

## A COMPARISON OF BIOENGINEERING FACULTY MEMBERS' TEACHING PATTERNS AT ONE RESEARCH UNIVERSITY

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**Abstract-** This paper explores and compares global teaching patterns of biomedical engineering faculty at Vanderbilt University as captured by the VaNTH Observation System (VOS). The VOS is a four-part classroom observation instrument developed in 1999 for use within VaNTH Engineering Research Center bioengineering classrooms at Vanderbilt University, Northwestern University, the University of Texas at Austin, and the Harvard/Massachusetts Institute of Technology Division of Health Science and Technology. Revised from the Stallings Observation System for K-12 classrooms, the VOS is used by trained observers to obtain qualitative and quantitative unbiased information about in-class student activities and faculty teaching patterns. The first part of the VOS, the Classroom Interaction Observation (CIO), records the frequency of faculty and student interactions, the type of classroom interactions, faculty's use of "How People Learn" learning theory constructs, and faculty's use of media. The second part, the Student Engagement Observation (SEO), notes the presence and absence of desired academic behaviors of students with media, a professor, or by themselves. Narrative Notes (NN), the third part of the VOS, allows observers to type information about the lesson content and context of a lesson on a keyboard in addition to details about extenuating in-class circumstances and additional observations. Finally, the Global Ratings (GR) note the presence or absence of classroom occurrences. Although the CIO, SEO, and NN data are recorded sequentially and cyclically throughout a class period, GR data is recorded once near the end of a class period. Using real-time data collected from the Global Ratings portion of the VOS for bioengineering faculty over several semesters, this study will explore the presence or absence of the following within observed classrooms: 1) faculty's signaling with cognitive organizers and usage of content linkages, (2) faculty and student in-class assessment patterns, and (3) professors' overall pedagogical patterns. More specifically, preliminary information about the percentage of observed instances of seventeen Likert scale items will be examined, and patterns across traditionally-taught and nontraditionally taught, HPL classes will be explored.

### Background and Introduction

The VaNTH Observation System (VOS) is a four-part classroom observation instrument developed in 1999 for use within VaNTH Engineering Research Center (ERC) bioengineering classrooms in VaNTH-member institutions (Vanderbilt University, Northwestern University, the University of Texas at Austin, and the Harvard/Massachusetts Institute of Technology Division of Health Science and Technology).<sup>1</sup> Select classes use instructor-developed educational materials based upon the "How People Learn" (HPL) learning theory.<sup>2</sup> These materials work to integrate the domains of bioengineering, learning science, and learning technology at the postsecondary level as they provide lessons that are *knowledge-centered*, *student-centered*, *assessment-centered*, and *community-centered*. These four "centerednesses," when used with traditional academic methods, have been found to optimize students' learning experiences. Classes in which HPL constructs are used contain appropriate and well-organized content, opportunities for students to connect-academic content and their prior knowledge and experiences, opportunities for both instructors and students to test formatively what is and is not

understood (checking conceptions and misconceptions, as opposed to giving a summative grade), and opportunities for students to collaborate with one another in problem-solving.

Revised from the Stallings Observation System for K-12 classrooms<sup>3</sup>, the four-part VOS has been used exclusively by trained classroom observers to obtain qualitative and quantitative information about students' activities and faculty's teaching patterns within bioengineering classes. Data are collected in a handheld PDA, with three of the four parts using touch-screen coding. In the first section of the VOS, the Classroom Interaction Observation (CIO), an observer records the frequency of faculty and student interactions, different types of classroom interactions, faculty's use of HPL learning theory constructs, and faculty's use of media. In the second part, the Student Engagement Observation (SEO), an observer notes the level of desired academic behaviors of students with media, a professor, or by themselves. The Narrative Notes (NN), the third part of the VOS, requires a keyboard to allow an observer to type information about the lesson content and teaching methods as well as details about extenuating in-class circumstances and additional comments.<sup>1</sup> Finally, with the Global Ratings (GR) an observer notes the presence or absence of classroom occurrences. The CIO, SEO, and NN data are recorded sequentially and cyclically throughout a class period; GR data is recorded once at the end of a class period.<sup>4</sup>

This paper reports and compares global teaching patterns of biomedical engineering faculty at Vanderbilt University as captured by the final component of the VOS, the GR. Using data collected from the GR portion of the VOS for bioengineering faculty during the 2002 fall semester and during the 2003 spring semester, this study will explore the presence or absence of the following within observed classrooms: (1) faculty's signaling with cognitive organizers and usage of content linkages, (2) faculty and student in-class assessment patterns, and (3) professors' pedagogical patterns. These three areas are reflected in seventeen items that comprise the GR. Preliminary information about the percentage of observed instances of these Likert scale items will be examined, and patterns across traditionally-taught, nonHPL classes and HPL-oriented classes will be explored.

### Faculty Sample

During the fall of 2002 and the spring of 2003, the first author, a trained classroom observer who has collected classroom data with the VOS for three years, obtained twenty-five global ratings observations (one each for twenty-five separate class sessions). This study is the first attempt to analyze GR data and to report initial information about frequencies of occurrence of global ratings indicators within bioengineering classes.

Of these twenty-five observations, nine GRs were taken in nine HPL-oriented classes, and sixteen GRs occurred in sixteen nonHPL classes. HPL-oriented classes included an upper-level Optics course, an upper-level Systems Physiology course, a freshman Optics course, and a freshman Electrocardiogram course. NonHPL classes were all upper-level courses and included a Biopharmaceutical course, a Biotechnology course, a Biomechanics course, and two Systems Physiology courses. Seven professors (2 females and 5 males) are included in the sample.

### Methodology

Classroom data for each faculty member was inputted into a SPSS file. For each of the seventeen items, faculty scores of 0, 1, 2, or 3 had been recorded by the VOS observer. A score of zero represented a minimal to no occurrence of an item, while higher values were given for items in which a faculty member was heavily engaged during a class period. Data were split according to faculty's implementation of HPL materials, and frequencies for each item were observed. From here, the percentage of observed instances for each item was calculated and was placed into three bar charts that represent the three primary GR areas.

## Global Ratings Results

HPL and nonHPL GR class comparisons are seen in Figures 1, 2, and 3. Figures 1 and 2 represent five GR items each, and Figure 3 represents ten items. The average ratings for nine HPL classes are reported in each HPL column, and the average ratings for sixteen nonHPL classes are reported in each nonHPL column.

Figure 1 displays comparisons of HPL and nonHPL bioengineering faculty's usage of organizers and linkages. More than nonHPL-oriented faculty, HPL-oriented faculty were considerably more likely to present both chronological objectives and behavioral objectives at the beginning of class, as well as HPL challenges during class. In addition, HPL-oriented faculty provided more in-class linkages and connections of course content than nonHPL faculty.

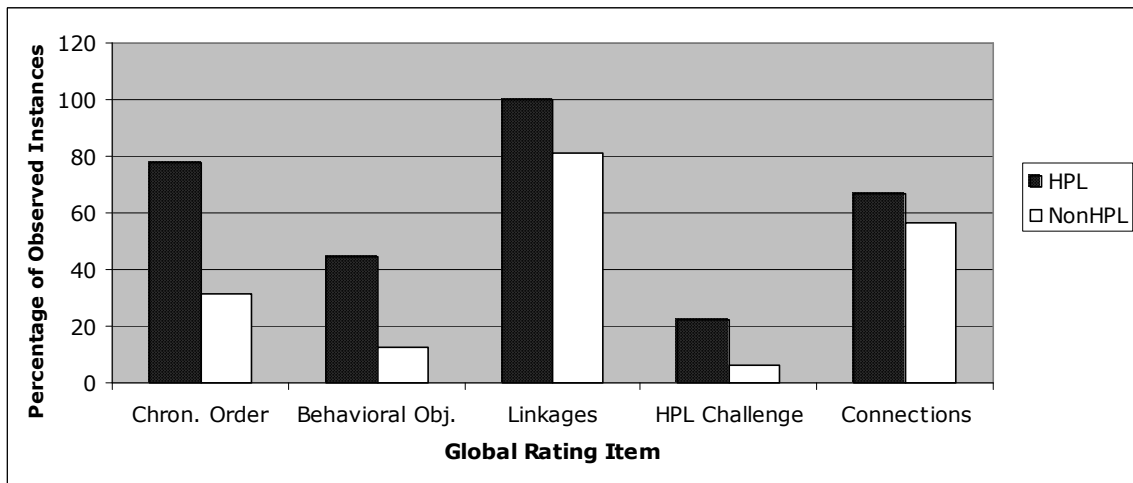


Figure 1- Percentages of Observed Instances of Faculty's Use of Organizers and Linkages

Figure 2 reports both student and faculty assessment that occurred during the observed class sessions. On two items, a professor's use of assessment throughout a class session and students' initiation of extending or higher order questions, nonHPL bioengineering faculty were found to have more instances of occurrence in their classes than their HPL counterparts. HPL-oriented professors, however, were more likely to engage in pre-assessment and post-assessment activities than nonHPL-oriented professors, and students in HPL-oriented classes were more likely to ask clarifying questions than students in nonHPL oriented classes.

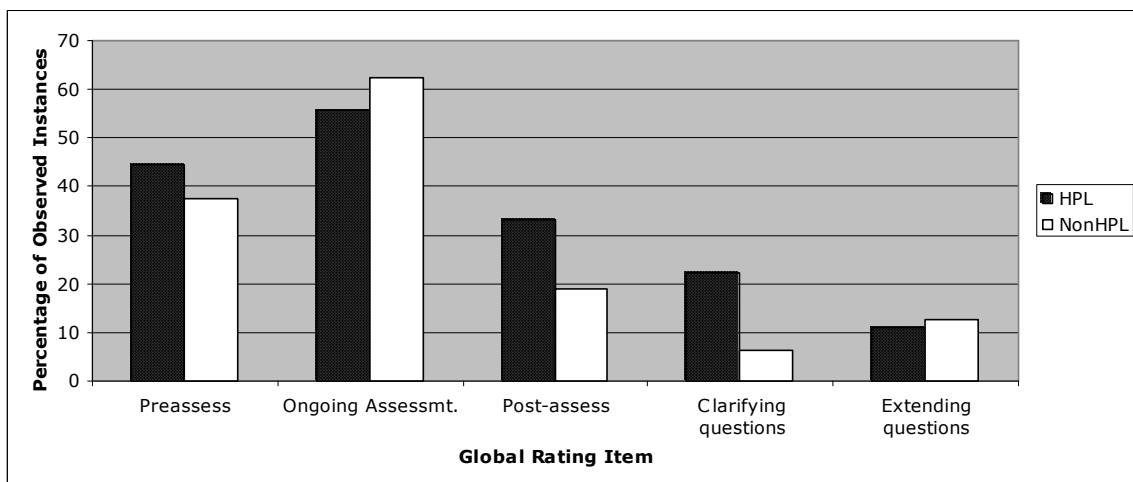


Figure 2- Percentages of Observed Instances of In-class Assessment

Figure 3 displays information about both HPL and nonHPL faculty members' in-class behaviors. HPL faculty demonstrated higher instances of eye contact and active monitoring than their nonHPL faculty counterparts. HPL faculty were also more likely to accept students' questions, to ask students clarifying and hypothetical questions, and to encourage student collaboration during class. The only behavior in which nonHPL faculty were observed to have a higher percentage of instances than HPL faculty was in the use of visual aids in class.

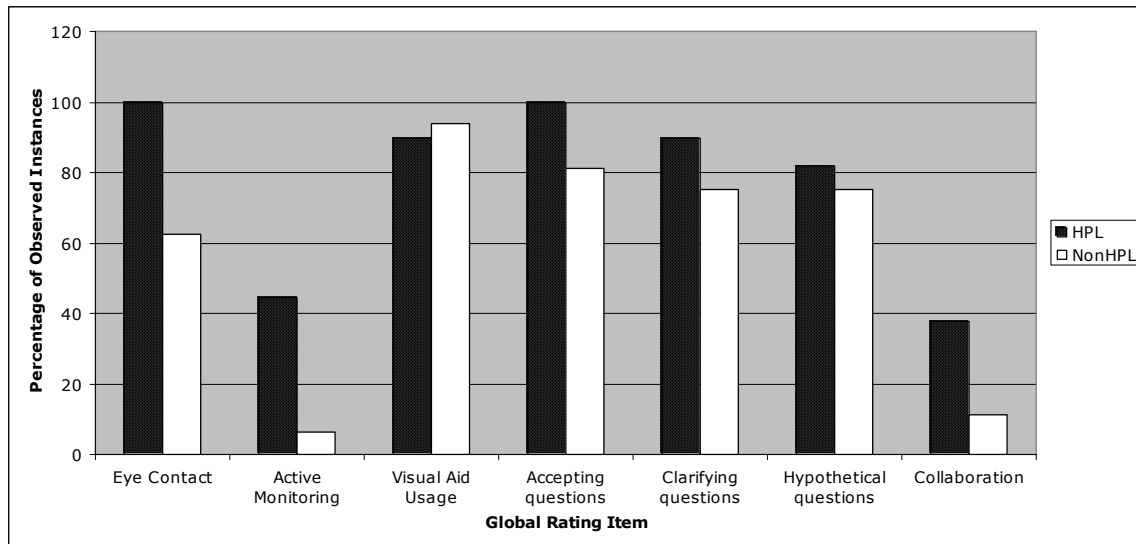


Figure 3- Percentages of Observed Instances of Professors' Behaviors

### Limitations

Despite the congruence of this study's findings with the principles of the HPL learning theory, limitations exist. While one component of the VOS, the CIO, has demonstrated consistent inter-rater received reliability across all observers, the SEO, NN, and GR portions of the VOS have not been subject to rigorous inter-rater reliability testing. For this reason, GR data from only one trained observer have been reported to note the frequency of faculty behaviors across classes. In this way, only general information about faculty's global teaching patterns may be observed at this time. Also, although a high percentage of HPL-oriented classes had no HPL challenges presented in them, this does not mean that they are not HPL-oriented. This challenge, which initiates a series of learning activities, occurs periodically in an HPL lesson format. Thus an observer might observe a class session on a day that a challenge is not presented or on a day that students are already engaged in a challenge or in portions of a challenge.

### Conclusion

In summary, initial findings show that there are differences in teaching behaviors between bioengineering faculty using HPL-oriented materials and bioengineering faculty not using HPL-oriented materials. Overall, HPL-oriented faculty are more likely to signal with cognitive organizers and linkages, to interact with students during class, and to encourage students to verbalize their understanding of lesson content. One reason for this may be the congruence of HPL-oriented materials to positive aspects of the GR.

The information gathered within the GR portion of the VOS is helpful for several reasons. First, although a study has found that instructors who exhibit certain types of nonverbal behavior within classes, such as eye contact, are more likely to be considered highly knowledgeable by their students,<sup>5</sup> additional information is needed about how professors' usage

of materials and questioning techniques ultimately affect student outcomes within engineering classrooms. More specifically, preliminary data gathered from the GR may provide information about classroom environments that may be mapped to student achievement data in the future. Second, the GR portion of the VOS can provide information to professors about their teaching patterns over time. This feedback, along with other classroom data, can assist professors who want to track their pedagogical patterns and who want to compare VOS data with student course evaluations. Third, future studies may examine any GR patterns that are common within certain types of classes (e.g., seminars, recitations, labs), levels of classes (e.g., freshman, graduate), or topic (e.g., Biomechanics, Imaging, Systems Physiology). Finally, since this study is the first attempt to analyze GR data and to report frequency information gathered by one trained observer, a comprehensive statistical analysis across observers must be attempted. Comparing data across these observers may help to provide information about the reliability of the GR portion of the VOS, and a comparison of GR data with data collected from other parts of the VOS may help to prove the validity of the VOS itself. With this information, classroom norms for bioengineering may be determined and may be compared with other engineering disciplines.

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