methods. Website URL [http://www.socialresearchmethods.net] site visited 9/2/04.

Schachar, R.J., Sandberg, S., & Rutter, M. (1986). Agreement between the teachers' ratings and observations of hyperactivity, inattentiveness, and defiance. Journal of Abnormal Child Psychology, 14, 2, 331-345.

Schwartz D.L., Brophy, S., Lin, X, & Bransford, J.D. (1999). Software for managing complex learning: Examples from an educational psychology course. Educational Technology, Research, & Development, 47, 2, 39-60.

Schuster, J.R., & Zingheim, P.K. (1992). The new pay: Linking employee and organizational performance. New York: Lexington Books.

Seymour, E. (2001). Tracking the processes of change in U.S. undergraduate education in science, mathematics, engineering, and technology. Science Education, 86, 79-105.

Silverman, S., & Buschner, C. (1990). Validity of Cheffers adaptation of Flanders Interaction Analysis System. Journal of Classroom Interaction, 25, 1, 23-28.

Sorcinelli, M.D. (1988). Satisfactions and concerns of new university teachers. To Improve the Academy, 7, 121-133.

Springer, L., Stanne, M.E., & Donovan, S.S. (1998). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. (Research Monograph No. 11). National Institute for Science Education, University of Wisconsin-Madison, Madison, Wisconsin.

Stage, S.A., Cheney, D., Walker, B., & LaRocque, M. (2002). A preliminary discriminant and convergent validity study of the teacher functional behavioral assessment checklist. School Psychology Review, 31, 1, 71-93.

Stallings, J. (1977). Learning to look: A handbook on classroom observation and teaching models. Wadsworth, Belmont, CA.

------------- (1978). The development of the contextual observation system. Paper presented at the American Education Research Association Conference. Toronto: Canada.

--------------(1980). Allocated academic learning time revisited, or beyond time on task. Educational Researcher, 40, 11-16.

--------------(1986). Effective use of time in secondary reading programs. In J. Hoffman (Ed.), Effective teaching of reading: Research and practice (pp. 85-106). Newark, Delaware: International Reading Association.

Stallings, J., & Kaskowitz, D.H. (1974). Follow through classroom observation evaluation, 1972-1973. Menlo Park: Stanford Research Institute.

Stallings, J., & Frieberg, H.J. (1991). Observation for the improvement of teaching. In Waxman, H.C., & Walberg., H.J. Effective teaching: Current research. Berkeley, CA: McCutchan 34 pgs.

Streveler, R., Moskal, B., Miller, R. & Pavelich, M. (2001). Center for engineering education: Colorado School of Mines. Journal of Engineering Education, 90, 3, 383-387.

Tindal, G., & Parker, R. (1987). Direct observation in special education classrooms: Concurrent use of two instruments and their validation. Journal of Special Education, 21, 2, 43-58.

Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center for Bioengineering Educational Technologies (VaNTH) (2002). Annual Report: Volume 1- Strategic Plan. Website URL [http://www.vanth.org].

Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center for Bioengineering Educational Technologies (VaNTH) (2003). Website URL [http://www.vanth.org], site visited 3/10/03.

Wiersma, W. (1983). Assessment of teacher performance: Constructs of teacher competencies based on factor analysis of observation data. ERIC Ascension Number ED230586.