Scaling large-size undergraduate classes at a top research university via eLearning strategies: A facilitated model of instruction using a Web 2.0 paradigm

Samuel S. Conn
Institute for Distance and Distributed Learning

John D. Boyer
Department of Geography

Deyu Hu
Institute for Distance and Distributed Learning

Thomas Wilkinson
Office of Distance Learning and Summer Sessions

Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Abstract

Faculty members who teach large-size undergraduate classes face unique and distinct issues and challenges. Examples of issues and challenges in teaching large, diverse undergraduate student populations include wide distribution of backgrounds and abilities, various majors versus students taking electives, lack of personal attention and student engagement, and determination of appropriate levels of instruction. This research involves collaboration between a Virginia Polytechnic Institute and State University undergraduate professor and the Virginia Polytechnic Institute and State University Institute for Distance and Distributed Learning to examine the use of information systems and eLearning strategies in concert with Web 2.0 technologies to increase the efficacy of instruction in large-size undergraduate classes. Developed as a case study, this investigation utilizes a mixed-method research approach where data were collected and analyzed from field notes, classroom observations, and student surveys. The initial results indicate a need for an increase in the overall effectiveness in instruction of large-size undergraduate classes via use of eLearning strategies. The researchers report the interim results of the work as a foundation for follow-on research to conduct a comparative analysis of a second case study of a large-size class taught by the same instructor, but enhanced by eLearning strategies and conducted in fall 2009.

Keywords: Large-size classes, undergraduate education, classroom models, eLearning, Web 2.0, eLearning information systems.

1. INTRODUCTION

Higher education institutions today face difficult decisions related to large-class size. Issues with facilities and classroom space, efficacy of instruction, learner perceptions related to academic quality and student achievement are historically related to large-size classes. For the purpose of this report, a large-size higher education class is defined as one with more than 500 students. The impact of class size has been a subject of investigation since the late nineteenth century (Glass & Smith, 1979).

The purpose and justification of the study were to determine the efficacy of eLearning strategies as an accommodating solution for improvement of instructional quality in large-size classes, and as a mechanism to address problems associated with scaling large-size university classes. In this investigation the researchers follow a consistent path of research, but advance the research to a facilitated model of instruction using a Web 2.0 paradigm.

Web 2.0 refers to services and user processes created with emerging Internet and Web open standards and technologies. Concatenation of maturing Web applications and technologies to create innovative, facilitative design for collaboration, knowledge creation, and information mediation (info-mediation) is a central Web 2.0 concept. Aggregation and brokering of user data, construction of social networks, creation of Web services, and exploration and discovery are driving goals in Web 2.0 initiatives. In effect, the old model of the Web as an information repository passively accessed by users changes to a platform for social constructs and collaboration, interaction and exchange, and personalized content ontologies (Bateman, Gašević, Hatala, Jovanović, and Torniai, 2008).

Seminal work in computer-assisted instruction (e.g., Hartley, 1977) created a foundation for advancing the use of technology in the classroom; the World Wide Web (WWW or Web) was the specific technology development platform involved in this study. The literature review provides a foundation for the relevancy of the study, a history and theory of research in large-size classes, and material facts related to discovery in the investigation. A case study of one large-size undergraduate class at Virginia Polytechnic Institute and State University (Virginia Tech) presents supportive qualitative data and provides the contextual exposition for the study. Quantitative and qualitative data were collected and visually abstracted to support investigation findings. Research methodology and instrumentation are presented in narrative form and support a justification for the study.

2. LITERATURE REVIEW

Glass and Smith (1979) concluded that more is learned in smaller classes. Conventional wisdom evolved as a result of atavistic regression to meta-analysis and findings from early work. However, all things are not equal in determining the impact of technology in teaching and learning. For example, prior to the mid-1990s research could not factor in the ubiquity of the Internet as a *game-changer* in how instruction could be delivered.

Swan (2001) notes the seminal work of Shank (1998) in differentiating between providing information and learning. Also of note is the work of Janick and Leifle (2001) who synthesized the early work of Anderson and Reiser (1985), Gagne, Briggs, and Wager (1988), Hannafin and Peck (1988), Tennyson (1989), Jonassen et al. (1995), and Ward and Lee (1995) to develop 10 concepts that support effective design of Web-based instruction (i.e., instructors acting as facilitators, use of a variety of presentation styles, multiple exercises, hand-on problems, learner control of pacing, frequent testing, clear feedback, consistent layout, clear navigation, and available help screens).

Swan (2001) also cites the work of Madden and Carli (1981), Powers and Rossman (1985), Weiner and Mehrabian (1968) as important considerations in eLearning strategies with respect to the immediacy of communications in student-teacher interactions. Moreover, Swan notes more recent studies by Gunawardena and Zittle (1997), LaRose and Whitten (2000), Rourke et al. (2001), and Richardson and Swan (2001) who concluded that instruction is facilitated by creation of a social presence using computer-mediated communications.

Positive correlations between perceived interactions with faculty and the average number of student responses were found in a study by Jiang and Ting (2000). Swan con-

cludes that students who perceive high levels of interaction with faculty report high levels of satisfaction and learning with the course.

With respect to interactions between students, Swan (2001) notes the work of Harasim (1990), Levin, Kim, and Riel (1990) who determined that students perceive online discussion as more equitable and democratic than face-to-face discussions, thus supporting Moore and Taylor (1996) who found that computer-mediated communication encourages sharing of ideas, experimentation, increased participation, and collaborative thinking between classmates. Based on Moore (1989) and Rourke et al. (2001), Swan describes the importance of creating opportunities for classmates to interact using online course mechanisms. Thematic in the body of literature noted is the efficacy of eLearning strategies in classroom instruction.

Wright (2008) reported the findings from a study of Web-based versus in-class instructional methods. Based on the work of Hazari and Schno (1999) and Twigg (2001), Wright notes research that demonstrates distance education students feel more compelled to work with peers than do students in face-to-face classrooms. The 24-hour access to a class aids students in managing work, study, and social obligations. Wright concludes from his and other studies (e.g., Frey, Faul, and Yanklov, 2003; Hara and Kling, 2000; and Howland and Moore, 2002) that learning environments can be improved through simulating and integrating in-class interactivity with Web-based learning environments.

Robbie, Finn, and Harman (1998) provided narrative on the effects of class size and student achievement. Their nascent view of class size as an influencing factor in educational quality describes the existence of a positive correlation between reduced class size and student achievement.

Herbert and Hannam (2002) described in a team report the results of a 2001 survey of 69 highly accomplished teachers and 21 academic developers in 23 Australian universities. The goal of the investigators was to identify and disseminate best practices for teaching large-size classes. Large-size classes were described as involving 500 plus students. According to Herbert and Hannam, 62.5 % of survey respondents included

Web-based learning activities to structure or facilitate instruction. Elearning technology use included Web sites, down-loadable course materials, Web-based conferencing or discussion boards, podcasting, and online video lectures. The authors found the major instructional or pedagogical issues with large-size classes were an inability to know students on a personal level and students' strong feelings of isolation and anonymity in the class. As a result, the authors suggested best practices involving technology and eLearning strategies to facilitate learning and communication in large-size classes.

Of thematic relevance to this study, Vermeulen and Schmidt (2008) noted the work of Kember and Leung (2005a, 2005b) in dividing the learning environment into three components: (a) the extent to which information and personal interaction between faculty and students is possible, (b) interaction with peers, and (c) the course curriculum. Moreover, the authors note previous studies (e.g., Arends (2001); Hativa, Barak, and Simhi (2001); Kember (2004); Mackenzie (1983); and Umbach and Wawrzynski (2005)) that conclude supportive, cooperative, and responsive faculty positively affect student learning. Additionally, Vermeulen and Schmidt describe the importance of peer interaction as a positive factor in student learning and engagement; a notion also supported by the work of Kember and Leung (2005a, 2005b).

Huang and Behara (2007) proposed an alternative view to experiential learning via use of Web 2.0 technologies combined with eLearning strategies. The authors focus on a pedagogical model that designs and structures courses based on learning outcomes rather than instructional formats. According to Huang and Behara, Web 2.0 technologies applied to an experiential learning model of instruction increase pedagogical efficacy, resolve problems with scalability and limited instructional resources, and create a focus on achievement of learning outcomes.

Used as learning tools, Web 2.0 technologies provide platforms of growing content and functionality, mechanisms for social networking and collaboration, and enhanced rich-media content syndication. Huang and Behara note the work of Biggs (2003), Buzzetto-More and Alad (2006), Chaker (2007), Connolly and Stansfield (2006), Heinze and Procter (2003), Kolb (1984), Lave and Wen-

ger (1991), Laurillard (2002), and Turban, Leidner, McLean, and Wetherbe (2007) in supporting the contention that Web 2.0 technologies, combined with eLearning strategies, can provide for a richer, more meaningful learning experience for students.

3. RESEARCH METHODOLOGY

In this study the researchers applied a mixed-method research approach. Based on Creswell (2009), qualitative and quantitative research approaches were applied to formulate the ontology for the study. Qualitative research techniques included classroom observations, field notes, and interviews. According to Yin (2009), appropriate techniques for qualitative investigation also can include case study. Using the aforementioned qualitative research techniques, the researchers constructed a case study involving one spring 2009 section of GEOG 1014 World Regions, an undergraduate core liberal education course.

The case study of this undergraduate course resulted in collection of data useful in establishing themes and patterns with respect to student perceptions of learning with introduction of eLearning strategies (Denzin & Lincoln, 2008). A priori knowledge was achieved utilizing empirical quantitative data collected through survey of the student universe. Posteriori knowledge was established utilizing qualitative data via classroom observations and field notes recorded between 1:45 – 3:25 pm on Thursday, April 23, 2009 during a scheduled class time.

Findings from the data collected were synthesized with the review of literature to reach conclusions regarding the hypotheses and associated research questions. The investigators formulated two research questions to guide the study. Research questions facilitated creation of five hypotheses regarding student perceptions of learning within a large-size class.

Table 1 features the guiding research questions and corresponding hypotheses. The quantitative research technique applied in the study involved survey of students in one population group where *n=582*: Spring 2009 section of a GEOG 1014 World Regions course.

Table 1: Research Questions and Associated Hypotheses

Question Number	Research Question and Associated Hypotheses
Research Question 1	*Is the level of student satisfaction with interactions between faculty member(s), content, and peers the same for large-size classes using eLearning strategies versus large-size classes not using eLearning strategies?*
	H_1: With eLearning strategies students are more satisfied with interactions with faculty member.
	H_2: With eLearning strategies students are more satisfied with interactions with content.
	H_3: With eLearning strategies students are more satisfied with interactions with peers.
Research Question 2	*Do students perceive large-size classes as being lower in quality than non large-size classes?*
	H_4: Student perception of quality has no relationship to large-size class.
	H_5: Use of eLearning strategies alters student perception of class size: students perceive class size is smaller than actual size.

Research Instrumentation

The sample for this analysis was composed of 582 undergraduate students registered in the spring 2009 semester. The survey was designed to solicit/obtain students' perceptions of interactivity between faculty/instructor and students as well as with fellow students/peers. Moreover, the survey obtained students' feedback regarding course content as delivered in a large-size class. Primarily the dimensions measured include interactivity and course content.

The survey was developed in two domains: Interaction and Content. The survey instrument was made available in electronic format via a Web-based survey system. Offered asynchronously online, the survey was voluntary and held open for 10 days, beginning in week 13 of the semester. The

response rate to the survey was determined to be 80.47%; 484 students responded to the survey. Distribution of the 31 survey items included 28 items related to students' perceptions of interaction and course content, and 3 items related to demographics. Of the respondents 37% were female and 63% were male. By year of undergraduate education, 33% were freshmen, 18% were sophomores, 11% were juniors, and 37% were seniors. Distribution of respondents by ethnic category included 2% African-American, 9% Asian, 80% White non-Hispanic, and 9% unidentified.

The observation data for the class were recorded during three timeframes: pre-class, class, and post-class. Pre-class observational data were collected between 1:45 – 2:00 pm, class data were collected between 2:00 – 3:15 pm, and post-class data were collected between 3:15 – 3:25 pm. For class data, the researchers constructed a matrix to collect class observation data in 5-minute intervals. The matrix was divided in two categories: interactivity and environment. Interactions between students and the faculty member and interactions between students were recorded along with student engagement. Student reactions to the faculty member lecturing, asking open-ended questions, and asking closed-ended questions were recorded. Additional data collected were the number of students concurrently wanting to respond and number of students who were able to respond. Environmental data collected during the observation included level of student inattentiveness during class, level of student focus on the class activities, level of student involvement in activities related to the class and in support of learning, and use of electronic and mobile devices.

4. CASE STUDY

Virginia Tech undergraduate students are required to complete coursework in compliance with university core curricula. As a result, each term many students register for large-size classes. This spring 2009 course was presented in a large-size lecture course format and conducted in the 547-seat auditorium.

The subject of the case study involved the spring 2009 section of GEOG 1014 World Regions, taught by a highly accomplished teacher. Weekly class meeting times include Tuesday and Thursday lectures from 2:00 – 3:15 pm. The lecture hall was centrally located on the campus and was divided into three major seating areas facing an elevated stage. A stage featured a large screen accommodating three projection panels. The auditorium was provisioned with wireless microphones and a public speaking amplification system. Lighting, sound, and projections were controlled via a central console located in a back-of-the-auditorium control booth. Current eLearning strategies integrated with pedagogy included: (a) a multimedia approach to content delivery, (b) use of Web site for content aggregation, (c) static mash-ups of Web and text content, (d) information retrieval of Web-based content using a search engine, and (e) blog.

5. RESULTS AND FINDINGS

Quantitative Results and Findings

Likert scale survey data were collected and statistically tabulated to examine agreement and disagreement in domains related to the research questions. Aggregated by (a) Interaction with Instructor, (b) Interaction with Classmates, and (c) Interaction with Content, results are presented in tabular form. Table 2 represents the results from respondents with respect to attributes associated with instructor interactions. The validity of the survey data is supported by the high level of response among those surveyed (generally 80% or higher).

Table 2: Survey results on Interaction with Instructor

Interaction with Instructor	N	Percent Agree
Quality of response to course related questions is good	476	96%
Response time outside of class to my course related questions is good	481	93%
Class interaction with instructor is encouraged and well-managed	482	91%
Frequency of interaction with instructor in class	483	29%
Frequency of talking with instructor outside of class	478	5%

Table 3 features the results of data collected in the domain of interaction with classmates. Survey items asked the student if he/she agreed or disagreed that the frequency of interact with classmates during and outside of class was sufficient. Overall, students indicated a desire for more social interaction during and outside of class. This finding is supported in the qualitative data where students were observed increasingly communicating electronically with one another during class-time.

Table 3: Survey results on Interaction with Classmates

Interaction with Classmates	N	Percent Agree
Frequency of interaction with classmates during class was sufficient	467	39%
Frequency of interaction with classmates outside of class was sufficient	436	39%

Results of data tabulation in the domain of interaction with content are presented in Table   4.

Table 4: Survey results on Content

Content	N	Percent Agree
Degree to which subject matter was made stimulating or relevant	475	97%
Learning in this environment was as effective as in other courses	479	96%
Quality of the content of student comments questions and interactions was good	480	94%
Course activities helped my regular interaction within the class	478	87%
Technologies used in the course helped me communicate with classmates	476	83%
I could register for this course with no trouble	478	72%
Extent to which the size of the class influences your perception of the quality of learning?	476	39%
Felt isolated in the course	478	8%

The majority of students found the learning environment to be effective and of sufficient quality; however, fewer respondents agreed that technology played an enabling role in facilitating communication with classmates.

Qualitative Results and Findings

The researchers evaluated interactions between the faculty member and students by recording related occurrences of faculty questions and student responses during 5-minute intervals over the class time. Utilizing a data visualization approach for analysis, Figure 1 illustrates the trends, patterns, and behaviors of the data recorded from occurrences of open-ended questions, close-ended questions, and student responses. From time interval 2:00 pm to 2:25 pm the occurrence of open-ended questions exceeded the occurrence of close-ended questions. During the same time interval, student responses lagged in concert with the general drop in open and close-ended questions. The pedagogical response to encourage student engagement was a strong increase in open and close-ended questions, as illustrated in the time interval from 2:35 pm to 2:50 pm.
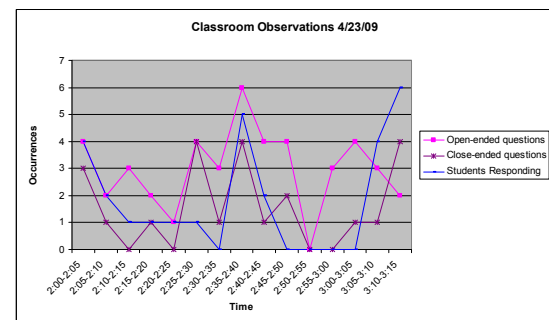

Figure 1: Measurement of Student Interactivity (Students responding to questions)

Student engagement declined rapidly between time interval 2:50 pm to 3:05 pm as a result of a decrease in faculty questions from 2:55 pm to 3:00 pm. In the final time intervals for the class, student engagement again increased rapidly in response to an

increase in open-ended questions, especially those related to course assignments and exams. These observations in a large-size class contribute to the following findings: (a) questions directly stimulate student engagement and interaction even in large-size classes, (b) open-ended questions have more impact than close-ended questions in motivating student interaction, (c) a substantial differential exists between the number of occurrences between questions and responses (i.e., the number of responses fall short of the number of questions). Figure 2 features a measurement of student ability to respond to questions in a large-size class.
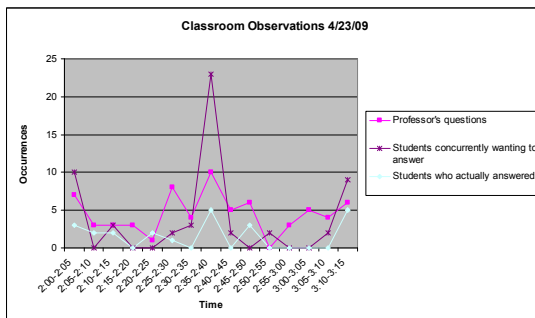

Figure 2: Measurement of Student Interactivity (Students ability to respond in large-size class)

6. CONCLUSIONS

Research Questions and Hypotheses

RQ1: Is the level of student satisfaction with interactions between faculty member(s), content, and peers the same for large-size classes using eLearning strategies versus large-size classes not using eLearning strategies?

H_1: With eLearning strategies students are more satisfied with interactions with faculty member.

Although the majority of students responded that quality and timeliness of responses from the faculty was good, 29% of students responding believed the frequency of interaction with the faculty member was sufficient and 5% indicated the frequency of interaction with the faculty member outside of class was acceptable. These indications establish a baseline for student satisfaction with faculty interaction in a robust technology-enabled classroom, but do not establish a rationale for proof or disproof of H_1. The follow-on study will provide comparative data to reach a conclusion.

H_2: With eLearning strategies students are more satisfied with interactions with content.

The majority of students responding indicated a high level of satisfaction in stimulating content, and effective learning environment, and the quality of content with other student comments and interactions. Of the respondents, 83% indicated the classroom technologies enabled them to communicate with classmates. As content in the course was delivered via an interactive, multi-media approach, the data indicated that students prefer interactions with content using an eLearning strategy. Based on the response data, H_2 was determined to be true.

H_3: With eLearning strategies students are more satisfied with interactions with peers.

Of students responding, 39% were satisfied with the frequency of interaction with classmates during and outside of class. The data indicates a potential for improvement in the frequency of social interaction between students, as would be accommodated via a structured social network. Based on the response data, H_3 was determined to be true.

RQ2: *Do students perceive large-size classes as being lower in quality than non large-size classes?*

H_4: Student perception of quality has no relationship to large-size class.

Of students responding, 39% agreed that class size influences their perception of the quality of learning. The majority of students did not believe a large-class size has a direct or indirect relationship to the quality of learning. As a result, H_4 was determined to be true.

H_5: Use of eLearning strategies alters student perception of class size: students perceive class size is smaller than actual size.

Of students responding, only 8% indicated s/he felt isolated in the course. This data supports the conclusion that large-size classes, properly facilitated, do not lead to feelings of isolation and will be used as a baseline measurement in the follow-on study. As a result, a determination for H_5 was inconclusive in this study.

7. SUMMARY

Utilizing a mixed-method research approach, the investigators synthesized quantitative and qualitative data from the study to achieve findings and conclusions. This study represents the initial base-line study for a follow-on study scheduled for fall 2009. In response to five hypotheses regarding use of eLearning strategies to conduct large-size university classes, the investigators synthesized findings from quantitative and qualitative data to determine: (a) in large-size classes students have a need for high levels of social interaction, (b) classroom technologies are generally inadequate in facilitating interactions between peers, (c) satisfaction with faculty interaction is largely driven by questioning and does not accommodate the majority of participating students, (d) students are excited and engaged when Web technologies are used to facilitate instruction and interaction, (e) students prefer to interact with faculty electronically, and (f) increased use of Web 2.0 technologies is indicated to improve the quality and quantity of interactions in the course. As a result, this base-line study will be used as a comparative basis in the fall 2009 follow-on study where increased implementations of Web 2.0 technologies and eLearning strategies will be introduced to a large-size class of similar composition. The purpose of the follow-on study is to reach additional conclusions regarding the efficacy of eLearning strategies in facilitating a large-size university class.

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