EFFECTS OF DISCUSSION POSTINGS IN ONLINE ELEMENTARY STATISTICS COMMUNITY COLLEGE CLASSES

by

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Abstract

Online learning in community colleges has grown from experimental status to a reality. In California community colleges, the number of online course sections has been increasing and is expected to continue to climb over the next decade, but the retention and academic success rates for students in the online sections are significantly lower than for students in the corresponding face-to-face sections. Research on why students in online sections do not succeed has been minimal. Although researchers of students in face-to-face sections have concluded that lack of interaction among community college students is a significant reason students do not succeed, the research is deficient about which individual forms of online interaction may lead to greater academic success and retention in online courses, or how these forms individually affect instructional design of courses. This study attempted to lessen that research void by studying the effect on retention and academic success through use of structured higher order thinking online discussion postings in online elementary statistics classes as the form of interaction. Elementary statistics sections at two California community colleges were randomly split into control and experimental sections after the students had self-enrolled into the online sections. The course requirements within each college were identical for the control and experimental groups with the exception that students in the experimental sections were required to participate in structured discussion postings requiring higher order thinking skills. The first research question asked if required interaction via structured online discussions contributed to higher retention rates in online courses. The second research question asked if required interaction in structured online discussions contributed to higher academic success rates in online courses. The study used an

experimental methodology with a one-variable design. For both research questions, the p-value was insignificant. These were surprising results as the literature and major distance learning organizations promote research and presentations involving discussion postings in online learning. Future research could expand into other disciplines, conduct research in community colleges in other states, study the effects of other forms of interaction methods, and look beyond community colleges to online high school through university courses.

Dedication

To my mother, Judy Sack, and the memory of my father, Paul Sack, who always encouraged me and believed I could do whatever I set my mind to, even when I did not believe it.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

Online learning in community colleges has grown from experimental status to a reality. In 2005, 72% of U.S. associate degree institutions agreed that online education was a part of their long-term strategy (Allen & Seaman, 2005). The executive director of the U.S. Distance Learning Association, John G. Flores, stated, “The question that you have to ask is not who is offering distance learning, but who isn’t” (Botelho, 2004, para. 7). However, while online courses are increasing, community college courses traditionally have high attrition rates (Nora, 2004; Schuetz, 2005). In face-to-face classes at community colleges, part of the high attrition rate is due to lack of student interaction (Halpin, 1990; Tinto, 1993). Conducting research on specific interaction strategies in online community college courses may provide information on how to reduce the online attrition rate. Stakeholders benefiting from this research include the academic community, the field of instructional design, faculty teaching online courses, and the students in online courses. This experimental research study focused on introducing higher order thinking discussion questions into two elementary statistics courses at two community colleges.

In the 2001-2002 academic year, 92% of the United States public two-year colleges offered distance education courses (Waits & Lewis, 2003), which reflected an increase from 90% in 2000-2001 and a sharp jump from 62% in 1997-1998 (Lewis, Farris, Snow, & Levin, 1999). The 1,472,000 students (duplicated head count) enrolled in public two-year college distance learning courses in 2000-2001 represented 48% of all United States 3,077,000 (duplicated head count) distance education students (Waits & Lewis). The number of institutions offering distance education courses and the number of students taking those courses is expected to continue to rise over the next decade (California Virtual Campus, 2005a; Waits & Lewis).

Ninety percent of the colleges offering distance education offered Internet courses using asynchronous computer-based instruction as the delivery method in 2000-2001 (Waits & Lewis, 2003). Much research and literature has focused on the level of quality of online classes as compared to face-to-face classes (Bernard et al., 2003; Dakwar, 2001), retention in online courses (Carr, 2000; Lamkins, 2004; Palloff & Pratt, 2001), academic success in online courses compared to face-to-face ones (Russell, 2001; Warren & Holloman, 2005), and student satisfaction in online learning (Allen, Bourhis, Burrell, & Mabry, 2002; Thurmond, Wambach, Connors, & Frey, 2002). The literature also supports inclusion of interactivity in online courses to improve student satisfaction and participation (Berge, 1999; Gilbert & Moore, 1998; Northrup, 2002; Jung, Choi, Lim, & Leem, 2002; Lamkins).

Research is deficient about which individual forms of online interaction may lead to greater academic success and retention in online courses, especially with community college students, or how these forms individually affect instructional design of courses. Of the literature that exists, the Institute for Higher Education Policy concluded that "research methodology on distance education did not meet acceptable standards, and, therefore, the vast majority of the research was inconclusive" (Phipps, 2004, p. 19). To draw conclusions, additional research using acceptable methodology is necessary. With the number of online students increasing each year, reducing this research void by conducting valid experiments may lead to greater understanding about how to increase academic success and lower attrition rates. This study attempted to lessen that research void by studying the effect on retention and academic success through use of structured higher order thinking online discussion postings in online elementary statistics classes as the form of interaction.

Background of the Study

Online interaction can take on many forms, such as collaborative projects, online discussion postings, chat rooms, and e-mail. Faculty may include some or all of these forms of interaction in hopes of helping students feel more connected with their classmates and instructor (Berge, 1999; Boettcher & Conrad, 2004; Northrup, 2002; Palloff & Pratt, 2001; Roberson & Klotz, 2002). Isolation and a lack of interaction exist in both four-year and community colleges (Halpin, 1990; Tinto, 1993, 1997). Online courses, by definition, do not include as many face-to-face meetings, if any, as compared to traditional classes, which may lead to feelings of more isolation in the online courses and to an increase in transactional distance, that is, the psychological and physical space between the instructor and the learners (Moore, 1997). Community college students, who already tend to be more isolated than four-year students (Tinto, 1993), may thus become even more isolated in online courses. Isolation and/or lack of interaction lead to student withdrawal or non-academic success of the class in many cases (Tinto). Tinto's current research (2000, 2005) on learning communities and retention continues to reinforce his previous works that classroom involvement and interaction are essential to retain students.

Scholarly literature is often both inconclusive and contradictory on whether participation in online discussion postings may increase the academic success and retention rates in the online courses (Berge, 1999; Christopher, Thomas, & Tallent-Runnels, 2004; Jung et al., 2002). Redesigning, developing, and evaluating online elementary statistics courses to include more structured online discussions, especially those involving higher order thinking, may lead to higher success and retention rates in these courses. Experimental research data can help determine if participation in discussion postings affects success and retention rates.

In California community colleges, the online format for distance education has grown almost exponentially since 1997 with telecourses and instructional software decreasing over the same time period (California Virtual Campus, 2005b). In the 2003-2004 academic year, close to 9000 students enrolled in online California community college courses, representing over twice the number enrolled in all other forms of distance education in this system for that year (California Virtual Campus). In 2004-2005, 26 of California's 109 community colleges offered at least one section of elementary statistics online and 50 California community colleges offered at least one online section of freshman composition. For the 2006-2007 academic year, six more California community colleges are offering at least one online section of elementary statistics. All indications are that enrollment in online courses among California community college students, just like national enrollment, will continue to increase (California Virtual Campus, 2005a; Golden, 2006).

Success rates for California community college elementary statistics, as well as other courses, such as English composition and history, differ between face-to-face classes and online classes, with the academic success and retention rates in the online sections significantly lower than the corresponding on-campus sections when course withdrawals are included in calculations. Information from Tom Nobert (2005, 2006) of the California Community Colleges Chancellor's Office shows this problem exists across California community colleges. The U.S. Department of Education is also concerned with distance education persistence. One of its concerns is that older and nontraditional students are taking distance education courses in an increasing number but tend to have lower retention rates the traditional, face-to-face students (Rovai, 2003). With the projected continual growth of California and U.S. community college students taking online courses, it is in the interest of faculty, administrators, and students that instructional design strategies for online interaction be developed, researched, and tested to learn which of these strategies may increase student retention and success.

Statement of the Problem

Interaction among students and/or faculty is an important component of the educational experience (Chickering & Gamson, 1987; Hassenplug & Harnish, 1998; Juler, 1990; Jung et al., 2002; Moore, 1989) for both face-to-face (Halpin, 1990; Tinto, 1993, 2005) and online courses (Berge, 1999; Hassenplug & Harnish; Northrup, 2002; Palloff & Pratt, 2001, 2003; Thurmond & Wambach, 2004). Research literature shows that isolation and a lack of interaction exist in traditional face-to-face (Halpin, 1990; Tinto, 1993, 1997) and online learning environments (Arsham, 2002) in four-year colleges and community colleges. Lack of interaction in online courses seems to contribute to lower retention and success rates in those courses than when interaction is included (Jung et al.). Abundant literature describes techniques to increase interaction, such as structured discussions in online courses (Boettcher & Conrad, 2004; Palloff & Pratt, 2001, 2003, 2005; Roberson & Klotz, 2002; Rovai, 2002). The literature is lacking, though, in how participation in structured online discussion postings affects student retention and academic success rates. There is even less information for discussion postings requiring higher order thinking. This study investigated the effect of introducing structured higher order thinking discussions in order to increase interaction and decrease isolation in online elementary statistics courses and therefore possibly provide insight about student retention and academic success rates. The study focused on elementary statistics courses at two California community colleges.

Purpose of the Study

The purpose of this study was to investigate the effect of structured higher order thinking discussion postings as a required student interaction on retention and academic course success rates in online courses. Specifically, this study looked at the effects in elementary statistics classes in community colleges, a course taken by the majority of California community college transfer students. The literature on interaction in online courses indicates that there is a positive effect, in general, on requiring interaction in online courses (Berge, 1999; Christopher et al., 2004; Jung et al., 2002). Drawing on the existing literature of interaction in online courses as well as the overall lower success and retention rates of California community college students in online elementary statistics courses compared to the face-to-face sections of those classes (Norbert, 2005), this study examined the introduction of structured online discussion postings.

Research Questions

This study examined the effect of required structured discussion postings involving higher order thinking in online courses. The study had two research questions.

1. Is the retention rate of the experimental group (with questions) higher than the retention rate of the control group (without questions)?
2. Is the academic success rate of the experimental group (with questions) higher than the academic success rate of the control group (without questions)?

Significance of the Study

The literature supports the positive effect of including interaction in online courses, but little research can be found about whether including the specific intervention of structured discussions that involve higher order thinking in online courses leads to an increase in the academic success and retention rates in such courses. When the learner population is narrowed further to community college students, even fewer scholarly sources exist. This experimental research study focused on two community college's elementary statistics courses to help fill this literature void. The results from the study should contribute to research in the field of online learning. The results may also provide faculty, course designers, and administrators with information that may allow them to contribute toward increasing the academic success and retention rates in their online courses, thereby helping students reach their academic goals.

Definition of Terms

Academic success rate. The number of enrollments with a grade of A, B, C, and Credit (Pass) divided by the number of enrollments with a grade of A, B, C, D, F, Credit, No Credit (No Pass), W (withdrawal), and I (incomplete). The difference between *academic success* and *retention* is that retention includes those students who remained in the course through the end, but earned grades of D, F, or No Credit. Courses with D, F, and No Credit grades do not transfer to the UC and CSU systems (California Community Colleges, Chancellor's Office, 2001).

Adult student/learner. A student older than the traditional college age, engaged in formal and/or informal education, after years of other activities (Cross, 1981; Neeley, Niemi, & Ehrhard, 1998). Adult learners are a subset of nontraditional learners.

Asynchronous discussion. Text questions typically posted on an online course site in which all members can post and read comments at their convenience. The discussions do not occur in real time (Palloff & Pratt, 1999).

Attrition. Withdrawal, either voluntarily or administratively, from a course, after the initial drop date.

Chat room. A Web site where members communicate, both privately and to the entire group, in real time.

Constructivism. A theory that focuses on learning instead of teaching, involves portraying tasks that require learners to interact, to share, and to construct their own knowledge with multiple perspectives, and includes reflective thinking (Boettcher & Conrad, 2004; Jonassen, 1999; Merrill, 1992; Palloff & Pratt, 2005).

Course success or *academic success*. Completion of the course with a grade of A, B, C, or Credit.

Distance education or *distance learning*. Education and learning when the instructor and classmates are physically separated and the delivery of instruction is assisted by communication technology (Academic Senate for the California Community Colleges, 1995).

Face-to-face (f2f) or *traditional class.* A class in which the instructor and students meet in the same physical location.

Higher order thinking. The higher levels of the six levels of Bloom's Taxonomy. The highest level is evaluation, followed by synthesis, and then analysis. The lower levels are knowledge, comprehension and application (Bender, 2003; Morrison, Ross, & Kemp, 2004).

Interaction. When at least two reciprocal events mutually influence one another (Wagner, 1994). Distance learning interaction may be learner-content, learner-instructor, learner-learner (Moore, 1989) or learner-interface (Hillman, Willis, & Gunawardena, 1994).

Isolation. Lack of interaction. A learner may be isolated in both or either a physical or a virtual classroom.

Nonsuccess. Either completion of a course with a grade of D, F, or No Credit, or withdrawal from the course.

Nontraditional student/learner. A college student who takes online classes and/or is an adult learner.

Online course or *online learning*. A 100% online course, except for possible proctored exams and optional on-campus labs or reviews.

Reflective thinking. Active and careful processing and questioning about the meaning of the material based upon the information that supports the knowledge (Palloff & Pratt, 2003).

Retention rate. The number of enrollments with a grade of A, B, C, D, F, Credit (Pass), No Credit (No Pass), and I (incomplete) divided by the number of enrollments with a grade of A, B, C, D, F, Credit, No Credit, W (withdrawal), and I. See *academic success rate* for a further explanation (California Community Colleges, Chancellor's Office, 2001).

Synchronous communication. Communication that takes place at the same time, either face-to-face or in an online chat room.

Threaded discussion. A continuous record of comments. The comments are kept in chronological order of replies to individual messages. Users may post replies to any of the messages, not just the most recent one.

Traditional student. A college student who both attends a face-to-face class and is typically between the ages of 18 and 24.

Transactional distance. The psychological and communications space between an instructor and the learners (Moore, 1997).

Transfer student. A student transferring from a two-year California community college to a four-year public university.

Withdrawal. Non-completion of a course, either voluntarily or administratively, with a grade of W.

Nature of the Study

Research Design

This study used an experimental methodology with a one-variable design. The two control groups at De Anza and Evergreen Valley Colleges had 45 to 15 participants, respectively. The two experimental groups had 30 and 16 members, respectively, for a total of 106 participants. Placement in the experimental or control group was done by a random number generator after students enrolled for the online courses. The population consisted of learners enrolled in California community college online elementary statistics classes. The sample was online elementary statistics students at Evergreen Valley and De Anza Colleges in the fall 2006 term. Evergreen Valley and De Anza are large northern California community colleges (11,000 and 22,000 students, respectively) with ethnically diverse student and faculty populations. The choice of colleges was based upon convenience, as one faculty member from each college agreed to participate in the study. The variable that was manipulated was discussion postings. The dependent variable was course grades, including grades of W.

Sources of Data

Data were collected from final grade sheets of participating instructors that had students' confidential information removed. The participating faculty supplied a sheet with the frequency of each letter grade they assigned for each group.

Course Descriptions of Elementary Statistics

The course descriptions are from De Anza and Evergreen Valley's online schedule of classes for fall 2006. Both courses transfer to the same colleges and universities. Although the course descriptions are not identical, both courses articulate with the University of California (UC) and California State University (CSU) systems as California Articulation Number (CAN) Stat 2, the first course of "Elementary Statistics."

De Anza College.

> Introduction to data analysis making use of graphical and numerical techniques to study patterns and departures from patterns. The student studies randomness with an emphasis on understanding variation, collects information in the face of uncertainty, checks distributional assumptions, tests hypotheses, uses probability as a tool for anticipating what the distribution of data may look like under a set of assumptions, and uses appropriate statistical models to draw conclusions from data. The course introduces the student to applications in engineering, business, economics, medicine, education, the sciences, and other related fields. The use of

technology (computers or graphing calculators) will be required in certain applications (De Anza College online catalog, 2006).

Evergreen Valley College.

This course is an introduction to the study of statistics. It does not require a knowledge of Calculus but does assume a familiarity with the basic concepts of intermediate algebra. Topics to be covered will include methods of describing data, common sample statistics, probability theory, random variables, common statistical distributions, point and interval estimation, hypothesis testing, and regression and correlation. Additional topics may include goodness of fit, tests of independence, non-parametric methods, and analysis of variance. Students will be required to use a computer software package or a hand calculator to complete several laboratory projects. (Evergreen Valley College online catalog, 2006).

Delimitations of the Study

This study was limited to online elementary statistics courses taught at De Anza and Evergreen Valley Colleges. The researcher is a mathematics and statistics faculty member. She developed and pilot tested discussion postings for her elementary statistics course. Revised and additional discussion posting questions, validated in a pilot test, as well as a grading rubric, were used for the actual research study. Required discussion postings requiring higher order and critical thinking can be introduced in other subjects taught online, as well. The researcher acknowledges that the external validity of the experiment and results would be increased if other colleges and other disciplines conducted similar experiments and obtained increased academic success and retention rates. When participants beyond those that were studied obtain similar findings, the greater the external validity and the more likely that the intervention causes the effect (Gall, Gall, & Borg, 2003).

The two colleges used different course management systems and different texts for their online statistics courses. De Anza College is one of three California community colleges on the 12-week quarter system; only two of which have both online and face-to-face elementary statistics sections. Evergreen Valley College operates on the semester system. Community colleges were limited to those in California, as California has one of the lowest in-state community college tuitions with course tuition the same at all schools. Restricting to just those schools reduced any effect on the withdrawal rate that variable tuition costs might have introduced.

The two participating faculty were long-term, tenured employees of their colleges. Both faculty members co-developed their online courses with another faculty member in their department. They had each previously taught online and had higher attrition rates in their online sections of elementary statistics as compared to their face-to-face sections. Neither faculty member received additional compensation by participating in this study. At the end of the term, each faculty member submitted a summary of the final grade sheet turned into their colleges. The summary contained the frequency of each grade that was recorded, including Ws. The grades were collected from final grade sheets of participating instructors.

Assumptions and Limitations

This research was based on four assumptions. The first assumption was that students would purposely enroll in the online sections of elementary statistics. Secondly, students were assumed to be academically prepared to take the course. Another assumption was that students had Internet access. The final assumption was that random placement into the control and experimental groups might have resulted in different demographics between the groups.

This research also acknowledges two limitations. The first limitation was that any student who had completed the Intermediate Algebra prerequisite or has passed a campus placement exam is allowed, by California law, to enroll in the online section of Elementary Statistics, regardless of whether he or she has the appropriate technical and computer skills. The other limitation was that withdrawals from the courses did not differentiate between voluntary and non-voluntary reasons. Students often drop out of community college classes for personal, non-academic reasons, beyond the control or influence of the instructor.

Organization of the Remainder of the Study

This introductory chapter described the background of the problem under study, along with the reasons for and significance of studying the problem. The purpose of and the nature of the study were discussed. Next, the working definitions of words to be used throughout the study and the individual college course descriptions were defined. Finally, the delimitations, assumptions and limitations of the study were presented. The following chapter contains a literature review of selected topics appropriate to the proposed study. Chapter 3 describes the methodology used to carry out the research, including the research questions and design. Chapter 4 will present the data. The last chapter will discuss the data. It will interpret the findings and give conclusions, if any, that can be made from the data. The final chapter will also give recommendations for further areas of research built upon this study.

CHAPTER 2. LITERATURE REVIEW

Introduction

This chapter presents and discusses the literature that informed the research study. A discussion of interaction, including transactional distance, the lack of isolation, and types of online interaction, opens the chapter. Interaction among online students, emphasizing structured discussion postings requiring higher order thinking skills, rounds out that discussion. Next, Bloom's Taxonomy and higher order thinking skills are explained. The focus then narrows to teaching and learning elementary statistics, the cases of online statistics and mathematics courses, the constructivist learning pedagogy and challenges with the California community college statistics student. The relationship with instructional design decisions and connections to attrition in face-to-face and online tertiary education follows.

The purpose and description of quantitative research design justifies its use for this project. A description of the grading rubric for the discussion questions and of the experiment preceding the research completes the chapter.

Interaction in Courses

Interaction has long been considered one of the most essential parts of learning (Dewey, 1938; Vygotsky, 1978). Moore (1989) classified interaction into three categories: learner-learner, learner-content, and learner-instructor. Learner-learner interaction involves peer discussions, group and collaborative projects, sharing of ideas. Social constructivism occurs in learner-learner interaction as students interact to construct knowledge (Berge & Muilenburg, 2002; National Research Council, 2001; Vrasidas, 2000). Learner-content interaction occurs between the learner and the material for the course. The material may be text based, graphics, oral, or visual. All learning is based upon this form of interaction (Moore; Vrasidas). Learner-instructor interaction may take the form of the faculty member delivering the content, communicating with the students, or even giving instructions.

A fourth form of interaction, learner-interface interaction, surfaced nearly 20 years ago, mainly associated with the field of distance education (Hillman et al., 1994). Students must interact with the delivery medium, be it the computer, television, or another medium, especially when instructional delivery occurs outside of a face-to-face class. Learner-interface takes a more prominent role than it had in the past with the increase of online learning,

Learner-centered interaction is an excellent way to enhance critical and higher order thinking in online discussions (Bender, 2003; Berge & Muilenburg, 2002). There are several types of this kind of interaction, including, but not limited to, collaborative learning projects, synchronous discussions, asynchronous discussions, and learning communities. As learners share their interests, resources and information, the methods will promote reflective thinking, which in turn will enhance critical thinking. Trends show that the learner population age will continue to rise for at least the next decade. Professionals should expect to see more research validating the benefits of learner-centered interaction in online discussions, be it in statistics community college courses or in other disciplines.

Transactional Distance

Students may be physically present in a classroom with their instructor or in different locations. Either way, there may be either or both psychological or communications space between the learners and the faculty member. This space is called transactional distance (Moore, 1997). Transactional distance is more commonly associated with distance education as the physical separation contributes more to the space; although there is definitely transactional distance in many face-to-face classes, especially the large, impersonal lecture classes that exist in many universities. There is great transactional distance when students are not active learners or engaged in their learning, independent of the physical proximity of the teacher to the learner (Bender, 2003). Students in distance education courses experience different levels of transactional distance based upon the structure of their course, the autonomy of the learner, and the dialogue between the instructor and the student (Moore). The instructor's behavior is instrumental in setting the tone of the class, which increases or decreases the transactional distance (Bender).

Certain subjects, such as social science topics, tend to allow for more dialogue and a less teacher directed approach (Moore, 1997), than elementary statistics affords. Students in classes of those subjects, as compared to statistics and mathematics courses, have smaller transactional distance between them and their instructors, based just upon the structure of many social science classes. Online learning can be viewed as a social process, with smaller transactional distance when students feel like they belonged to a community of practice (Bender, 2003). Learning is said to take place in a social fashion (National Research Council, 2001). By the nature of basic information courses such as statistics, in order to overcome and reduce transactional distance, increased efforts must be made to increase dialogue and to be especially responsive to the variety of learner needs. Required discussion questions are one such instructional design possibility as they allow for student creation of knowledge, one of the essential components in distance education programs (Moore).

Isolation and Lack of Interaction in Courses

Tinto (1993) concluded through his extensive studies that one of the main reasons students leave college was that the institutions did not promote learning through active involvement. He stated, “Quite simply, the more students invest in learning activities, the more they learn” (p. 131). Within his five necessary requirements to promote student retention — high expectations, support from the university, instructor feedback, social and academic involvement, and fostering learning — students must interact with their classmates in order to become more involved with their own learning (Tinto, 2003, Conditions for Student Retention section, para. 1-6). Although Tinto’s studies focused on students from both residential and commuter universities, as well as two-year and four-year colleges, his subjects were in face-to-face classes. Vygotsky’s (1978) studies of the process of how children learn concluded that interaction was an essential part of learning. Palloff & Pratt (2003) stated that “what the virtual learner wants and needs is very clear: communication and feedback, interactivity and a sense of community, and adequate direction and empowerment to carry out the tasks required for the course” (pp. 129-130).

Just as Chickering expanded his “Seven Principles for Good Practice in Undergraduate Education” (Chickering & Gamson, 1987) to Internet-enhanced education (Chickering & Ehrmann, 1996), Tinto’s necessary conditions, which focus on student interaction, can be expanded to the world of online classrooms (Berge, 1999). The best practices that faculty use in their face-to-face classes to increase active learning will promote online participation, as well (Palloff & Pratt, 2001). Most experts concluded that the interaction is essential in online classes for students to learn successfully (King & Doerfert, 1996; Palloff & Pratt, 1999; Roblyer &

Wiencke, 2003; Rovai, 2002a, 2002b). Chickering and Ehrmann went as far as to propose that the greatest success in the application of technology to principle of encouraging student/faculty discussions was by the use of asynchronous discussions.

One dissenting opinion was from Boettcher and Conrad (2004). They give a drawback to interaction of it "not necessarily promot[ing] the team-building process" (p. 119). Their very next paragraph after stating this drawback, discusses using collaboration for team-building. Therefore, one can conclude that Boettcher and Conrad do support interaction, just possibly not a very narrow definition of the term that excludes the activities other experts include as a part of interaction.

Lack of Interaction Requirements

In most community colleges, faculty design and develop of their online courses without specific institutional requirements as to the types, if any, of interaction the faculty must include. Professional organizations for community college faculty, such as the Academic Senate for California Community Colleges and American Mathematical Association of Two-Year Colleges (AMATYC) provide position papers and best practice suggestions to include interaction, although these papers are not based upon research, nor do they recommend a particular form of interaction. The Two-Year College English Association (TYCA), the national professional organization for community college faculty, does not even address online learning on its Web site.

Community college faculty generally do not conduct research as part of their employment requirement. They often rely on best practices articles, Web sites, and listservs, as well as anecdotal stories of what does and does not increase academic success and retention in both the traditional and virtual classrooms, for their sources. The sources may or may not be supported by legitimate research. As recently as February 2006, AMATYC's Distance Learning Committee's listserv included a lengthy discussion about including online discussion postings as part of online developmental mathematics course requirements. Postings were anecdotal and opinions. None of the responses were backed by research. The following posting by a Los Angeles mathematics community college faculty member summarizes the need for research on which instructional design strategies for online interaction increase student retention and success.

> I really like the suggestions being posted! It's obvious to me that implementing them would improve the program at my school, and my department chair would readily agree. But he'd get in trouble if he were to ask that faculty make such changes based essentially on hearsay and common sense.
>
> Do we have any documentation about what works for online classes (developmental math in particular)? Or do we have recommendations on "best practices" from a reputable organization? (Posted February 22, 2006)

Interaction among Online Students

Learning was not necessarily considered a social experience in the past. Online interaction among students turns learning into a social experience, one that can aid in the variety of students' learning styles and needs (Gulati, 2004). This section describes four methods that faculty use to promote peer interaction in their courses. These techniques are not meant to be exhaustive, but highlight commonly used methods in higher education. They fall primarily into Moore's (1989) classification of learner-learner interaction. In addition, instructors may use one, two, three or all four of the methods in their classes, either separately or jointly. Discussion postings, also known as asynchronous discussions, have their own description, but can be incorporated as features into online collaborative learning and learning communities.

Synchronous Communication

Synchronous discussions can be either structured or non-structured (free-form). These discussions often take place in chat rooms, in that participants go into a virtual room and chat using informal writing and abbreviations. The instructor may or may not be present in the chat room. Some professors hold office hours in their virtual chat room and are present to answer questions. Others may post questions to all attendees. Still, other instructors may be silent observers while learners present the content or projects.

With structured synchronous discussions, a faculty member is generally present in the chat room. Jiang's research (1998) found that the presence and active participation of the instructor lead to increased student participation. Morrow (2005) demonstrated how synchronous online teaching increases interaction and can be used to satisfy each of the "Seven Principles for Good Practice in Undergraduate Education" (Chickering & Gamson, 1987). When the instructor desires to group students, those students may work interactively on problem solving, even though they may be physically apart. This encourages the "cooperation among students" in Chickering and Gamson's second principle and the active learning in their third principle. When the instructor is present in the chat room, students usually receive prompt feedback, satisfying the fourth principle. Even when the instructor is not present, students actively provide real-time feedback to each other (Morrow).

Opposite of structured asynchronous discussions, free-form chat rooms most often encourage socialization that does not necessarily have an academic component (Berge, 1999). Students may meet here to build a learning community (Boettcher & Conrad, 2004), to work collaboratively on projects, to get assistance from their instructor and/or peers, or just to socialize. The instructor does not necessarily need to be present in the chat room, although the faculty member may, as in cases in which office hours take place in these synchronous discussions. A benefit is that social involvements encourage students to continue as active participants in their courses (Tinto, 1993).

With structured, but even more so with free-form synchronous, discussions, there are at least three disadvantages in their use. As in a face-to-face classroom, a few students may dominate the room. The instructor tends to have more control in the face-to-face course in holding back the dominating students and soliciting responses from other students. Another drawback to synchronous discussions, as with asynchronous discussions, is the absence of verbal cues. An additional drawback to synchronous discussions is the requirement to be on the computer at a particular time. This requirement violates the convenience component that has made online learning so popular (Poole, 2003).

Asynchronous Discussions

Asynchronous discussions are also referred to as listservs and electronic mailing lists. They may take on free-form and structured forms in online courses. A common form of structured asynchronous discussions is for the instructor to post a question or comment and for students to answer the instructor as well as comment on their peers' responses. This form of learner-learner interaction involves active learning as the means to reaching the goal of increased knowledge (Rovai, 2002a). Chickering and Gamson's (1987) second principle of good practice is that "good practice encourages cooperation among students." Palloff & Pratt (2003) promote "well-designed discussion assignments" (p. 131) as a way to facilitate this cooperation among students. As a part of these assignments, they broaden their concept of "discussion assignments" to include collaborative learning in small groups integrated into the design of courses.

When higher level discussion questions are designed well, they tend to force a learner to think critically (McKenzie, 1972) and enhance constructivist thinking (Berge & Muilenburg, 2002). These questions formatively assess students in a way that promote learning (Baron & Keller, 2003). The learner has a chance to reflect on the question and give a thoughtful response. According to Palloff and Pratt (2003, p. 12), "reflection … is a hallmark of online learning." Palloff & Pratt emphasize that when an instructor poses direct questions, those questions encourage reflection. John Dewey defined what is considered as modern critical thinking. He used the phrase "reflective thinking" as its name (Fisher, 2001). Dewey wrote, "*Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends* constitutes reflective thought" (Dewey, 1933, p. 9, original emphasis).

When the questions are well designed and require analysis and evaluation, the reflection will enhance critical thinking, along with other forms of higher order thinking (Muilenburg & Berge, 2000). Composing the written responses promotes critical thinking more than giving oral responses in a face-to-face classroom, just by the nature of the assigned writing. This self-reflection, an "internal reconstruction of an external operation" was called "internalization" by Vygotsky (1978, p. 56).

One of the goals of education is promoting understanding of the subject. Discussion postings accomplish that goal (Perkins, 1992). Learners benefit from their classmates' perspectives on subjects which is one of the major attributes of constructivist learning theory

(Jonassen, 1992). Often, there is no right or wrong answer to a particular question. As learners are building their knowledge based upon their experiences and not striving for just one correct answer, students and faculty are following a constructivist approach with the discussion postings (Duffy & Jonassen, 1992). Students also have an opportunity to reflect on their learning before they respond with asynchronous discussions. This reflection is a key component of online learning (Palloff & Pratt, 2003, p. 12). The learning that is based upon the reflection and interpretation was named transformative learning by Jack Mezirow (as cited by Palloff & Pratt, 1999, p. 129). Students have reported a higher perception of learning in classes that involve online discussions in separate studies involving a combined total of several thousand students (Wu and Hiltz, 2004). The more important issue is whether students actually did learn more in those classes. The above studies did not address that question.

Gulati (2004) disagrees about the constructivist nature of required discussion postings. She emphasized that by requiring participation in online discussions, as well as a due date, the online discussion posting activity is objectivist in nature, rewarding participatory behavior, a philosophy Skinner influenced. Gulati further states that when the faculty member requires such a behavior, that person violates the constructivist theory.

Arthur Chickering is well known for his “Seven Principles of Good Practices in Undergraduate Education” article, originally published in the *American Association of Higher Education Bulletin* (Chickering & Gamson, 1987), reprinted on numerous Web sites, and cited in dozens to hundreds of publications. Chickering’s second principle is “good practice encourages cooperation among students” (p. 3). Graham, Cagiltay, Lim, Craner and Duffy (2001) modified Chickering and Gamson’s principles for online teaching. Their corresponding “lesson for online instruction" is "well-designed discussion assignments facilitate meaningful cooperation among students." Graham et al. make eight recommendations to help accomplish this lesson. These recommendations include requiring participation and focusing the discussions on a task that "should always result in a product."

Discussion postings in the proposed study involve writing about statistics and statistical concepts. Over the past thirty years, dozens of articles and conference presentations through AMATYC and the National Council of Teachers of Mathematics have promoted that integrating writing into the mathematics curriculum may increase student success, as well as reduce student anxiety. Onweuegbuzie and Wilson (2003) reported statistics anxiety rates of up to 80% in graduate students in social science fields. They cite six sources (Caine, Centa, Doroff, Horowitz & Wisenbaker, 1978; Lundgren & Fawcett, 1980; Blalock, 1987; Gaydosh, 1990; Schacht & Stewart, 1990; and Zeidner, 1991) which indicate that "for many students, statistics is one of the most anxiety-inducing courses in their [programs] of study" (p. 195). This researcher has taught elementary statistics, remedial mathematics and college mathematics for almost twenty-five years and vouches for the high level of statistics anxiety among undergraduate social science students as well. Many community college students put off taking their statistics course until just before they intend to transfer which adds to the scope of the problem. This additional pressure also adds to students' anxieties. The high level of statistics anxiety that students in non-technical majors share adds to the difficulty in retaining elementary statistics students in online courses.

Writing in mathematics courses is now mainstream with writing assignments included in most recent tertiary text books. Integrating writing into the statistics curriculum is an extension of this practice. Pan and Tang (2004) analyzed the effect of integrating two "application-oriented teaching methods" into their face-to-face class of graduate social science statistics students. They determined that the two writing assignments led to decreased anxiety among the students. An extension of this study is to analyze the anxiety reduction that undergraduate online elementary statistics students exhibit from their discussion postings. A lower anxiety level could lead to students remaining in the course longer and possibly completing it.

Reflection that is learned as part of one online course will hopefully continue after the course ends and become a part of an individual's life-long learning process (Palloff & Pratt, 2001). The emphasis is not on manipulation of variables and numbers in online constructivist statistics courses. Faculty instead strive to empower learners to evaluate and analyze data and conclusions presented in journals, newspapers, and employment settings. Students learn the critical thinking and higher order thinking skills they need to synthesize statistical concepts they confront in the real world through experiences in reflective thinking in online discussions, collaborative projects, chat rooms, and learning communities.

Classroom Assessment Techniques (CATs) are another method that may help to lower attrition rates among community college students (Angelo and Cross, 1993). Angelo and Cross' CATs were developed for use in face-to-face classes and are not graded assessments. Discussion postings are formative assessments and therefore follow the spirit of CATs even though the postings are for virtual classrooms and often graded. Online faculty can use the learner postings to gain insight into student course learning. Faculty can provide interventions as needed, based upon a student's lack of participation in the discussions and poor display of knowledge.

With the second form of asynchronous discussions, students interact with each other and the instructor in a non-structured environment. Social interaction is the strategy an instructor adopts to promote interpersonal encouragement and sense of belonging in this free-form style (Jung et al., 2002; Rovai, 2002a, 2002b). The instructor may or may not elect to participate. In Jung and colleagues' research (2002), the students using this form of peer interaction had higher achievement scores than those students in the group doing online collaborative projects without non-structured discussions. Rovai sees this form of peer interaction as a way for students to build relationships with their classmates and the instructor, which leads to a sense of trust and belonging to a community.

Two major benefits of free-form asynchronous discussions are the same as with structured asynchronous discussions. These are that the messages can be permanent, allowing students to reread them, and that learners have an opportunity to reflect upon posted comments and their responses before contributing to the discussion (Hron & Friedrich, 2003). Learners may exchange messages at any time without needing to follow a protocol of waiting for their turn. Students often write longer messages with more detail than they would in a synchronous setting because the next message may not be immediately posted (Hron & Friedrich). However, the accumulation of lengthy messages can also become overwhelming as students struggle through so many messages (Hron & Friedrich).

Collaborative Learning

Collaborative projects are one form of learner-learner interactions. Discussion postings may be incorporated into these projects. Generally, the projects assigned are from a constructivist approach requiring students to work together towards a goal by sharing their multiple perspectives and creating their own knowledge. One of the goals of collaborative activities is to develop and increase critical thinking skills (Palloff & Pratt, 2003). In addition, the act of collaboration on the assignments may promote the feeling of students participating in a learning community (Palloff & Pratt, 2001). Many instructors praise collaborative learning as a main way to change passive learners to active ones. Students in collaborative projects must share ideas, analyze their peers' contributions, and write clearly and logically. They can also use their metacognitive skills (Ally, 2004). Collaborative projects address multiple learning styles (Palloff & Pratt, 2003). Not only do they increase development of critical thinking skills, but, by the nature of the assignment, collaborative projects require students to reflect upon their learning, construct knowledge, and transform the manner in which they learn (Palloff & Pratt, 2003).

This requirement of timely active participation may result in a drawback. One of the most common reasons that students report taking online courses is individual flexibility (Thurmond, 2003). Online classes requiring collaborative projects force time constraints that often go against individual flexibility. Even so, a study by Jung, Choi, Lim, and Leem (2002) reported higher learner satisfaction as a benefit of collaborative online projects, even higher than the benefit from social interaction. Jung and colleagues also reported that the group requiring collaborative projects produced lower learner achievement scores than in the group requiring purely social interaction. Both of the just mentioned groups did have higher learner achievement and satisfaction scores than the control group with only learner-instructor contact.

One potential drawback to online collaborative learning is that students may not participate. It is essential that there is instructional support in order to reduce communication and learning problems (Hron & Friedrich, 2003). This support can take place within the collaborative learning groups or via course links for the entire class. Students will be likely to participate once they are aware of the requirements and have resources to help them succeed.

Learning Communities

Learners build communities in both their face-to-face and online courses. Many instructors promote building learning communities as a way for students to construct knowledge, increase their course success, and reduce feelings of isolation (Ehrlich, 2002; Palloff & Pratt, 2005; Rovai, 2002a; Tinto, 1993). Rovai suggests seven factors that affect instructors promoting learning communities in online classes: transactional distance, social presence, social equality, small group activities, group facilitation, teaching style and learning state, and community size. Students generally do not see each other's facial expressions or feel their spirit in online courses. Learners and instructors need to address both the educational and the emotional needs of the members to build the sense of community (Rovai). Even the definition of what a community is changes in the online environment. Learners may not live close by; they may even live thousands of miles apart. Community members may never meet face-to-face. More than just people are involved in an online learning community. The elements include people as well as technology, shared purpose, guidelines, collaborative learning, and reflective practice (Palloff & Pratt, 2005). The instructor's role includes incorporating these elements into the course design to build the learning community. The instructor is a part of the community, but functions more as a consultant than as the leader (Boettcher & Conrad, 2004).

Boettcher & Conrad (2004) warn of drawbacks to online learning communities. These disadvantages include greater faculty time and greater student time for building and promoting the community. The learning community also diminishes one of the main advantages for students who take online courses, that of flexibility in scheduling. In the community, just as with required synchronous discussions, the learners are on a more rigid schedule than they would be if they remained completely independent since the students need to respond to each other in a timely manner. Some students may indeed fall behind the schedule which can create resentment from the other community members. Another drawback involves what is not present in online learning, emotional cues. Classmates may view jokes and expressions of differing opinions as personal attacks and insults without the face-to-face environment. In such situations, students may stop participating in their learning communities, collaborative projects, and discussion postings which could increase the transactional distance those individuals experience.

Summary of Interactions

This section presented four methods of interaction in online courses: synchronous communication, asynchronous communication, collaborative learning, and learning communities. Each method may be used individually or with the others. All four methods promote learning and involve students actively participating in their courses. Tinto stressed (1993) the importance of students learning together via learning communities that incorporate collaborative activities. Asynchronous and synchronous communications in online courses also promote students learning together. Tinto's findings applied to face-to-face students as he has not researched students in the virtual classroom (V. Tinto, personal communication, January 26, 2006). Rovai has studied online students, courses, and pedagogy. He concurs with Tinto in that encouraging students to learn from each other is beneficial to the students (Rovai, 2003).

Thinking Levels

Instructional objectives give information about what the learner is to accomplish. One of the functions of objectives is to assist instructional designers and instructors in designing instruction that will lead to effective learning (Morrison et al., 2004). Cognitive objectives, also referred to as objectives in the cognitive domain, include those objectives which involve the intellectual aspects of learning. These intellectual aspects can be lower types of learning, such as recall of information, through higher levels, such as making judgments. Bloom categorized six levels of cognitive objectives. His taxonomy is presented next, followed by a discussion of the higher levels of Bloom's Taxonomy.

Bloom's Taxonomy

Benjamin Bloom developed six levels of observable verb levels to express behavior for the cognitive domain. These levels are collectively known as Bloom's Taxonomy (Bender, 2003; Morrison et al., 2004). There are several verbs within each level that represent knowledge acquisition at that level. From lowest to highest, the levels and what they represent are:

1. Knowledge: recall information
2. Comprehension: interpret information in one's own words
3. Application: use of knowledge or generalization in a new situation
4. Analysis: break down knowledge into parts and show relationships among parts
5. Synthesis: bring together parts of knowledge to form a whole and build relationships for new situations
6. Evaluation: make judgments on basis of given criteria (Morrison et al., p. 115)

Higher Order Thinking Skills

Educators and researchers refer to *higher order thinking skills* to describe learning that occurs using the highest three levels of Bloom's Taxonomy. The discussion postings in the proposed study will involve the higher levels of Bloom's Taxonomy to promote learning. Most educators agree that frequent feedback to students helps students to stay motivated and continue learning. When learners participate in discussion postings, their communication involves reflective thinking which, in turn, requires students to analyze, synthesize, and evaluate their peer's writing. These three activities, analysis, synthesis, and evaluation, are the three higher order thinking levels of Bloom's Taxonomy, and are also referred to as critical thinking skills (Fisher, 2001).

Bender (2003) promotes designing high-level discussion questions in the online class to enhance constructive thinking. She suggests that the questions be thought provoking or evaluative to increase student learning. These types of questions require higher order thinking skills in order to answer the questions.

Statistics Education

Professors in higher education have traditionally taught with an objectivist approach (Duffy & Jonassen, 1992). Faculty transmit knowledge intending that the students learn the same knowledge as each other and as the instructors profess (Jonassen, 1992). The lecture is considered the traditional instructional format and has been the most common teaching method of the introductory statistics course (Garfield et al., 2002). In undergraduate mathematics and statistics courses students often stayed up all night before exams memorizing formulas and proofs. The course experience was often not enjoyable for both students and instructors (Garfield et al.). In the past twenty-five years, the call for statistics reform, both in content and pedagogy, initiated by statisticians Cobb (1992), Hogg (1992), and Moore (1997), along with project funding by the National Institute of Science has resulted in a new focus for the course.

History of the Introductory Course

Less than 100 years ago, the field of statistics was considered neither an academic subject nor a course for undergraduate social science students (American Statistical Association [ASA], 2005). In 1925, Fisher, one of the founders of modern statistics and statistics education, published an introductory statistics text that was intended for already practicing scientists. Snedecor, another of the modern leading statisticians and statistics educators, published his 1937 text that was one of the first books geared toward undergraduate future scientists (ASA). Over the next several decades, the statistics course evolved from heavily relying upon mathematical probability theory to a course involving exploratory data analysis to the era of the modern elementary statistics course which students who do not plan on becoming scientists take. This modern era began in 1978 with a text by David S. Moore and one by David Freedman, Robert Pisani, and Roger Purves (ASA).

The change in the demographics of students taking an introductory statistics course occurred during the evolution of the content and pedagogy for the course. Originally, the course was geared to scientists, was mathematically structured, and had highly motivated learners. Currently, elementary statistics is a non-calculus based course that most social science majors require. Motivating these students is often a challenge (ASA, 2005). Since 1997, College Board has offered an advanced placement (AP) non-calculus based statistics exam which allows high school students to earn college credit as if they had actually taken the course in college. Seven thousand five hundred high school students took the exam its first year. In 2005, 76,786 students, or ten times the original number of students, took the exam (College Board, 2006). The annual elementary statistics enrollment at De Anza College during that same time period grew from approximately 2500 to 3800 (L. Blankenship, personal communication, July 27, 2006). The growth is more dramatic when compared to the 1989 annual elementary statistics enrollment of 1300, especially since the total campus enrollment was higher in 1989 than it was in 2005. Nationally, the number of elementary statistics students has also increased during these periods.

Reform Movement

The reform movement for the elementary statistics course centers on the change from a mathematical and theoretical course intended for college majors that heavily involve mathematics to an applied, conceptual course taken mostly by students studying fields other than mathematics, physics chemistry or engineering. Garfield and Chance provide seven goals that they considered to be “a summary of currently accepted learning goals for students learning statistics across most grade levels” (2000, p. 100). A review of these goals indicate a focus on the qualitative features of statistics, such as sampling techniques and formulating studies, instead of the previous almost exclusively quantitative nature of the discipline. The focus is now on “concepts, reasoning and thinking” (Garfield et al., 2002). One method students may prove their qualitative understanding of the material is through their written discussion postings. These postings may allow opportunities for additional assessments of students in addition to typical exams and projects.

The main goal now for all non-calculus based elementary statistics courses is that students will be able to think statistically and be statistically literate (ASA, 2005). The American Statistical Association makes six recommendations for the course. These are:

1. Emphasize statistical literacy and develop statistical thinking.
2. Use real data.
3. Stress conceptual understanding, rather than mere knowledge of procedures.

4. Foster active learning in the classroom.
5. Use technology for developing concepts and analyzing data.
6. Use assessments to improve and evaluate student learning. (ASA, 2005, pp. 7-13).

The recommendations fall into three main categories of outcomes: learning, persistence, and attitudes and beliefs (Garfield et al., 2002). The attitude and beliefs category includes keeping learners interested in the course so that they will persist and learn. The reform movement appears to adapt a lesson from the producers and writers of the Sesame Street television show. The insight is “that if you can hold the attention of children, you can educate them” (Gladwell, 2000, p. 100). Some professors advocate use of humor in the elementary statistics course as another learning enhancement (Friedman, Friedman, & Amoo, 2002).

The reform movement for teaching elementary statistics has been led by statisticians involved with the American Statistical Association. Most elementary statistics courses, however, are taught in departments other than statistics departments and with faculty who are not statisticians (Garfield et al., 2002). In a search on community college Web sites, not one community college in California, New York, Texas or Florida had a separate statistics department. The elementary statistics course is mostly housed in the mathematics department with some statistics courses taught in social science and business departments. There is not an accurate assessment of the percent of faculty teaching these courses who are statisticians or statistically trained (Garfield et al.) Most of the faculty are thought to be mathematicians, especially those in community colleges. From a survey that Garfield conducted, the most commonly used text in the community college elementary statistics course is one that statisticians consider to be traditional, not reform (Garfield et al.). It is difficult to assess whether the two-year college faculty are teaching the course with the content and pedagogy that ASA encourages and with the goals the organization recommends. There is an indication that, overall, students prefer a more non-traditional approach to the course, but not whether that preference is an increasing trend (Johnson & Dasgupta, 2005) or whether the students understand the concepts better with a reform approach.

Constructivism in Mathematics/Statistics Courses

In recent decades, many education theorists have moved away from instructor-centered classes with passive learning and memorization to learner-centered ones with active learning (Chickering & Gamson, 1987), cooperative and collaborative learning (Palloff & Pratt, 2005; Tinto, 1993), and constructivist philosophies (Bruner, 1966; Palloff & Pratt; Vygotsky, 1978). Constructivism in community colleges is increasing in popularity as an educational approach to student learning, especially among faculty of and theorists on adult learners. Much of this has to do with the life experiences that an increasingly older college population brings to the classroom, both face-to-face and virtual, when compared to those of the traditional eighteen to twenty-two year olds of decades ago. Faculty are realizing that learners build more complete knowledge when they construct it based upon their life experiences. Professional organizations are promoting the constructivist philosophy in community college mathematics courses as well. American Mathematical Association of Two-Year Colleges (AMATYC), the national professional organization for community college mathematics and statistics faculty, now stresses active learning as the major instructional strategy. The organization specifically emphasizes constructivist learning and deemphasizes memorization of procedures (AMATYC, 2006).

The theory of constructivism is not new, but dates back to the works of Vygotsky on social constructivism in the early 1900s and Piaget on cognitive constructivism in the 1960s

(Huitt, 2003; Palloff & Pratt, 2005). John Dewey's work in the 1930s also emphasized the constructivist philosophy without using the term "constructivism" (Boettcher & Conrad, 2004). Researchers differ on the finer points of what constitutes pure constructivism. They do agree that constructivism focuses on learning instead of teaching, involves portraying tasks that require learners to interact and to construct their own knowledge with multiple perspectives, includes reflective thinking, and that constructivism is not just the transferring of facts without any regard to content and learning style (Bednar, Cunningham, Duffy, & Perry, 1992; Boettcher & Conrad; Jonassen, 1992; Merrill, 1992; Sims, 2003).

In the past two decades, the National Science Foundation has awarded grants to redesign college mathematics pedagogy (and, by extension, andragogy) to a constructivist theoretical perspective (Dubinsky, Mathews, & Schwingendorf, 2004; Gleason & Hughes Hallett, 1992). Many American mathematics educators have embraced the resulting "reform mathematics" movement with its constructivist approach. Building upon this movement, authors of elementary statistics textbooks have developed learner-centered books focusing on knowledge construction (Illowsky & Dean, 2002).

Presenters at annual conferences of AMATYC and the California Mathematics Council, Community Colleges (CMC^3) report that community college students seem to prefer learner-centered statistics courses in which they actively build their knowledge (personal communications, 1999-2005). This preference for learner-centered courses, a characteristic of andragogy, is a logical outcome of the increase in the average age of community college students over the past decade.

Statistics Courses in Community Colleges

The majority of college degrees require an introductory statistics courses (Onweuegbuzie and Wilson, 2003). For example, all social science, business and health science majors in the University of California (UC) and California State University (CSU) systems require at least one elementary statistics course given from the mathematics department. Even if the major does not require elementary statistics, specifically, transfer students to the UC and CSU systems are required to complete at least one college-level mathematics course before transferring. Both the CSU and UC systems require that the transfer course has intermediate algebra (a pre-transfer level mathematics course) as its prerequisite.

Gateway Courses

Elementary Statistics is often considered a gateway course in California since most students who transfer from California community colleges take this course to fulfill their transfer requirements. With the increase of students taking this and other gateway courses online, such as English composition and history, and the higher attrition and non-success rates in California community colleges in the online sections compared to the on-campus sections (California Community Colleges Chancellor's Office, 2006; Norbert, 2005, 2006), faculty and administrators are searching for methods to increase the success and retention rates of their online students.

Most transfer students from California community colleges continue their education in the UC or CSU systems. At the end of the 2003-2004 academic year, 60,897 California community college students made such a transfer (California Postsecondary Education Commission, 2005). The Foothill-De Anza Community College District alone accounted for

2581 of these students (Institutional Research and Planning, 2006). Given the opening of a tenth UC campus, UC Merced, in September 2005, even more students are expected to transfer into these universities.

Attrition

As discussed in chapter 1, the attrition rate across California community colleges is statistically significantly higher for online elementary statistics courses as compared to on-campus classes. This disparity is not limited to just elementary statistics courses or to just California community college students (Carr, 2000; Rovai, 2003). Diaz (2002) investigated the non-academic reasons surrounding the higher online drop rate. One of the significant characteristics of successful online learning students was “a strong independent learning style” (para. 6). Diaz also discovered that the successful online learning students often outperformed the successful traditionally taught students (para. 7). This finding is consistent with this author’s almost fifteen years of teaching elementary statistics via various delivery methods. Diaz cited Gibson’s 1998 report that there are “three categories of factors that have merged to explain and predict attrition in distance courses” (para. 12). Only the third category, educational systems factors, can be partially addressed by introduction of required discussion postings. The other two categories are student factors and situational factors. They are beyond the scope of this study.

Demographics of Community College Students

A major feature of the California Master Plan for Higher Education is that California community colleges “admit any student capable of benefiting from instruction” (University of California, 2004). This open enrollment policy means that any California adult or high school graduate may take any course that does not have prerequisites (California Community Colleges Chancellor's Office, 2004). That policy, along with a 53% non-White state population, compared to a 31% non-White U.S. population (U.S. Department of Census, 2006), leads to a more diverse California community college population than in other states and in other forms of higher education. Nationally, the learner characteristics of the 2.5 million community college students are more diverse than in any other United States form of higher education. U.S. community colleges also enroll more postsecondary students than the rest of the nation's colleges and universities combined (Cox, 2005). In four-year universities, over 57% of all undergraduates are under age 22. At community colleges, only 47% are that young (Evangeleauf, 2006). At Evergreen Valley College in California approximately 55% of the students in fall 2006 were under 25 years old (California Community Colleges Chancellor's Office, 2006), about three years older than the corresponding national percent. At De Anza College, for fall 2005, the median age was 22 years old (Institutional Research and Planning, 2006). It is important to be aware of age groups in the targeted population. Research has shown that adults learn differently than the younger, more traditional college students (Cross, 1981) and more older students are attending tertiary schools (Rovai, 2003).

Another difference between the demographics of Californians and the national demographics is the percent of people who speak a language other than English at home. The percent is 17.9% nationally. In California the percent is 39.5, as compared to Iowa, for example, where that percent is 5.8 (U.S. Department of Census, 2006). The high percent of English Second Language (ESL) speakers in California adds to the instructional design challenges.

Instructional Design

Instructional Systems Design (ISD) is the systematic, scientific, and creative process of creating and designing instruction (Gagné, Wager, Golas, & Keller, 2005; Reigeluth, 1999). ISD is used when there is a gap in performance due to the lack of certain skills or knowledge (Gagné et al.). There are hundreds of instructional design models (Gustafson & Branch, 1997), but the most commonly known one is the ISD model consisting of five phases (analysis, design, development, implementation, and evaluation).

With the advances in computer technology over the past twenty years, professionals have developed non-linear processes to create instruction. There is growing disagreement about whether traditional ISD is still the most appropriate model to use (Gayeski, 1998; Gordon & Zemke, 2000; Gustafson & Branch, 1997; Tennyson, 1997), especially for e-learning.

The goal of ISD remains the same today, but the word “training” has been expanded to the education field to include other forms of learning. John Barson is among the first individuals to have defined “instructional development” as a “systematic process for improving instruction” (Gustafson & Branch, 1997, p. 14). Barson’s goal was improving college courses. The concept is still the same. First, identify a problem that can be solved by training or instruction. Determining the instructional goal(s) may be the most critical activity in the ISD process (Dick, Carey, & Carey, 2001). Then, proceed through a series of phases in a systematic manner. The outputs from one phase become the inputs to the next phase. These steps include analyzing the requirements needed for a solution, designing the solution, developing the product, implementing it, and evaluating the results. The problem may be as large as the mass training of recruits in the military. Or, it may be as small as creating one course for a single school.

Often mistaken as interchangeable, ISD differs from instructional design theory in that ISD is a process to design instruction. ISD does not imply any particular learning theory (Gagné et al., 2005). Instructional-design theory is about which methods of instruction should be used, such as cooperative learning, lecture, games, or discovery, to facilitate learning (Reigeluth, 1999). Nonlinear learning must be examined for its impact when studying online learning theory (Bender, 2003) just as nonlinear ISD is now under consideration.

Although ISD and instructional design theory are not the same, they are quite closely related (Reigeluth, 1999). A learning theory is a descriptive theory of how people learn (Morrison et al., 2004). An instructional theory expands upon the learning theory to provide a prescriptive theory of how to ensure that the actual intended theory takes place (Morrison et al.). An instructional design theory combines the learning theory and the instructional theory to determine which methods to use to produce effective lessons. For the remainder of this literature review, the instructional design theory, i.e. the methods of instruction, will be of interest to reduce isolation and lack of interaction in online courses. Required discussion postings with questions are the specific instructional design method that will be examined. Such questions can promote continued discussion and social learning in a constructivist, online setting (Berge & Muilenburg, 2002).

Research Design

"[R]esearch is a process of identifying something unknown and then collecting data to make it known" (Gall et al., 2003, p. 35). In particular, educational research "develops new knowledge about teaching, learning, and educational administration" (Gall et al., p. 3). Researchers attempt to discover or validate techniques and theories that will improve educational practice. Research that describes, predicts, improves, and explains is valuable and contributes to education (Gall et al.). Individuals ideally choose their methodology based upon their research goals and whether or not they are hoping to generalize their findings to a population.

Quantitative Research

Quantitative research, also called positivist research, involves collecting numerical data and performing statistical analyses on them (Gall et al., 2003). These numerical data are used to represent the social environment. The samples studied must reflect the population characteristics for quantitative data to be valuable (Illowsky & Dean, 2002). The researcher's opinion (i.e. bias) must also be removed from the research. This means that different researchers studying the same sample should obtain similar results with any differences due to randomness in the sampling. It also means that reports of the research should be objective, without any interpretations based upon the researchers' construction of the data. Another name for this type of study is scientific inquiry as the "study of observable behavior [is] the basis for building scientific knowledge" (Gall et al., p. 15). Gall and colleagues also state that the features involved in quantitative research do not vary much throughout time and are independent of the researcher. This research project involved scientific inquiry and analysis of collected data which are attributes of quantitative research.

Researchers will very often conduct an experiment when they are concerned with how one variable affects another variable. The experiment is a powerful tool that, when done correctly, can lead to the development of important theories as well as applications. The experiment is especially valuable when others repeat the experiment in different settings and get similar results. The external validity of the experiment is strengthened in such situations. This proposed study involves introducing a single form of interaction, required discussion postings involving higher order thinking, into online elementary statistics classes. Development of and support for instructional design theories is a goal of this proposed research project. Another quantitative study (Jung et al., 2002) investigated the effects of academic, collaborative, and social interaction, that is, three types of interaction, on learning in online courses. In that study, the type of interaction was the independent variable. One of the dependent variables was learner achievement.

As many extraneous variables as possible must be eliminated or held constant in order to have strong internal validity of experiments and results (Gall et al., 2003). One of the ways to increase the internal validity is to use a reliable random number generator to separate a sample into control and experimental subgroups (Gall et al.; Illowsky & Dean, 2002). The researcher is best not working directly with the participants so as to reduce the possibility of introducing bias into the experiment. For example, if a new instructional technique is under study, then the researcher should consider not being the instructor for the participating students.

It is important for research to have goals and results that are beneficial, in addition to the methodological choice (Hosteller, 2005). Hosteller considered the ultimate aim of educational research to make the lives of students better. This educational research would be beneficial to students in online community college statistics classes if the results of the research indicated that including discussion postings involving higher order thinking skills might lead to higher retention and academic success rates. It was hopeful that the results of this study might lead to further research and to instructional design strategies that would increase the likelihood that students would remain in and pass the course and continue on to reach their educational goals.

Grading Rubric

A rubric is a type of formative assessment that supports student learning and critical thinking (Andrade, 2000; Baron & Keller, 2003). Students learn the grading criteria for their work with rubrics (Andrade; Baron & Keller; Palloff & Pratt, 2005; Popham, 1997) before they submit the assignments. Students are able to judge their own work and, therefore, have more of a sense of ownership about their course performance (Baron & Keller). In some cases rubrics are designed to guide students in enhancing their critical and higher order thinking skills (Washington State University, 2002).

Grading rubrics vary considerably, but all contain the criteria to be evaluated as well as levels of quality (Andrade, 2000; Baron & Keller, 2003; Popham, 1997). These levels may be either qualitative or quantitative, continuous or discrete. Marzano (2002) found that topic-specific rubrics were preferable to constrained point method grading, generic rubrics, or unconstrained point method grading for precision assessment. Yet, he warned that further studies of the four grading methods needs to occur.

In this study discussion postings (the intervention) were graded according to a grading rubric. Three evaluation criteria were used to guide both students and instructors without overwhelming either group, as recommended by Popham (1997). Each instructor was to assess both the control and experimental groups identically, according to the practice of the individual faculty member, aside from the addition of points earned by the rubric for these postings. Much of the student assessment was objective with both participating instructors, such as with multiple choice exams and labs requiring filling in the blanks with data and analyses. The discussion postings might have been the most subjective assessments for all the students. Thus, a rubric should have provided grading consistency.

The final grading rubric, shown in Appendix B, evolved from established grading rubrics and articles (Baron & Keller, 2003; Capella University, 2004a; Christopher, Thomas, Tallent-Runnels, 2004; Roblyer & Wiencke, 2003). J. Dautermann (personal communication, August 14, 2006) and R. Bloom (personal communication, August 4, 2006) provided guidance and editing advice for the rubric customization.

Experiment from Spring 2005

In spring 2005, the author conducted an experiment in her online elementary statistics course. She had co-developed the online class and taught it for six years. Each term, the retention and academic success rates in her and colleagues' online sections were lower than their face-to-face sections. The purpose of the spring 2005 and previous experiments was to help the author identify instructional design strategies that she would further investigate with a formal study in an attempt to increase the retention and academic success rates in the online elementary statistics classes.

The author wrote seven original discussion questions as part of the experiment. Statistics professors at her college formatively evaluated these seven questions and edited them, before the questions were administered. The Week 7's discussion questions were based upon the Reflective Questions that Capella University uses in Week 5 of its PhD in Education courses. The Week 1 and Week 11 questions were similar to commonly required questions that the researcher and other faculty members have used for over ten years (Illowsky & Dean, 2005). Week 1 required students to introduce themselves. Week 11 asked students to write a letter of advice to their "best friend", who would be fictionally taking the course the next term. Week 9 did not have a discussion requirement.

Students were required to post at least a 100 word written response to each week's questions. They also needed to post at least a 50 word response to at least one classmate. Students received detailed instructions about the length, format and style of their postings. The students' original postings and their responses to classmates were graded on a 0 – 5 point basis. Each week, a student was able to earn up to 10 points, for a total of 110 points for the term.

Appendix A contains the discussion questions for the spring 2005 experiment. In that pilot, fifty-four students self-enrolled into the online section of De Anza Community College's Elementary Statistics course. The researcher and the office assistant used the integer random number generator on the Texas Instruments TI-83+ calculator to move 27 students into an experimental group. Due to a glitch in the enrollment software, 15 additional students were allowed to enroll in the control group, before the error was noticed and the class re-closed. The class sizes for the experimental and control groups did not remain equal as a result.

During the first few weeks of the course, during which students often drop and add courses without receiving a grade of record, nine students dropped the control group section and seven students dropped the experimental group section. The initial drop rates were not statistically significant (p-value = .8480) when testing to see if the proportions of drops were the same or different. The final group sizes became 33 for the control group and 20 for the experimental group.

The control group contained 20 passing grades (A, B, C), one D (non-passing), and 12 withdrawals for the final grades. The experimental group contained 17 passing grades (A, B, C), one D (non-passing), and two withdrawals (non-passing). Using the pilot data to test if the retention rates were the same for both groups or if the retention rate for the experimental group was higher yielded a *p*-value of .0174. Using the same data to test if the academic success rates for the groups were the same or if the experimental group had a higher rate, the *p*-value = .0304. The results of the pilot study suggest that further study is warranted, based upon a significance level $\alpha = .05$.

Conclusion

This chapter discussed the literature that informed the proposed research study. A discussion of interaction, including the lack of it, transactional distance, and different interaction strategies was presented. Most researchers agreed that interaction was a desired instructional design strategy and should be included in face-to-face and online courses. The remainder of this chapter focused on teaching and learning elementary statistics, the cases of online statistics and mathematics courses, the constructivist learning pedagogy and California community college student demographics. The literature showed that the quantitative method for this project was justified. The results of experiment that the author conducted in spring 2005 which led her to the research project ended this discussion. The next chapter describes the quantitative experiment based upon introducing the instructional design strategy of including required discussion postings that incorporate higher order thinking.

CHAPTER 3. METHODOLOGY

Introduction

Chapter 3 describes the methodology adopted to conduct the research for this study. First, discussion focuses on the purpose of the study and the research questions. The next section describes the design of the study, including the intervention, and targeted population and sample that was examined. The final sections in this chapter describe the pilot tests that were conducted, data collection, limitations, and expected finding and ethical issues involved in the data collection and data analyses that was done. Lastly, a timeline is presented for as part of the documentation of the research project.

Purpose of the Study

The purpose of the study was to investigate the effect of higher order thinking discussion postings as a required student interaction on retention and academic course success rates in online courses. The literature on interaction in online courses indicated that there is generally a positive effect on requiring interaction in online courses (Berge, 1999; Christopher, Thomas, & Tallent-Runnels, 2004; Jung et al., 2002). This study examined the effect of the specific interaction of structured online discussion postings. Several previous studies researched students' perceived level of increased learning, as reported by Wu and Hiltz (2004), but not whether retention or academic success increased. This study looked at the effects of structured online discussion postings in elementary statistics courses in California community colleges. Historically, California community college students in online elementary statistics courses have had statistically significantly lower retention and academic success rates than their counterparts in the face-to-face sections of those classes (Norbert, 2005).

Research Questions

This study examined the effect of adding required structured higher order thinking discussion postings to online courses. There were two research questions.

The first research question asked if required interaction via structured online discussions contributed to higher retention rates in online courses. The alternate hypothesis for this question was:

$H_{1\text{-}1}$: The retention rate of the experimental group (with questions) is higher than the retention rate of the control group (without questions).

The second research question asked if required interaction in structured online discussions contributed to higher academic success rates in online courses. The alternate hypothesis for this question was:

$H_{1\text{-}2}$: The academic success rate of the experimental group (with questions) is higher than the academic success rate of the control group (without questions).

Research Design

This study used an experimental methodology with a one-variable design. The design was justified as the intent of the study was to determine if introducing a single intervention, in this case structured higher order thinking discussions, would have an effect on the retention and academic success rates of the course (Gall, Gall, & Borg, 2003).

Experiments at both De Anza College and Evergreen Valley College in California were conducted simultaneously. The more colleges that participated in the experiment, the higher the external validity of the design would be. De Anza operates on a 12-week quarter system; Evergreen Valley on a 16-week semester system, with both distance learning sections commencing about one week into the terms. The participating instructors were long-term, tenured employees, both of whom co-designed their online courses with faculty colleagues. De Anza College used the WebCT® course management system. The statistics faculty member at Evergreen Valley used MyMathLab's CourseCompass® as his course management system. The instructors used different textbooks. Both courses transfer to the University of California and the California State University systems as non-calculus based elementary statistics (California Articulation Number (CAN) Stat 2).

The two control groups had 15 and 45 participants. The two experimental groups had 16 and 30 participants, for a total of 106 students involved in the research. The group sizes were determined by the class sizes at each of the colleges. After students self-enrolled for the online courses they were told that their class would be randomly divided into two sections. A TI-83+ calculator was used to randomly generate integers, and the random generation process is described in the next section. Students on the class roster remained in the control group or moved to the experimental group depending upon whether the integer or the integer value plus two corresponding to their class placement was selected. Students in control and experimental groups at each college took identical exams, quizzes and assignments. Students in the experimental groups additionally had the intervention of the higher order thinking discussion postings.

Sample Selection

The population consisted of learners enrolled in community college online elementary statistics courses. The targeted population was online elementary statistics students at Evergreen Valley and De Anza Colleges in fall 2006 terms enrolled in the participating instructors' sections. Evergreen Valley and De Anza are northern California community colleges (11,000 and 24,000 students respectively, including both full-time and part-time students) with ethnically diverse student and faculty populations. The choice of colleges was based upon convenience, as one faculty member from each college had agreed to participate in the study.

All participants self-selected into online elementary statistics at their respective colleges. Random sampling, via a random number generator, placed the enrolled participants into either the control or experimental groups. Once the sections were closed to additional enrollment, the random assignments took place as described next. At Evergreen Valley College, a graphing calculator with an integer random number generator chose integers from 1 to the total number of students enrolled in the section. The number of integers chosen was half the total number of students. Since there were initially 33 students enrolled in the section, 16 integers numbered 1 to 33 were randomly chosen. Each integer corresponded to a student's position on the class roster. In other words, if the number 30 was chosen, then the thirtieth student on the list would move into the experimental section. At De Anza College, a graphing calculator with an integer random number generator chose one integer from 1 to the total number of students enrolled in the section. That number became the starting position number. Then, the instructor used systematic sampling to move every second student into the experimental group. Dividing participants into the control and the experimental groups these ways ensured that the groups were formed with the least amount of researcher bias and the highest probability of the groups each being representative of the targeted population (Creswell, 2003). Any differences in demographics between the control and experiments groups could be explained by random chance.

Pilot Test

In spring 2005, the results of a pilot study conducted in the researcher's online elementary statistics class at De Anza College supported further study of the proposed research project. The purpose of that pilot was twofold: to test the discussion posting questions and to assist in determining the soundness of the proposed research topic. Details of the spring 2005 pilot study are included in the literature review (chapter 2).

A different pilot test was conducted in July and August 2006. That test was of the actual postings that students would respond to in the research experiment in fall 2006, as well as the grading rubric faculty would use to assess the postings. The original discussion posting questions were developed for a community college operating on the quarter system. The researcher did not include a grading rubric in the first pilot. One college in the full research project has semester length terms. Although all of the statistics courses from both colleges articulated to the UCs and CSUs, there were minor differences in topics covered from college to college. Thus, some of the previously used discussion questions did not apply in the semester length college's course. The semester length course also needed supplemental questions due to the longer term length. Therefore, this second pilot test of discussion posting questions and a grading rubric was conducted.

In this second pilot test, the previously used and edited questions (see Appendix A) were sent as samples to the faculty who participated in the study. They also received a proposed grading rubric for the discussion postings. The faculty were tenured mathematics and statistics instructors at their community colleges and considered experts for their courses and the needs of their students. The professor at Evergreen Valley College was the president of the California Mathematics Council, Community Colleges (CMC^3) for 2006 and 2007. CMC^3 is the state professional organization for California community college mathematics faculty from Santa Barbara through northern California. De Anza College's participating professor had taught elementary statistics for over fifteen years at her college. She was awarded the 2005 CMC^3 Teaching Excellence Award, a peer-determined honor.

When first approached about participating in the research project, both professors stated that they desired to be involved in the editing and writing of the discussion questions for their courses. Once the project got underway, however, both professors requested to not be involved in the actual writing and editing of the discussion questions and grading rubric. After receiving the sample questions from the spring 2005 pilot, they each asked to be given the final, revised and additional questions, along with the grading rubric. They then chose the questions to administer from the final list. Neither participating faculty member desired to modify questions, customize them, or write new ones. As a result, the researcher wrote drafts of additional questions and the grading rubric and sent them to the statistician and the distance learning expert for their review. The two editors contributed greatly in the final wording and format of the questions and the grading rubric. The statistician wrote the first draft of one of the new questions, as well. The final questions and grading rubric are included in the Appendices B, C, and D.

The statistician was educated at Princeton and Harvard Universities. She had been teaching community college elementary statistics for almost ten years, in addition to previously working in industry when she assisted with the research project. She also had written curriculum for elementary statistics and other undergraduate mathematics courses. The statistician and the researcher met professionally over 15 years ago. They are currently colleagues at the same community college, but the researcher was not on her hiring or tenure committees. The researcher had no authority over the participating statistician and they taught using different texts.

The distance learning expert is currently Program Director, Teaching Learning and Technology, for the State University of New York (SUNY) Learning Environments. In addition to training SUNY faculty in online teaching and learning, she conducts and oversees research in distance learning for the State of New York. The executive director of the SUNY Learning Environments introduced the researcher and the distance learning expert to each other via e-mail in spring 2006. The two have not physically met.

Data Collection Procedures

The categorical data consist of a tally of the final course grades, including grades of W. The participating faculty members and their respective administrative deans signed permission forms authorizing the faculty members to release the grade summaries. A change to the discussion administration at one of the colleges was necessary after that faculty member determined that he did not have the time to manage the Discussion Board. That faculty member, his administrator, and Capella University’s Institutional Review Board agreed to allow the researcher to administer just the Discussion Postings of that college’s participating section.

After the participating faculty members turned in their grades in December 2006 at their colleges, they supplied a summary of the number of their grade sheets, including the number of

A, B, C, D, F, W, Credit, and No Credit grades to the researcher. The summary contained no student identifying marks to ensure student anonymity. The grades in aggregate form for each college and by delivery method, not by individual instructor, are public information, retrievable on the California Community Colleges Chancellor's Office Web site.

Limitations of the Study

The researcher acknowledged the advantages of obtaining a large sample. The larger the sample size, the higher the statistical power of the test (Gall et al., 2003). The test of two proportions is more robust with larger sample sizes, and the chance of making Type I and Type II errors decreases with larger sample sizes (Gall et al.; Illowsky & Dean, 2002). However, each college determined the maximum class size for its classes, and classes do not always fill to maximum size. The power of the tests from each individual college was marginally high enough at only one college to make valid conclusions from the results of the experiments. In the data analysis, it was possible to combine data from both colleges to increase the power and improve the validity of the results. Additionally, there were many extraneous variables that could have contributed to retention and academic success, making it difficult to determine if the intervention would have been the cause of any rate change (M. Adkins, personal communication, June 8, 2006).

Another limitation to the study was conducting the experiment at just two California community colleges. As the tuition is the same at all California community colleges, excluding other states in the study eliminated tuition as an extraneous variable, one that could have affected the internal validity of the results. Of the 109 California community colleges, 32 were scheduled to offer at least one online section of elementary statistics in the 2006-2007 school year. That number was an increase of the online format of six schools from the 2004-2005 school year, which was an increase from the previous year (California Community Colleges Chancellor's Office, 2006; Norbert, 2005). As a result, many of the faculty teaching the online section of their college's elementary statistics course were new to online teaching, and may or may not have even been experienced statistics faculty. Convincing faculty to incur the extra work involved in this project without financial compensation was a challenge, especially while they were still acclimating themselves to teaching online.

The final limitation to this study was that the researcher participated in one of the experiments. This action was not the original intent. When the faculty member at a third college backed out of participating in the experiment, the professor at Evergreen Valley College volunteered to assist. Just before the experiment was about to begin, he realized that he did not have the time to facilitate the Discussion Postings, including the grading rubric. Ideally, the researcher should not participate in the experiment to avoid the introduction of unintentional bias. The researcher's role at Evergreen Valley College was limited to facilitating and grading the Discussion Postings, in order to minimize any bias that might inadvertently be introduced by having the researcher involved in the experiment. It was necessary to accommodate the Evergreen Valley instructor so that the research project could move forward.

Data Analysis Procedures

Both hypothesis tests were tests of two proportions. In each case, a z test of two proportions was the appropriate test (Moore, 2000; Illowsky & Dean, 2002). For the first hypothesis test, the random variable, R, representing retention, was the number of students who completed the course, including those students whose final grade was D, F, or No Credit. The sample size was the sum of the number of students who completed the class and the number who withdrew, receiving a grade of W. For the second hypothesis test, the random variable, *S*, representing success, was the number of students who completed the course with a grade of A, B, C, or Credit. The sample size remained the same as in the first hypothesis test. Sample size was restricted by the class sizes at the individual colleges. Students who dropped the class in the introductory weeks of the term and did not receive any grade on their transcript were not included in the final sample size. The reason is that for reporting procedures to the California Community Colleges Chancellor's Office, the dropped students were not included in the head count or class statistics.

The hypothesis tests were conducted with data from more than one college and instructor to increase population validity and reduce the probability of making a Type I error. A *p*-value less than .05 is necessary to make the outcome statistically significant, based only upon calculations. Although the experimental groups were randomly selected from the population, future repetitions of the experiment at additional community colleges will be essential to draw conclusions regarding the significance of the intervention (Gall et al., 2003). Such repetition will increase the external validity of the results (Gall et al.).

Expected Findings and Ethical Issues

There were two expected findings for this study. First, the retention rate for the experimental groups would be higher than for the control groups. Second, the academic success percent would be higher in the experimental groups at each college than for the control group.

There were no ethical issues involved in the research. The participating faculty only submitted the final grade sheet, including a summary of the final grade distribution for each class to the researcher. These course grade distributions are publicly retrievable through the California Community Colleges Chancellor's Office via its Data Mart search tool. Still, to avoid waiting for each college to submit the data to the Chancellor's Office and for the Chancellor's staff to post the data, the professors were granted permission from their administrators to give summaries directly to the researcher. The researcher did not receive any identifying student marks. Thus, students maintained complete anonymity. Each participating faculty member, along with an administrator from each college, signed a letter authorizing the faculty member to release the grade distribution at the conclusion of the fall 2006 term.

Faculty at California community colleges are free to design their own courses, including deciding upon the number of assignments, structure of those assignments, assessment, and course delivery methods. A faculty member may introduce an intervention into one section of a course and not another. This choice remains the instructor's free decision to make without obtaining student permission or informing the student. U.S. Department of Health and Human Services Federal Code §46.117(c:2) (2005) allows waivers of informed consent when "the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research" and §46.101(b:1) considers this research project exempt. Students needed to be randomly placed into the control and experimental groups without the option to switch sections in order to keep the internal validity of the experiment results.

Timeline

The research project took place in three phases. Phase 1 occurred in July and August 2006. This first phase involved four main tasks. The first task was to develop, revise, approve, and finalize the discussion posting questions for each experimental group. While the questions were in the production phase, the researcher constructed and modified existing discussion posting grading rubrics and submitted them to the distance learning expert for verification. The permission letter was concurrently sent to and signed by the participating faculty as well as their administrators. In addition, Capella University received and approved the Institutional Review Board (IRB) form.

Phase 2 took place from August through December 2006. Participating faculty conducted the experiment in the fall term. The data was delivered to the researcher in late December. The last phase of this research project involved analyzing, describing, and writing about the data. This activity occurred in January through March 2007.

Summary

This chapter concentrated on the research methodology for the study. The purpose of the study and the research questions, along with the corresponding hypothesis tests were first presented. Next, the chapter described the research design, along with the intervention that was used in the experimental groups. After that, the logistics of the sample selection were explained. The first pilot study in spring 2005 along with the second pilot test were presented. Next, the data collection, limitations of the data and sample, along with the proposed data analysis were described. The ethical issues, along with the expected findings, followed with the timeline completing this chapter.

CHAPTER 4. DATA COLLECTION AND ANALYSIS

Introduction

The intent of this study was to determine if required discussion postings involving higher order thinking skills contributed to reducing attrition and increasing success rates in online elementary statistics community college courses. An experiment was conducted at two California community colleges in the fall 2006 term. Students who self-enrolled in the online Elementary Statistics sections were randomly placed in either the control or the experimental groups. The intervention in the experimental groups was required discussion postings involving higher order critical thinking skills. This chapter displays the data and analyses resulting from the experiment.

California community college students have the beginning weeks of a term to drop from their classes with no record of enrolling in the course included their transcript. Course enrollment numbers sent to the Chancellor's Office for official reporting purposes do not include these students who dropped. In the De Anza College course, after the class was split into the control and experimental sections, enough students in the control group dropped that the administration reopened that section without informing the class instructor and added more students to it. At the end of the drop period, the control group was left with 45 students and the experimental group had 30 students, as no additional students were added to the experimental section. In the Evergreen Valley College course, no students were added after the class was split into two sections. At the end of the drop period, the control and experimental groups were more evenly balanced at 15 and 16 students, respectively.

Grading Rubric Use

Faculty graded the discussion postings according to the grading rubric in Appendix B. After students posted their original answers and responded to their classmates, the instructor completed the grading rubric and recorded the score of zero to ten points. Specifically, the instructor highlighted the appropriate box for each section of the rubric, added individual feedback at the top of the form, and returned the completed rubric to the student via e-mail. Figure 1 displays a competed rubric for an Evergreen Valley College for her Week 3 Posting.

In each experimental group, the discussion posting score counted for ten percent of the overall grade points. Each student who passed the course in the experimental groups at both colleges had individual averages of at least nine points on the postings. None of the students in either experimental group who did not pass the course completed all of the postings.

According to both participating faculty, without being solicited some students e-mailed their instructor to say that they appreciated the rubric form for the grading of the discussion postings. Both faculty commented that those students asked if their projects and lab work could be graded through use of a rubric, as they found the rubric very helpful. The two instructors indicated that they are considering including the given rubric for their future courses. They felt that the rurbric was a very fast way and easy-to-understand way to deliver feedback to their students. Students did not complain about their scores, either, as they knew exactly why they earned their recorded points. The researcher has also decided to use a grading rubric as part of the evaluation for assessment involving writing and subjective work.

Figure 1

Rubric for an Evergreen Valley College Student

Posting 3 - Grade: 10/10
Good explanations in your posting. By the way, if the data are relatively close together as you mentioned in your posting, then the box would be small. You gave a strong explanation as to how your thoughts changed from what you first expected.

Grading Rubric for Initial Discussion Posting – 5 points

	Excellent	**Satisfactory**	**Unsatisfactory**
Points →	**1**	**0.5**	**0**
Focus	The posting demonstrates that the student understands the key concepts.	The posting somewhat demonstrates that the student understands the key concepts.	The posting does not demonstrate that the student understands the key concepts.
Complete-ness	The posting includes examples when appropriate and has adequate detail.	The posting includes some examples and some detail.	The posting neither includes examples when appropriate nor does it provide adequate detail.
Detail and facts	The posting has no significant factual errors and/or misconceptions.	The posting has a few significant factual errors and/or misconceptions.	The posting includes many factual errors and/or misconceptions.
Mechanics	The posting is written in complete sentences and with proper grammar.	Most of the posting is written in complete sentences and with proper grammar.	There are several incomplete sentences and cases of poor grammar.
Deadline and length	The posting is completed on time and with a minimum of 100 words.	The posting is completed one to two days late or has fewer than 100 words.	The posting is more than 2 days late and/or has significantly fewer than 100 words.

Grading Rubric for Discussion Response – 5 points

	Excellent	**Satisfactory**	**Unsatisfactory**
Points →	**1**	**0.5**	**0**
Connection	The response concretely connects with the original posting.	The response somewhat connects with the original posting.	The response does not connect with the original posting.
Significance	The response adds significantly to the original posting.	The response adds somewhat to the original posting.	The response does not add to the original posting.
Contribution	The response contributes good suggestions to expand or improve the original posting.	The response contributes fair suggestions to expand or improve the original posting.	The response does not contribute good suggestions to expand or improve the original posting.
Mechanics	The response is written in complete sentences and with proper grammar.	Most of the response is written in complete sentences and with proper grammar.	There are several incomplete sentences and cases of poor grammar.
Deadline and length	The posting is completed on time and with a minimum of 50 words.	The posting is completed one to two days late or has fewer than 50 words.	The posting is more than 2 days late and/or has significantly fewer than 50 words.

Presentation of the Data Collected

The participating faculty members provided the researcher with the grade lists at the end of the fall 2006 term. Data were resorted into three groups for each class section. The first group contains the grades of A, B, C, and Credit. The second group contains the D, F, and No Credit grades. That second group consists of the students who officially completed the course, but did not have academic success. There is no grade distinction between the students who earned F grades while completing the course and those students who earned the F as they were still enrolled because they did not withdraw, but were no longer active course members. However, the participating faculty did include in their final grade sheets the exam and quiz grades for the term. The information is available as to the number of students in each section who earned F grades as a result of lack of course completion. At both colleges, the majority of F grades were for students who stopped participating in the course, but did not officially withdraw from it. The final group contains the W grades.

Table 1 contains the grade distribution for De Anza College students.

Table 1

De Anza College Grades

Grades	Control group	Experiment group
A, B, and C	15	8
D, F, and No Credit	14	6
W	16	16
Total	45	30

Table 2 contains the information for Evergreen Valley College students.

Table 2

Evergreen Valley College Grades

Grades	Control group	Experimental group
A, B, and C	4	4
D, F, and No Credit	4	5
W	7	7
Total	15	16

Table 3 contains the data for De Anza and Evergreen Valley Colleges combined. Combining data may strengthen the power of the test.

Table 3

De Anza and Evergreen Valley Colleges Combined Grades

Grades	Control group	Experimental group
A, B, and C	19	12
D, F, and No Credit	18	11
W	23	23
Total	60	46

Research Question 1

The first research question asked if required interaction via structured online discussions contributed to higher retention rates in online courses. The alternate hypothesis for this question is:

H_1: The retention rate of the experimental group (with questions) is higher than the retention rate of the control group (without questions).

The data were analyzed for each college separately and then combined. At De Anza College, the control group had a higher retention rate (64.4%, *n* = 45) than the experimental group had (46.6%, *n* = 30). The *p*-value is .9364, which was not significant at the .05 level and which was not enough to reject the null hypothesis. At Evergreen Valley College the retention rates for the control and experimental groups were identical with the exception being that the experimental group (*n* = 16) had one more student enrolled in it than did the control group (*n* = 15). Again, the *p*-value of .4352 was not significant at the .05 level and was not enough to reject the null hypothesis. The data from the two colleges were then combined to strengthen the power of the test. The resulting *p*-value of .8852 was still not significant at the .05 level and not enough to reject the null hypothesis. The test statistics for the three right-tailed tests are shown in Table 4.

Table 4

Hypothesis Test 1

Test Statistic	De Anza College	Evergreen Valley College	Colleges Combined
z =	-1.52	0.16	-1.20
	$p > .05$	$p > .05$	$p > .05$

Research Question 2

The second research question asked if required interaction in structured online discussions contributes to higher academic success rates in online courses. The alternate hypothesis for this question is:

> H_1: The academic success rate of the experimental group (with questions) is higher than the academic success rate of the control group (without questions).

The data were analyzed for each college separately and then combined. At De Anza College, the control group had a higher academic success rate (33.3%, $n = 45$) than the experimental group had (26.6%, $n = 30$). Both of these academic success rates were lower rates than the participating faculty member had ever had in her online sections over the eight years that De Anza College has offered the course. The *p*-value of .7302 was not significant at the .05 level and was not enough to reject the null hypothesis. At Evergreen Valley College, the academic success rates for the control (26.7%, $n = 15$) and experimental (25%, $n = 16$) groups were again identical accounting for the one additional student in the experimental group the control group. Again, the data the *p*-value of .5422 was not significant at the .05 level and was not enough to reject the null hypothesis. The professor from Evergreen Valley College also commented that these success rates were among his lowest. He did not feel that the addition of the researcher facilitating the Discussion Postings had any effect on his lower than normal rates, as the lower retention and academic success rates were in the control group, as well. One noticeable difference between the Evergreen Valley College groups was the breakdown of the actual success letter grades of the two groups. The four success grades in the experimental group consisted of two A grades and two B grades. In the control group, the four success grades consisted of three B grades and one C grade. The sample sizes were too small to show any significant difference, so the difference is just noted.

The data from the two colleges were then combined to strengthen the power of the test. The resulting p-value of .7343 was still not significant at the .05 level and not enough to reject the null hypothesis. The test statistics for the three right-tailed tests are shown in Table 5.

Table 5

Hypothesis Test 2

Test Statistic	De Anza College	Evergreen Valley College	Colleges Combined
z =	-0.62	-0.11	-0.63
	$p > .05$	$p > .05$	$p > .05$

Summary

This study investigated the effect that structured discussion postings involving higher order thinking skills had on the retention and academic success rates of online California community college elementary statistics courses. The use and results from the grading rubric were discussed. The data from two colleges were analyzed both individually and collectively. In each case, the p-value was not significant at the .05 level. The decision was to not reject either the first or the second null hypothesis for the individual college testing and for the colleges combined.

The next chapter will discuss the conclusions that can be drawn from the data and the interpretation of the findings. Possible significance of the research and recommendations for further research will be presented. Final thoughts will conclude this chapter and dissertation.

CHAPTER 5. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This final chapter will discuss any conclusions that might be drawn from the research project and data. The chapter will also describe some of the possible contributing variables to the data outcomes. Finally, the chapter will provide possible significances of the study and suggested areas for further research.

Discussions and Conclusions from the Data

The research project involved introducing higher order thinking discussion questions into online courses. Two California community college online elementary statistics sections participated in the project. The study had two research questions:

1. Is the retention rate of the experimental group (with questions) higher than the retention rate of the control group (without questions)?
2. Is the academic success rate of the experimental group (with questions) higher than the academic success rate of the control group (without questions)?

For both research questions, the p-values were not significant. The null hypotheses were not rejected. In fact, for the individual case of De Anza College, the control group had a higher retention rate (64.4%, $n = 45$) than the experimental group had (46.6%, $n = 30$). The control group also had a higher academic success rate (33.3%, $n = 45$) than the experimental group had (26.6%, $n = 30$). The right tailed tests yielded p-values greater than 50% (.9364 and .7302, respectively). The only conclusions based strictly upon the data are that the control and experimental groups had the same retention rates and that the control and experimental groups had the same academic success rates.

Interpretation and Significance of the Findings

According to the results of the hypothesis tests, the intervention of adding required discussion postings involving higher order thinking increased neither the retention nor the academic success rates of the online elementary statistics sections. These were surprising results for three reasons. First, the pilot test in spring 2005 supported the increase in both rates. Second, the literature supports interaction for students in both face-to-face and online courses to increase the likelihood that the students will stay in and succeed in the courses. Effective practices research in online teaching suggests that adding interaction methods, including discussion postings, will increase student satisfaction and motivation, thereby increasing the likelihood that students will remain in and pass their courses. Organizations and journals, such as the Sloan Consortium and the *Journal of Asynchronous Learning Networks*, continue to promote research and presentations involving discussion postings in online learning. Third, student answers to the posting asking students to reflect upon the course, asked approximately two-thirds of the way through the course, seemed to indicate that the discussion postings would make a significant difference in the rates. Following are two partial answers to the question, “Compare your involvement level in this course, including the discussion area, to your involvement level in courses that meet on-campus.” “I am more involved in discussion area of a course when I take a distance learning class since it is easy for me to communicate in writ[ing] (student A, English Second Language student) and “The fact that we have a discussion board is also another incentive to stay involved because you have to apply what you learned in the course to answer some of the questions." (student B).

Another student sent the following unsolicited comments about the discussion postings.

> The posting is really helpful, because it helps reinforces what I have learn[ed] from the assignment. In addition, keeping the questions that you asked us to answer clear and understandable so that I can fully understand what you are asking help[s] a lot. (student C, English Second Language student).

The participating professors remarked that their academic success and retention rates for both their control and experimental groups were lower than for previous terms. One of the professors shared her thoughts as to why her rates decreased. From her experience, as the demographics of online students has changed at her college, a lower percentage of online students at the college are prepared for online courses. Years ago, the distance education students mostly consisted of older and highly motivated students who could not attend the face-to-face classes. Online courses now attract younger students, as well, who often take both online and face-to-face courses. The college has a mandatory orientation to online learning, but California law prohibits enforced screening of students from entry into any class, so long as the students have the academic prerequisites satisfied, in this case, Intermediate Algebra or a satisfactory score on a placement exam. There is no screening process for a student's preparedness to engage in higher order thinking assignments or for the student's ability to work with technology or work independently. Although the professor's explanation may explain the decrease in her overall retention and success rates, it does not address why the experimental section did not perform better than the control section.

One possible confounding variable was the online course assessment techniques used. Both instructors had already developed their courses to require extensive use of learner-learner, learner-content, learner-instructor, and learner-interface interaction. The courses included required group activities. The transactional distance for the students enrolled in both the control and experimental sections for the courses had already been minimized, compared to other online courses that did not involve much interaction among students or with the faculty member. It is possible that with the built-in interactivities, the added value of the discussion postings was negligible. Perhaps in online classes void of any other required form of peer-to-peer interaction, participation in required discussion postings involving higher order thinking skills would effect the retention and academic success rates.

Another possible confounding variable was the instructor for each class. Both participating professors were highly respected faculty at their colleges with generally higher-than-average retention and academic success rates than their department colleagues. The De Anza course, co-developed by the faculty member, had earned the 2002 California Virtual Campus top award for a California community college online course. The faculty member was often recommended by former students for her willingness to work long hours with learners until they understand the material. The Evergreen Valley instructor sent out frequent e-mails to the students and included a great deal of interactive technology in the course. In separate discussions with the faculty members after the courses ended, each instructor claimed to answer student e-mails within half a day, including on weekends. Both faculty members thus had high levels of student contact, again reducing transactional distance resulting from lack of learner-instructor interaction. With the number of online course offerings expected to continue to grow, more faculty will be needed to teach those courses. The quality of those instructors should start to be more representative of the overall faculty quality at the institutions.

Additionally, since the only prerequisite allowed by California law for the course is Intermediate Algebra and not a course specifically designed to develop critical thinking skills, students might not have been prepared to engage in the types of discussion postings involved in the experimental sections. It is possible that instead of the questions promoting higher order thinking, students might have viewed the requirement as a barrier to their success. The learners might have withdrawn from the experimental sections for a variety of reasons caused specifically by the discussion posting requirement, such as poor writing skills, a weak English language competency, and fear of not being able to communicate mathematical concepts. Many weaker mathematics students have difficulties in connecting solving algebraic equations to those solutions for real world applications.

Recommendations for Further Research

The literature suggested that investigating the effect of interaction methods in online courses would be a valuable contribution to the academy. This research project concentrated on the one interaction method of required discussion postings involving higher order thinking skills, specifically in California community college online elementary statistics sections. The research did not produce significant results. Based upon the literature and the spring 2005 pilot, further experimentation may still prove to be valuable. As a first step, more reliable results could be obtained by repeating the same experiment at several other California community colleges. The more colleges included in the sample, the higher the external validity of the results. The curriculum differences in elementary statistics throughout California's community colleges would require possible modification to some of the discussion questions.

Within the elementary statistics course, a logical next step is to expand the experiment outside of California. Should the experiment be conducted at several community colleges within a single state, there would not be the confounding variable of varying tuition, as long as the community colleges within the state have the same tuition as each other. Expanding outside the community college system, whether staying in California, public universities, or private schools, is a possible area for further investigation. The student demographics, including motivation, will need to be investigated in these venues. Researchers would need to investigate the effect of additional variables, such as motivation, high tuition, student preparedness, and ability of colleges to restrict online enrollment to certain students, for such studies.

The literature and research investigating interaction was not focused on just elementary statistics classes or even mathematics courses. Faculty in other disciplines could conduct similar experiments in their online courses, be it at California community colleges, other community colleges, or other institutions of higher education throughout the world. The online field is currently expanding to both high school education and adult basic skills education. These would be two additional areas to investigate.

There are areas for further study beyond expanding the current research project to the above situations. Still focusing on the intervention of discussion postings involving higher level thinking skills, the actual questions asked might be re-evaluated to determine if they are suitable for community college elementary statistics students. The questions were evaluated individually, but not examined to determine if they collectively might be overwhelming for this level of student. Even if a similar experiment were repeated, researchers could gain useful information by interviewing students who withdrew from the course to determine if the discussion posting requirement contributed to their withdrawal or encouraged them to remain in the course longer than they might have without the intervention.

The literature promotes interaction as a way to increase student retention and academic success. Although journal articles and professional organizations discuss increasing the use of discussion postings as one method to do so, other interaction methods are discussed in chapter 2. Whether within the course of elementary statistics, within the community college system, or outside of both of these areas, randomized experiments with other interaction interventions might provide useful knowledge leading to an increase in student retention and academic success.

In private universities and, possibly, in community colleges or four-year public universities outside of California, schools might be allowed to include demonstration of a certain level of critical thinking skills in order for students to enroll in specific courses. These same colleges might also be permitted to assess their students' potential to succeed in online learning and to determine which students are allowed to enroll in the online sections of a course. The prerequisite for such sections would involve a more holistic assessment of the students' preparedness. An area for further research would be to conduct similar experiments with control and experimental groups that contain students considered prepared to succeed in online learning sections, as opposed to allowing complete access to any course delivery method to all students meeting the academic prerequisite, regardless of whether they contain the characteristics and abilities necessary to succeed in online learning or the critical thinking skill needed to answer discussion postings requiring higher order thinking.

Summary and Final Thought

Participation in online learning is expected to grow over the next decade. Institutions of higher education are including expansion of online class sections and programs into their strategic plans. There are challenges associated with taking online courses, such as ensuring peer-to-peer interaction in these courses. Requiring participation in online discussions is one solution to that particular challenge. Whether incorporating higher order thinking skills into these discussions will increase the retention and academic success rates for students in these classes has not been thoroughly investigated across the disciplines and types of institutions. It is an area worth further study in order to assist our students in accomplishing their educational goals.

REFERENCES

Academic Senate for the California Community Colleges. (1995, November). Curriculum committee review of distance learning courses and sections. Retrieved January 25, 2007, from http://www.academicsenate.cc.ca.us/Publications/Papers/Downloads/ DLREVIEW. doc

Allen, I. E., & Seaman, J. (2005, November). *Growing by degrees: Online education in the United States, 2005*. Needham, MA: Sloan Consortium.

Allen, M., Bourhis, J., Burrell, N., & Mabry, E. (2002). Comparing student satisfaction with distance education to traditional classrooms in higher education: A meta-analysis. *The American Journal of Distance Education*, *16*(2), 83 – 97.

Ally, M. (2004). Foundations of educational theory for online learning. In T. Anderson & F. Elloumi (Eds.), *Theory and practice of online learning*. Retrieved January 25, 2007, from Athabasca University Web site: http://cde.athabascau.ca/online_book/ch1. html

American Mathematical Association of Two-Year Colleges. (2006). *Beyond crossroads: Implementing mathematics standards in the first two years of college*. Retrieved January 25, 2007, from http://www.bc.amatyc.org/index.html

American Statistical Association. (2005, February). Guidelines for Assessment and Instruction in Statistics Education College Report. Retrieved January 25, 2007, from http://www.amsta t.org/education/gaise

Anderson, T. (2003, October). Getting the mix right again: An updated and theoretical rationale for interaction. *International Review of Research in Open and Distance Learning, 4*(2). Retrieved January 25, 2007, from http://www.irrodl.org/index.php/irrodl/article/view/149 /230

Andrade, H. G. (2000, February). Using rubrics to promote thinking and learning. *Educational Leadership, 57*(5), 13-18. Retrieved May 16, 2006, from Academic Search Premier database.

Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers* (2nd ed.). San Francisco: Jossey-Bass.

Arsham, H. (2002). *Students' dropout: Cause and prevention*. Invited online paper presented at The Open and Distance Learning, UK Open University. Retrieved January 25, 2007, from http://www9.ocn.ne.jp/~nick/dropout.html

Baron, J., & Keller, M. (2003, November). *Use of rubrics in online assessment*. Paper presented at the meeting of the Evaluations and Assessment Conference, Adelaide, South Australia. Retrieved January 25, 2007, from http://www.unisa.edu.au/evaluations/Full-papers/Baron Full.doc

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link? In T. M. Duffy & D. J. Jonanssen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 17-34). Hillsdale, NJ: Erlbaum.

Bell, J. A. (2003, fall). Statistics anxiety: the nontraditional student. *Education, 124*(1), 157-162. Retrieved September 9, 2005, from Academic Search Premier database.

Bender, T. (2003). *Discussion-based online teaching to enhance student learning*. Sterling, VA: Stylus Publishing.

Berge, Z. L. (1999, January/February). Interaction in post-secondary Web-based learning. *Educational Technology*, *39*(1), 5-11.

Berge, Z., & Muilenburg, L. (2002, March 4). A framework for designing questions for online learning. Berge Collins Associates. Retrieved January 25, 2007, from http://www.emoder ators.com/moderators/muilenburg.html

Bernard, R. M., Lou, Y., Abrami, P.C., Wozney, L., Borokhovski, E., Wallet, P.A., et al. (2003). How does distance education compare to classroom instruction? A meta-analysis of the empirical literature. Presented as a Symposium at the *Annual Meeting of The American Educational Research Association*, Chicago, IL.

Botelho, G. (2004, August 13). Online schools clicking with students. *CNN.com*. Retrieved January 25, 2007, from http://www.cnn.com/2004/EDUCATION/08/13/b2s.elearning/in dex.html

Boettcher, J. V., & Conrad, R-M. (2004). *Faculty guide for moving teaching and learning to the Web* (2^{nd} ed.). Phoenix, AZ: League for Innovation in the Community College.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.

California Community Colleges Chancellor's Office. (2006). Chancellor's Office Data Mart: Program retention/success rates. Retrieved January 25, 2007, from http://misweb.cccco. edu/mis/onlinestat/ret_sucs.cfm

California Community Colleges Chancellor's Office. (2004). *Frequently asked questions – colleges*. Retrieved January 25, 2007, from http://www.cccco.edu/faq_colleges.htm

California Community Colleges Chancellor's Office. (2006). Chancellor's Office Data Mart: Student Demographics. Retrieved January 25, 2007, from http://misweb.cccco.edu/mis/onlinestat/studdemo_coll_cube.cfm

California Postsecondary Education Commission. (2006). Transfer Pathways. Retrieved January 25, 2007, from http://www.cpec.ca.gov/OnLineData/TransferPathway.asp

California Virtual Campus. (2005a). Distance education enrollment as a percentage of total system enrollment: a 12-year projection. Retrieved January 25, 2007, from http://pdc.cvc.edu/images/charts/de_trends12.gif

California Virtual Campus. (2005b). Growth of distance education courses 1995-96 through 2003-04. Retrieved January 25, 2007, from http://pdc.cvc.edu/images/charts/de_growth.gif

Capella University. (2004a). *Scoring guide*. Unpublished manuscript, Capella University, Minneapolis, MN.

Capella University. (2004b). *Unit 5 reflections*. Unpublished manuscript, Capella University, Minneapolis, MN.

Carr, S. (2000, February 11). As distance education comes of age, the challenge is keeping the students. *The Chronicle of Higher Education, 46*(23), A39.

Chickering, A., & Ehrmann, S. (1996, October). Seven principles of effective teaching: Technology as lever. *AAHE Bulletin,* 3-7. Retrieved January 25, 2007, from http://www.tltgroup.org/programs/seven.html

Chickering, A., & Gamson, Z. (1987). Seven principles of good practice in undergraduate education. *AAHE Bulletin, 39*(7), 3-7. Retrieved January 25, 2007, from http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/7princip.htm

Christopher, M. M., Thomas, J. A. & Tallent-Runnels, M. K. (2004, Spring). Raising the bar: Encouraging high level thinking in online discussion. *Roeper Review, 26*(3), 166-171. Retrieved September 26, 2005, from Academic Search Premier database.

Clark, D. (2000, November 6). Introduction to instructional system design. Retrieved January 25, 2007, from http://www.nwlink.com/~donclark/hrd/sat1.html

Cobb, G. (1992). Teaching statistics. In L. Steen (Ed.), *Heeding the call for change* (MAA Notes No. 22, pp. 3-34). Washington, DC: Mathematical Association of America.

College Board. (2006). *Advanced placement report to the nation 2006*. Retrieved January 25, 2007, from http://www.collegeboard.com/prod_downloads/about/news_info/ap/2006/2006_ap-report-nation.pdf

Cox, R. (2005, August). Online education as institutional myth: Rituals and realities at community colleges. *Teachers College Record, 107*(8), 1754-1787.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Cross, K. P. (1981). *Adults as learners*. San Francisco: Jossey-Bass.

De Anza College online catalog. (2006). Math 10: Elementary statistics and probability course description. Retrieved January 25, 2007, from http://www.deanza.edu/publications/catalog/2006-2007/journ-meteor.pdf

Dewey, J. (1933). *How we think*. Lexington, MA: D.C. Heath.

Dewey, J. (1938). *Experience and education*. New York: Collier Macmillan.

Diaz, D. (2002, May/June). Online drop rates revisited. *The Technology Source*. Retrieved January 25, 2007, from http://technologysource.org/article/online_drop_rates_revisited/

Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction* (5th ed.). New York: Addison Wesley Longman.

Dubinsky, E., Mathews, D., & Schwingendorf, K. (2004, May 11). Calculus, concepts, computers, and cooperative learning (C4L): The Purdue calculus reform - constructivist learning theory in practice. Retrieved January 25, 2007, from http://www.pnc.edu/Faculty/kschwing/C4L.html

Duffy, T. M., & Jonanssen, D. H. (1992). Constructivism: New implications for instructional technology. In T. M. Duffy & D. J. Jonanssen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 1-16). Hillsdale, NJ: Erlbaum.

Ehrlich, D. B. (2002). Establishing connections: Interactivity factors for a distance education course. *Educational Technology & Society, 5*(1). Retrieved January 25, 2007, from http://www.ifets.info/journals/5_1/ehrlich.pdf

Evangeleauf, J. (Ed.). (2006, August). Almanac Issue 2006 – 2007. *The Chronicle of Higher Education, (53)*1, 15.

Evergreen Valley College online catalog. (2007, January 25). Math 063: Elementary statistics course description. Retrieved January 25, 2007, from http://www.evc.edu/mse/course_desc.asp?subject_title=Mathematics

Fisher, A. (2001). *Critical thinking: An introduction*. Cambridge, England: Cambridge University Press.

Friedman, H. H., Friedman, L. W., & Amoo, T. (2002, November). Using humor in the introductory statistics course. *Journal of Statistics Education, 10*(3). Retrieved January 25, 2007, from http://www.amstat.org/publications/jse/v10n3/friedman.html

Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of instructional design* (5th ed.). Belmont, CA: Thomson Wadsworth Learning.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational research: An introduction* (7th ed.). Boston: Allyn & Bacon.

Garfield, J., & Chance, B. (2000). Assessment in statistics education: Issues and challenges. *Mathematics Thinking & Learning, 2*(1), 99-125. Retrieved July 14, 2006, from Academic Search Premier database.

Garfield, J., Hogg, B., Schau, C., & Whittinghill, D. (2002, July). First course in statistical science: The status of educational reform efforts. *Journal of Statistics Education, 10*(2). Retrieved January 25, 2007, from http://www.amstat.org/publications/jse/v10n2/garfield.html

Gayeski, D. M. (1998, April 11). Out-of-the box instructional design: Moving from assembly-line models to non-linear performance models. Retrieved January 25, 2007, from http://www.dgayeski.com/t&disd.html

Gilbert, L., & Moore, D. L. (1998, May/June). Building interactivity into Web courses: Tools for social and instructional interaction. *Educational Technology, 38*(3), 29-35.

Gladwell, M. (2000). *The tipping point: How little things can make a big difference*. New York: Little, Brown and Company.

Gleason, A. M., & Hughes Hallett, D. (1992, Spring). The calculus consortium based at Harvard University. *Focus on Calculus, 1*(1). Retrieved January 25, 2007, from http://www.wiley.com/college/cch/Newsletters/issue1.pdf

Golden, D. (2006, May 9). Online university enrollment soars. The Wall Street Journal. Retrieved January 25, 2007, from http://www.post-gazette.com/pg/pp/06129/688698.stm

Gordon, J. & Zemke, R. (2000, April). The Attack on ISD. *Training*, (12), 42-53.

Graham, C., Cagiltay, K., Lim, B., Craner J., & Duffy, T. M. (2001, March/April). Seven principles of effective teaching: A practical lens for evaluating online courses. The Technology Source. Retrieved January 25, 2007, from http://technologysource.org/article/274/

Gulati, S. (2004, April). *Constructivism and emerging online learning pedagogy: A discussion for formal to acknowledge and promote the informal*. Paper presented at the Annual Conference of the Universities Association for Continuing Education – Regional Futures: Formal and Informal Learning Perspectives, Pontypridd, Wales.

Gustafson, K. L., & Branch, R. M. (1997, May). *Survey of instructional development models* (3rd ed.). Syracuse, NY: Information Resources Publications, Syracuse University. (ERIC Document Reproduction Service No. ED411780)

Halpin, R. (1990, Spring). An application of the Tinto model to the analysis of freshman persistence in a community college. *Community College Review, 17*(4), 22-32. Retrieved February 2, 2006, from Academic Search Premier database.

Hassenplug, C., & Harnish, D. (1998). The nature and importance of interaction in distance education credit classes at technical institutes. Community College Journal of Research & Practice, 22(6), 591. Retrieved March 11, 2006, from Academic Search Premier database.

Hillman, D. C., Willis, D. J., & Gunawardena, C. N. (1994). Learner-interface interaction in distance education: An extension of contemporary models and strategies for practitioners. *The American Journal of Distance Education, 8*(2), 30-42.

Hogg, R. (1992). Report of workshop on statistics education. In L. Steen (Ed.), *Heeding the call for change* (MAA Notes No. 22, pp. 34-43). Washington: Mathematical Association of America.

Hosteller, K. (2005, August/September). What is “good” education research? *Educational Researcher, 34*(6), 16-21. Retrieved November 13, 2005, from ProQuest database.

Hron, A., & Friedrich, H. F. (2003, March). A review of Web-based collaborative learning: Factors beyond technology. *Journal of Computer Assisted Learning*, *19*(1), 70-79. Retrieved October 28, 2005, from Academic Search Premier database.

Huitt, W. (2003). Constructivism. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved January 25, 2007, from http://chiron.valdosta.edu/whuitt/col/cogsys/construct.html

Illowsky, B., & Dean, S. (2002). *Collaborative statistics: Text*. Cupertino, CA: Illowsky Publishing.

Institutional Research and Planning. (2006, February 6). Fact Book. Foothill-De Anza Community College District. Retrieved January 25, 2007, from http://research.fhda.edu/factbook/factbook.htm

Jiang, M. (1998). Distance learning in a Web-based environment: An analysis of factors influencing students' perceptions of online learning (Doctoral dissertation, UMI No. 9913679). Retrieved November 10, 2005, from ProQuest Dissertations database.

Johnson, H. D., & Dasgupta, N. (2005, July). Traditional versus non-traditional teaching: Perspectives of students in introductory statistics classes. *Journal of Statistics Education, 13*(2). Retrieved January 25, 2007, from http://www.amstat.org/publications/jse/v13n2/johnson.html

Jonanssen, D. H. (1992). Evaluating constructivist learning. In T. M. Duffy & D. J. Jonanssen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 137-148). Hillsdale, NJ: Erlbaum.

Jonanssen, D. (1999). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory: Volume II,* (pp. 215-239). Mahwah, NJ: Erlbaum.

Juler, P. (1990). Promoting interaction; maintaining independence: Swallowing the mixture. *Open Learning, 5*(2), 24-33.

Jung, I., Choi, S., Lim, C., & Leem, J. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in Web-based instruction. *Innovations in Education and Teaching International, 39*(2), 153-162. Retrieved October 23, 2005, from Academic Search Premier database.

King, J. C., & Doefert, D. L. (1996). Interaction in the distance education setting. Retrieved January 25, 2007, from http://www.ssu.missouri.edu/ssu/Aged/NAERM/s-e-4.htm

Lamkins, J. E. (2004, November). Logging off: A study of online attrition in community college level coursework (Doctoral dissertation, UMI No. 3171841). Retrieved February 2, 2006, from ProQuest Dissertations database.

Lewis, L., Farris, E., Snow, K., & Levin, D. (1999, December). *Distance education at degree-granting postsecondary institutions: 1997-1998.*U.S. Department of Education, National Center for Education Statistics. NCES 2000-013. Washington, DC. Retrieved January 25, 2007, from http://nces.ed.gov/pubs2000/2000013.pdf

Marzano. R. J. (2002). A comparison of selected methods of scoring classroom assessment. *Applied Measurement in Education, 15*(3), 249-267.

McNeil, S. (2004). A hypertext history of instructional design. Retrieved January 25, 2007, from http://www.coe.uh.edu/courses/cuin6373/idhistory/1940.html

McKenzie, G. R. (1972). Some effects of frequent quizzes on inferential thinking. *American Educational Research Journal, 9*(2), 231-240.

Merrill, M. D. (1992). Constructivism and instructional design. In T. M. Duffy & D. J. Jonanssen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 99-114). Hillsdale, NJ: Erlbaum.

Moore, D. S. (1997). New pedagogy and new content: The case of statistics. *International Statistical Review, 65*(2), 123-165.

Moore, D. S. (2000). *The basic practice of statistics* (2nd ed.). New York: W. H. Freeman and Company.

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education*, *3*(2), 1-6. Retrieved January 25, 2007, from http://www.ajde.com/Contents/vol3_2.htm

Moore, M. G. (1997). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22-38). New York: Routledge. Retrieved April 25, 2006, from Academic Search Premier database.

Morrison, G., Ross, S., & Kemp, J. (2004). *Designing effective instruction* (4th ed.). Hoboken, NJ: John Wiley & Sons.

Morrow, B. (2005, November 4). *Synchronous online teaching: The California community college solution*. Presentation at the Fall Plenary Session of the Academic Senate for California Community Colleges, Pasadena, CA.

Muilenburg, L. & Berge, Z. (2000). A framework for designing questions for online learning. *DESONEWS 10*(2). Retrieved January 25, 2007, from http://www.ed.psu.edu/acsde/deos/deosnews/deosnews10_2.asp

National Research Council. (2001). *Knowing what students know: The science and design of educational assessment.* Washington, D.C.: National Academy Press.

Neeley, L., Niemi, J., & Ehrhard, B. (1998). Classes going the distance so people don't have to: Instructional opportunities for adult learners. *T H E Journal, 26*(4), 72. Retrieved March 11, 2006, from Academic Search Premier database.

Nobert, T. (2005). 2003-2004 & 2004-2005 California community colleges that offer face-to-face and online elementary statistics [Data file.] Sacramento, CA: California Community Colleges Chancellor's Office.

Nobert, T. (2006). 2004-2005 California community colleges that offer face-to-face and online first course transferable English composition [Data file.] Sacramento, CA: California Community Colleges Chancellor's Office.

Nora, A. (2004). *Reexamining the Community College Mission*. American Association of Community Colleges. Retrieved January 25, 2007, from http://www.aacc.nche.edu/Content/NavigationMenu/ResourceCenter/Projects_Partnerships/Current/NewExpeditions/IssuePapers/Reexamining_the_Community_College_Mission.htm

Northrup, P. (2002). Online learners' preferences for interaction. *The Quarterly Review of Distance Education 3*(2), 219-226. Retrieved January 16, 2006, from Academic Search Premier database.

Onwuegbuzie, A. J., & Wilson, V. A. (2003, April). Statistics anxiety: Nature, etiology, antecedents, effects, and treatments – a comprehensive review of the literature. *Teaching in Higher Education, 8*(2), 195-209. Retrieved September 9, 2005, from Academic Search Premier database.

Palloff, R. M., & Pratt, K. (1999). *Building learning communities in cyberspace: Effective strategies for the online classroom*. San Francisco: Jossey-Bass.

Palloff, R. M., & Pratt, K. (2001). *Lessons from the cyberspace classroom: The realities of online teaching*. San Francisco: Jossey-Bass.

Palloff, R. M., & Pratt, K. (2003). *The virtual student: A profile and guide to working with online learners*. San Francisco: Jossey-Bass.

Palloff, R. M., & Pratt, K. (2005). *Collaborating online: Learning together in community*. San Francisco: Jossey-Bass.

Pan. W., & Tang. M. (2004, June). Examining the effectiveness of innovative instructional methods on reducing statistics anxiety for graduate students in the social sciences. *Journal of Instructional Psychology, 31*(2), 149-159. Retrieved September 9, 2005, from Academic Search Premier database.

Perkins, D.N. (1992). Technology meets constructivism: Do they make a marriage. In T. M. Duffy & D. J. Jonanssen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 45-55). Hillsdale, NJ: Erlbaum.

Phipps, R. (2004, September). *How does technology affect access in postsecondary education? What do we really know?* (NPEC 2004-831). Washington, DC: National Postsecondary Education Cooperative. Retrieved January 25, 2007, from http://nces.ed.gov/pubs2004/2004831.pdf

Phipps, R., & Merisotis, J. (1999, April). *What's the difference?: A review of contemporary research on the effectiveness of distance leaning in higher education.* Washington, DC: The Institute for Higher Education Policy.

Poole, D. (2003, Winter). Student participation in a discussion-oriented online course: A case study. *Journal of Research on Computing in Education, 33*(2), 162-177. Retrieved November 10, 2005, from Academic Search Premier database.

Popham, W. J. (1997, October). What's wrong – and what's right – with rubrics. *Educational Leadership*, 55(2), 72-75. Retrieved May 16, 2006, from Academic Search Premier database.

Reigeluth, C. M. (1999). What is instructional-design theory and how is it changing? In C. M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory: Vol. 2.* Mahwah: N.J.: Erlbaum.

Reiser, R. A. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology, Research and Development 49*(2), 57-67. Retrieved November 28, 2005, from ProQuest Psychology Journals database.

Roberson, T. J., & Klotz, J. (2002, Winter). How can instructors and administrators fill the missing link in online instruction? *Online Journal of Distance Learning Administration, 5*(4). Retrieved January 25, 2007, from http://www.westga.edu/~distance/ojdla/winter54/roberson54.htm

Roblyer, M. D., & Wiencke, W. R. (2003). Design and use of a rubric to assess and encourage interactive qualities in distance courses. *The American Journal of Distance Education, 17*(2), 77-98.

Rovai, A. (2002a, April). Building sense of community at a distance. *International Review of Research in Open and Distance Learning, 3*(1), 1-16. Retrieved October 22, 2005, from Academic Search Premier database.

Rovai, A. A. P. (2002b, July). A preliminary look at the structural differences of higher education classroom communities in traditional and ALN courses. *Journal of Asynchronous Learning Networks*, *6*(1), 41-56. Retrieved January 25, 2007, from http://www.sloan-c.org/publications/jaln/v6n1/pdf/v6n1_rovai.pdf

Rovai, A. P. (2003). In search of higher persistence rates in distance education online programs. *The Internet and Higher Education, 6*(1), 1-16.

Russell, T. L. (2001). *The No Significant Difference Phenomenon* (5th ed.). Montgomery, AL: The International Distance Education Certification Center [IDECC].

Schuetz, P. (2005, Spring). UCLA Community College Review: Campus Environment: A Missing Link in Studies of Community College Attrition. *Community College Review 32*(4), 60-80. Retrieved February 23, 2006, from Academic Search Premier database.

Sims, R. (2003, May). Promises of interactivity: Aligning learner perceptions and expectations with strategies for flexible and online learning. *Distance Education*, *24*(1), 87-103. Retrieved October 18, 2005, from Academic Search Premier database.

Tennyson, R.D. (1997). A system dynamics approach to instructional systems development. In R.D. Tennyson, F. Schott, N. Seel, & S. Dijkstra (Eds.), *Instructional design: International perspectives* (pp. 413-426). Mahwah, NJ: Erlbaum.

Thurmond, V. A. (2003). Examination of interaction variables as predictors of students' satisfaction and willingness to enroll in future Web-based courses while controlling for student characteristics (Doctoral dissertation, UMI No. 3111497). Retrieved June 12, 2006, from ProQuest database.

Thurmond, V. A., & Wambach, K. (2004, January). Understanding interactions in distance education: A review of the literature. *International Journal of Instructional Technology and Distance Learning*. Retrieved January 25, 2007, from http://itdl.org/journal/Jan_04/ article02.htm

Thurmond, V. A., Wambach, K., Connors, H., R., & Frey, B. B. (2002). Evaluation of student satisfaction: Determining the impact of a Web-based environment by controlling for student characteristics. *The American Journal of Distance Education, 16*(3), 169-189. Retrieved November 21, 2005, from Academic Search Premier database.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). Chicago: The University of Chicago Press.

Tinto, V. (1997, November/December). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education*, 68(6), 599-623.

Tinto, V. (2000, March/April). What have we learned about the impact of learning communities on students? *Assessment Update, 12*(2), 1-3. Retrieved June 13, 2006, from Academic Search Premier database.

Tinto, V. (2003, November). *Promoting student retention through classroom practice*. Paper presented at the meeting of Enhancing Student Retention: Using International Policy and Practice. Retrieved January 25, 2007, from http://www.staffs.ac.uk/institutes/access/docs/ Amster-paperVT(1).pdf

Tinto, V. (2005, December). Reflections on student retention and persistence: Moving to a theory of institutional action on behalf of student success. *Studies in Learning, Evaluation, Innovation and Development,* 2(3), 89-97. Retrieved January 25, 2007, from http://sleid.cqu.edu.au/viewissue.php?id=8

U.S. Department of Health and Human Services. (2005, November 17). *Code of Federal Regulations §46.101(b:1) To what does this policy apply?* (Office for Human Research Protections). Washington, D.C.: Author. Retrieved January 25, 2007, from http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm#46.101

U.S. Department of Health and Human Services. (2005, November 17). *Code of Federal Regulations §46.117(c:2): Documentation of informed consent*. (Office for Human Research Protections). Washington, D.C.: Author. Retrieved January 25, 2007, from http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm#46.117

University of California. (2004, March 30). About UC: California master plan for higher education. Retrieved January 25, 2007, from http://www.universityofcalifornia.edu/aboutuc/masterplan.html

U.S. Census Bureau. (2006, January 12). State and county quickfacts. Retrieved January 25, 2007, from http://quickfacts.census.gov/qfd/states/06000.html

Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications, 6*(4), 339-362. Retrieved January 25, 2007, from http://scholar.google.com/scholar?hl=en&lr=&q=cache:oOIy0WrxaHgJ:www.cait.org/vrasidas/continuum.pdf+%22Learner-technology+interaction%22

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wagner, E.D. (1994). In support of a functional definition of interaction. *American Journal of Distance Education, 8*(2), 6-26.

Waits, T., & Lewis, L. (2003, July). *Distance education at degree-granting postsecondary institutions: 2000–2001* (U.S. Department of Education, National Center for Education Statistics. NCES 2003-017). Washington, DC: Author. Retrieved January 25, 2007, from http://nces.ed.gov/pubs2003/2003017.pdf

Warren, L. L., & Holloman, H. L., Jr. (2005, June). On-line instruction: Are the outcomes the same? *Journal of Instructional Psychology, 32*(2), 148-151. Retrieved June 12, 2006, from ProQuest database.

Washington State University (2002). *Critical thinking project: The critical thinking rubric*. Retrieved January 25, 2007, from http://wsuctproject.wsu.edu/ctr.htm

Wu, D., & Hiltz, S. R. (2004, April). Predicting learning from asynchronous online discussions. *Journal of Asynchronous Learning Networks, 8*(2), 139-152. Retrieved January 25, 2007, from http://www.sloan-c.org/publications/jaln/v8n2/v8n2_wu.asp

APPENDIX A. SPRING 2005 DISCUSSION POSTINGS

Faculty instructions to the student

Posting Requirements

Hi. Part of your points for this course will be from your discussion postings. Each week, I will post a topic for each group. You are required to post a 100 word minimum posting by Thursday night and a 50 word minimum response to at least one member of your group by Sunday night. When you respond to a group mate, give suggestions for improvement and make corrections. Be polite. The purpose of these postings is to increase learning.

Hints for writing

Consider writing your posting in a word processing application (such as Word) before you submit it. That way, you can run the spell and grammar check. Then copy and paste your posting into the Discussion space.

Discussion posting assignments

Week 1: Welcome Posting

> Hi everyone,
>
> Welcome to Elementary Statistics! I am quite excited to be your professor this term. Part of your points for this term is based upon your online discussion postings. You are responsible for posting each week and responding to at least one posting. See "Discussion Requirements" on the left column. Next week, I will divide you into groups of 6 students each, so that you are not overwhelmed with reading and responding.
>
> For this first posting, introduce yourself to the class. (Remember, you are graded on this, so make it worth our reading your posting.) I will start.
>
> I have been teaching at De Anza full-time for 16 years. I really love teaching at the community college level. I co-developed this online course with Susan Dean, another faculty member here. You will see her name throughout this course. I have 3 "children" who are mostly grown. My oldest, Rachel, is at UCSD. My twins, Matthew and Rebecca, are at Santa Clara and Stanford, respectively. All of my children came to De Anza. This is where they learned HOW to learn.
>
> I earned my Masters degree in 1983 in Statistics. In June 2004, I started back to graduate school to earn my PhD. It is hard being 45 years old, in graduate school,

and working full-time. Fortunately, my husband is busy starting a start-up company, and shares the cooking with me. I hope to finish my PhD in 2007.

I have a lot of the same concerns that you do... How will I fit in my homework? Can I handle it all? Do I really need to do ALL the homework assigned? (The answer is YES to that one!) Will I succeed?

I look forward to reading your introductions. By the way, feel free to address me as, "Barbara." If you are not comfortable with that, then "Professor Illowsky" or "Mrs. Illowsky" are also fine.

Happy Spring! Barbara :-)

Week 2 posting:

Individually, come up with a topic that you would be interested in studying. You will need to be able to collect two pieces of quantitative data (either continuous or discrete) from each individual. An example would be height and weight. (You cannot use my example!) Describe your sampling technique. You might collect data off the Web, at a mall, by telephone, etc. You may NOT use convenience sampling. If you were to collect this data, explain how you might use cluster, stratified, systematic or simple random sampling. (Just explain how you might use one of these methods, not all of them.) Identify your population, sample, parameters, statistics, variables and data.

When you respond to a group mate, give suggestions for improvement and make corrections. Be polite. The purpose of these postings is to increase learning, NOT to belittle anyone.

NOTE: read the Discussion Requirements accessed by the left column link. Your posting is worth five points. Your response to a group mate is also worth five points.

USE THIS THREAD FOR YOUR DISCUSSION.

Week 3 Posting:

Look at graph (b) of homework problem #15 in chapter 2. Draw a box plot of what the data in the graph looks like. This might take you several tries. Would you expect long tails or short ones or no tails? Would you expect a big spread of the middle 50% of the data or a compressed box? Does it look like there are any outliers?

Describe in detail what your box plot looks like as well as answer the questions above. Read each other's postings. See if you have different ideas. Find someone whose description is different from yours. Explain why you think yours is correct. If you think the other person's is correct, then explain to that person what you think you did wrong. Based upon your description, another person should be able to draw your box plot. If everyone has very similar descriptions, you most likely have drawn your box plots correctly.

Good luck! Use this thread for your discussions.

Week 4 Posting:

Think about two specific times that you based a decision upon chance. One event should be a time that you thought that there was a pretty high probability that something would happen, but it turned out you were wrong (meaning that the event did NOT happen). The other event should be when you thought that the probability was very low that something would happen, but it turned out that you were wrong again.

Explain HOW you determined the probabilities to be "high" or "low." (You do not need actual numbers here.) Also, explain why you think you were wrong. Was it just chance? Were your probability estimates wrong? If your probability estimates were wrong, looking back at the situation now, where did you make your mistake? When you reply to a classmate, if the classmate did not explain in enough detail about the mistaken probability, ask questions.

Here is an example of when I thought that the probability was low, the event happened, and why I now know my probability estimate was off. (I am picking an event from eighteen years ago, only because I am giving a high probability of none of you having been in this situation. Maybe I am wrong, again!)

Barbara's "low probability" example:
I wondered if I was having twins in my second pregnancy, but by the day of the delivery, I gave it a low probability. (I was wrong!) Even though I often thought I was having twins, halfway through the pregnancy, my doctor performed a sonogram (ultrasound) to "shut me up" and "prove" to me that there was just one baby inside of me. The day before I delivered Matthew and Rebecca, another doctor in the practice performed a different exam and said that he "guaranteed" me that there was only one baby.

Looking back at the situation, I realized that I should have paid more attention. One of the doctors kept hearing the heart beat near the top of my womb; the other near the bottom. My second pregnancy was completely different than my first one in that I was sick most of the second pregnancy and I felt kicking “all over the place” the second time. Plus, I was REALLY BIG. Also, I gave in to the knowledge and experience of my doctors to the extent that I did not press them enough in my check-ups. I should not have been so surprised when Matthew was discovered after I delivered Rebecca!

Week 5 Posting

This week's posting has two separate questions. You need to answer both of them.

1. Do you think that mutually exclusive events must also be dependent events? (Another way of asking the above question is: Could mutually exclusive events be independent events, too?) Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to explain in complete sentences.

2. Do you think that dependent events must also be mutually exclusive events? Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to explain in complete sentences.

Week 6 Posting

Construct the PDF (probability distribution function) for the following distributions (get the values from your calculator for x going from 0 to n):

B(5, 0.4), B(10, 0.4), B(30, 0.4)

Next, sketch (by hand – a rough sketch) the three histograms for these distributions. On the horizontal axes, put X, the number of successes. On the vertical axes, put the probability. Look at the three graphs.

For your posting, describe the shapes of the graphs (in words, as if you were talking to someone over the telephone) in complete sentences. For example, are the graph heights all the same? Do they go up and then down?

What happens to the concentration of X as n (the number of trials) increases? Do the graphs get more concentrated about a value or do they seem to spread out? As n increases, is it more or less likely that the value for X in each case would be the end values for X (meaning 0 or n), instead of the middles? Why?

Week 7 Posting

This week, you have just a posting without a response. Your posting is worth the entire 10 points. I am interested in learning how the course is going for you – what is working, what is not working, how I can help you more. I am not grading your answers. I want you to be honest. The points are for answering thoroughly and in complete sentences. I have similar questions to answer in my graduate program at Capella University (2004b). I have found that they help me prepare for what I need to do for the second half of the course.

Discussion 1: Learning
a. What have learned the most or the best in this course so far?
b. How would you evaluate your ability to learn Elementary Statistics via ths distance learning course?

Discussion 2: Involvement
a. Compare your involvement level in this course, including the discussion area, to your involvement level in courses that meet on-campus.
b. How will you ensure that you achieve a high level of participation in the rest of the course?

Discussion 3: Success
a. What can I do to help you be more successful in this course?
b. What questions do you have questions for me?

Week 8 Posting

Last week, we studied the Central Limit Theorem. This theorem states that, in almost every case, no matter what the original distribution of X is, when you take groups of size *n* and graph the distribution for X-bar (the average of *n* X-values), instead of looking like the graph of X, the graph will become bell-shaped even if the graph for X is not bell-shaped. The theorem also says that the theoretical mean of X-bar will be the same as the theoretical mean of X. Further, the theoretical standard deviation of X-bar will be equal to the theoretical standard deviation of X divided by the square root of *n*, the number of values averaged together at a time.

Either by hand, on your calculator, or on the computer, graph the following three distributions ON THE SAME COORDINATE SYSTEM. Pay close attention to the heights of the graphs too. The area under each curve must be equal to 1.

X ~ Exp(1/5)

X ~ U(-3.66025, 13.66025)
X ~ N(5, 5)

Calculate the mean and standard deviation for each of the above distributions.

Suppose that samples of size 9 were surveyed from each of the above distributions. By the Central Limit Theorem, the distributions for X-bar for each of the above should be the same. State the distribution for X-bar. Graph the distribution for X-bar on the same coordinate system as the above graphs. Pay close attention to the height. The area under the curve must equal 1.

Suppose that samples of size 25 were surveyed from each of the above distributions. By the Central Limit Theorem, the distributions for X-bar for each of the above should be the same. State the distribution for X-bar. Graph the distribution for X-bar on the same coordinate system as the above graphs. Pay close attention to the height. The area under the curve must be equal to 1.

Suppose that samples of size 81 were surveyed from each of the above distributions. By the Central Limit Theorem, the distributions for X-bar for each of the above should be the same. State the distribution for X-bar. Graph the distribution for X-bar on the same coordinate system as the above graphs. Pay close attention to the height. The area under the curve must be equal to 1.

For your posting:
State the distributions for each of the X-bar distributions. They should be in the form of:
X ~ . Fill in the mean and standard deviation as well as labeling the distribution.

Describe the shapes of the three graphs (in words, as if you were talking to someone over the telephone) of X-bar in complete sentences. What happens to the shape of X-bar as *n* increases? Do the graphs get more concentrated about a value or do they seem to spread out?

Week 9 Posting:

Surprise! You all get a "free pass" this week (and still earn the 10 points). Use this Discussion thread to ask each other questions on the homework and lab. Study up!

Week 10 Posting:

For this week, I want you to post two questions that you have from chapters 7 - 10. You must be very specific. For example, you may not just write, "I don't understand hypothesis testing," even if you don't understand hypothesis testing. You need to find a specific question you have about the topic. For the above example, maybe you don't understand why a homework problem or a text example has the null and alternative hypotheses set up the way they do. Be sure to explain your question well so that someone else can answer it.

Then, you must explain the answer to at least one question that someone else has posted. Do not answer a question that another person has answered. If you do not know the answers to any of the posted questions, research them. Maybe you could ask at tutoring.

The idea is that you will learn by writing out your two questions. You will learn even more by writing out, in detail, the answer to a question. When you are done, you might consider reading the questions and answers from the other groups to help you learn.

Week 11 Posting:

For the Week 11 posting (the last one!) all 10 points are for your posting. You do not need to post a response, although you are always welcome to. This posting is due on Thursday.

Write AT LEAST 100 words (complete sentences, paragraph form) of advice that you would give your “best friend” if he or she were taking this course next term. You can include what projects you liked the best/least, how you helped yourself to complete the course, what you wished that you had/had not done this term and suggestions to me for improvement.

APPENDIX B. GRADING RUBRIC

Scoring Rubric for Initial Discussion Posting – 5 points

	Excellent	Satisfactory	Unsatisfactory
Points →	1	0.5	0
Focus	The posting demonstrates that the student understands the key concepts.	The posting somewhat demonstrates that the student understands the key concepts.	The posting does not demonstrate that the student understands the key concepts.
Complete-ness	The posting includes examples when appropriate and has adequate detail.	The posting includes some examples and some detail.	The posting neither includes examples when appropriate nor does it provide adequate detail.
Detail and facts	The posting has no significant factual errors and/or misconceptions.	The posting has a few significant factual errors and/or misconceptions.	The posting includes many factual errors and/or misconceptions.
Mechanics	The posting is written in complete sentences and with proper grammar.	Most of the posting is written in complete sentences and with proper grammar.	There are several incomplete sentences and cases of poor grammar.
Deadline and length	The posting is completed on time and with a minimum of 100 words.	The posting is completed one to two days late or has fewer than 100 words.	The posting is more than 2 days late and/or has significantly fewer than 100 words.

Scoring Rubric for Discussion Response – 5 points

	Excellent	Satisfactory	Unsatisfactory
Points →	1	0.5	0
Connection	The response concretely connects with the original posting.	The response somewhat connects with the original posting.	The response does not connect with the original posting.
Signifi-cance	The response adds significantly to the original posting.	The response adds somewhat to the original posting.	The response does not add to the original posting.
Contribu-tion	The response contributes good suggestions to expand or improve the original posting.	The response contributes fair suggestions to expand or improve the original posting.	The response does not contribute good suggestions to expand or improve the original posting.
Mechanics	The response is written in complete sentences and with proper grammar.	Most of the response is written in complete sentences and with proper grammar.	There are several incomplete sentences and cases of poor grammar.
Deadline and length	The posting is completed on time and with a minimum of 50 words.	The posting is completed one to two days late or has fewer than 50 words.	The posting is more than 2 days late and/or has significantly fewer than 50 words.

APPENDIX C. DE ANZA COLLEGE DISCUSSION POSTINGS

Faculty instructions to the student

Posting Requirements
Hi. Part of your points for this course will be from your discussion postings. Each week, I will post a topic for each group. You are required to post a 100 word minimum posting by Thursday night and a 50 word minimum response to at least one member of your group by Sunday night. When you respond to a group mate, give suggestions for improvement and make corrections. Be polite. The purpose of these postings is to increase learning.

Hints for writing
Consider writing your posting in a word processing application (such as Word) before you submit it. That way, you can run the spell and grammar check. Then copy and paste your posting into the Discussion space.

Discussion posting assignments

Posting #1

> Hi everyone,
>
> Welcome to Elementary Statistics! I am quite excited to be your professor this term. Part of your points for this term is based upon your online discussion postings. You are responsible for posting each week and responding to at least one posting. See "Discussion Requirements" on the left column. For this first posting, introduce yourself to the class. (Remember, you are graded on this, so make it worth our reading your posting.) I will start.
>
> I have been teaching at De Anza for almost 19 years. I started as a part-time instructor and became full-time after four years. I have thoroughly enjoyed my time teaching at the community college level, especially teaching statistics. I co-developed this online course with Barbara Illowsky. She does the videos that you view. I have two grown children and two grandchildren (my married daughter's children). My 21-year old son attends Humboldt State and is a marine biology major.
>
> I have a Masters degree in Applied Math from Santa Clara University. When I was working on the degree, I was teaching at De Anza and raising two children. I had the same concerns that you do … How would I fit in homework? Could I handle it all? Will I succeed? (Just to let you know, I did ALL my homework and you should too!)

I look forward to reading your introductions. By the way, feel free to address me as “XXXX.” If you are not comfortable with that, then “Mrs. XXXX” is just fine.
 HINTS FOR WRITING: Consider writing your posting in a word processing application (such as Microsoft Word) before you submit it. That way, you can run the spell and grammar check. (SPELLING AND GRAMMAR COUNT!) Then, copy and paste your posting into the DISCUSSION space.

Posting #2

A large city is proposing a parcel tax to support education. Each property owner would be assessed a tax of $100 per property per year. The parcel tax will be voted on by voters in the next election. It will pass if 2/3 of the voters vote in favor of the tax.

1. A TV news station in a large city conducts a call-in survey. Viewers are asked whether they favor or oppose the parcel tax. Viewers are asked to dial a toll free 800 number to record their votes. The poll is publicized and responses are solicited by announcements on the TV station's evening news programs.

2. A group of parents and teachers supporting the parcel tax randomly select and call residents in the city. They identify themselves as members of the Parent Teachers Association for the school system and ask the person who answers the telephone call if they support the parcel tax.

3. A professional polling organization conducts a survey in which it calls randomly selected residents in the same large city. If the resident is a registered voter, he or she is asked his/her their opinion about the proposed parcel tax. They are asked whether they favor the tax, oppose the tax, or have no opinion.

a. Which survey do you think would produce the most accurate prediction of the election results? Defend your answer.

b. For each of the other two surveys, what problems do you think there might be with the information obtained? Explain your reasoning.

Posting #3

Look at graph (b) of homework problem #15 in chapter 2. Construct a box plot of what the data in the histogram looks like. This might take you several tries. Would you expect long tails or short ones or no tails? Would you expect a big spread of the middle 50% of the data or a compressed box? Does it look like there are any outliers? Defend your answers.

Describe in detail what your box plot looks like as well as answer the questions above. Examine each other’s postings. See if you have different ideas. Find someone whose description is different from yours. Explain why you think yours is correct. If you think the other person’s is correct, then explain to that person what you think you did wrong. Based upon your description, another person should be able to draw your box plot. If everyone has very similar descriptions, you most likely have drawn your box plots correctly.

Posting #4

This week's posting has two separate questions. You need to answer both of them.

1. Must mutually exclusive events also be dependent events? (Another way of asking the above question is: Could mutually exclusive events be independent events, too?) Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to defend your answer in complete sentences.

2. Must dependent events also be mutually exclusive events? Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to defend your answer in complete sentences.

Posting #5

Construct the PDF (probability distribution function) for the following distributions (get the values from your calculator for x going from 0 to n):
B(5, 0.3), B(10, 0.3), B(30, 0.3)

Next, draw (by hand) the three histograms for these distributions. On the horizontal axes, put X, the number of successes. On the vertical axes, put the probability. Analyze the three graphs.

FOR YOUR POSTING, describe the shapes of the graphs (in words, as if you were talking to someone over the telephone) in complete sentences. For example, consider the following characteristics of the graphs:

At what value is the peak of the distribution located? Explain why.

For each graph, observe and describe the overall shape of the graph. (What is the overall pattern the bar heights follow? Is the graph skew or approximately symmetric?)

As n increases from 5 to 10 to 30, what happens to the spread of the data in the different graphs? (Do the graphs get more concentrated about a value or do they seem to spread out?)

Does the graph seem to fill the entire interval from 0 to n? As n increases from 5 to 10 to 30, what happens to the bar heights when X is near 0 or near n? Why?

Are the peak heights of the graphs all the same? Describe how they differ as n increases from 5 to 10 to 30?

Posting #6

This week, you have just a posting without a response. Your posting is worth the entire 10 points. I am interested in learning how the course is going for you – what is working, what is not working, how I can help you more. I am not grading your answers. I want you to be honest. The points are for answering thoroughly and in complete sentences. A colleague has similar questions to answer in her graduate program at Capella University (2004b). She has found that they help her prepare for what she needs to do for the second half of the course.

Discussion 1: Learning
a. What have learned the most or the best in this course so far?
b. How would you evaluate your ability to learn Elementary Statistics via this distance learning course?

Discussion 2: Involvement
a. Compare your involvement level in this course, including the discussion area, to your involvement level in courses that meet on-campus.
b. How will you ensure that you achieve a high level of participation in the rest of the course?

Discussion 3: Success
a. What can I do to help you be more successful in this course?
b. What questions do you have questions for me?

Posting #7

Surprise! You all get a "free pass" this week. There is no required discussion posting. Use this thread to ask each other questions on the homework, if you have any. Study up!

Posting #8

Post two questions that you have from chapters 7 – 10. You must be very specific. For example, you may not just write, "I don't understand hypothesis testing," even if you don't understand hypothesis testing. You need to find a specific question you have about the topic. For the above example, maybe you don't understand why a homework problem or a text example has the null and alternative hypotheses set up the way they do. Be sure to explain your question well so that someone else can answer it.

Then, you must explain the answer to at least one question that someone else has posted. Do not answer a question that another person has answered. If you do not know the answers to any of the posted questions, research them. Maybe you could ask at tutoring. You must be able to defend your answer.

The idea is that you will learn by writing out your two questions. You will learn even more by writing out, in detail, the answer to a question. When you are done, you might consider reading the questions and answers from the other groups to help you learn. For this assignment, you do not have a minimum number of words for your two questions. Your answer must be at least 50 words.

APPENDIX D. EVERGREEN VALLEY COLLEGE DISCUSSION POSTINGS

Faculty instructions to the student

Posting Requirements
Hi. Part of your points for this course will be from your discussion postings. Each week, I will post a topic for each group. You are required to post a 100 word minimum posting by Thursday night and a 50 word minimum response to at least one member of your group by Sunday night.

When you respond to a group mate, give suggestions for improvement and make corrections. Be polite. The purpose of these postings is to increase learning. Please review the grading rubric which will explain the scoring guide for what I expect in your original postings and responses. To get to the grading rubric, click on the title (above), "Discussion Requirements - READ!!", and you will go to the thread.

Hints for writing
Consider writing your posting in a word processing application (such as Word) before you submit it. That way, you can run the spell and grammar check. Then copy and paste your posting into the Discussion space.

Posting #1

> Normally, all your postings are due on Thursday nights, by 9 pm. For just this week, your posting is due by 9 pm, Thursday, Sept. 14. Your response is due by 9 pm, Sunday, Sept. 17.
> To post your welcome message, click on "Posting #1" in the title. Then click "Add New Thread." It is that easy! Reply to at least one classmate in his/her thread.
>
> For all other questions and comments, please contact Dr. XXXX directly.
>
> From Dr. XXXX:
> Hello to all my on-line statistics students. You are about to embark on a course of study which many of you will think is the very best Math course you have ever taken. I have rewritten parts of this course to include a dose of probability, a research paper and a discussion board that will be administered by a good friend and colleague, Professor Barbara Illowsky from De Anza College. The good news for students is that the written in class tests which used to count for 70% of your final grade will now only count for 50%. Professor Illowsky and I are both on the Board of Directors of the California Mathematics Council for Community Colleges. I am the President and Professor Illowsky is our special projects advocate and has spent a great deal of time in Sacramento on behalf of

Mathematics Education in Community Colleges. Professor Illowsky will be the person with whom you will interact on the discussion board and will responsible for assigning your grade for that portion of your overall course grade. I will be taking care of all other aspects of the course. If at any time you need to contact me, the fastest way will be by e-mail. I want you to know that I will be reading my e-mails several times a day. So, if you do e-mail me you should expect an answer later that day or, if it's late, the next day. I am also available in my office (room A6-133) M-Th. From 9:15 – 10:30 AM. Again, welcome to the course and now here is Professor Illowsky.

From Professor Illowsky:
Hi everyone,
Welcome to Elementary Statistics! I am quite excited to be assisting your professor this semester. Part of your points for this term is based upon your online discussion postings. You are responsible for posting each week and responding to at least one posting. See "Discussion Requirements - READ" above. Starting with the second posting, I will divide you into groups of six students each, so that you will only need to read at most five other postings.

For this first posting, introduce yourself to the class. (Remember, you are graded on this, so make it worth our reading your posting.) I will start.

I have been teaching at De Anza full-time for 17 years. I really love teaching at the community college level. I have three "children" who are mostly grown. My oldest child graduated a few months ago from UCSD. My twins are at Santa Clara and Stanford universities. My son is also in Air Force Reserve Officer Training Corps. He will start his active duty as an officer after graduation. All of my children went to community college for two years. That is where they learned HOW to learn.

I earned my Masters degree in 1983 in Statistics. In June 2004, I started back to graduate school to earn my PhD. It is hard being in my forties, in graduate school, and working full-time. Fortunately, my husband is busy starting a start-up company, and shares the cooking with me. All I have left is my dissertation. I hope to finish my PhD in 2007.

I have a lot of the same concerns that you do... How will I fit in my homework? Can I handle it all? Do I really need to do ALL the homework assigned? (The answer is YES to that one!) Will I succeed?
I look forward to reading your introductions. By the way, feel free to address me as, "Barbara." If you are not comfortable with that, then "Professor Illowsky" or "Mrs. Illowsky" are also fine.
Happy Fall Semester! Barbara :-)

Posting #2

A large city is proposing a parcel tax to support education. Each property owner would be assessed a tax of $100 per property per year. The parcel tax will be voted on by voters in the next election. It will pass if 2/3 of the voters vote in favor of the tax.

1. A TV news station in a large city conducts a call-in survey. Viewers are asked whether they favor or oppose the parcel tax. Viewers are asked to dial a toll free 800 number to record their votes. The poll is publicized and responses are solicited by announcements on the TV station's evening news programs.

2. A group of parents and teachers supporting the parcel tax randomly select and call residents in the city. They identify themselves as members of the Parent Teachers Association for the school system and ask the person who answers the telephone call if they support the parcel tax.

3. A professional polling organization conducts a survey in which it calls randomly selected residents in the same large city. If the resident is a registered voter, he or she is asked his/her their opinion about the proposed parcel tax. They are asked whether they favor the tax, oppose the tax, or have no opinion.

a. Which survey do you think would produce the most accurate prediction of the election results? Defend your answer.

b. For each of the other two surveys, what problems do you think there might be with the information obtained? Explain your reasoning.

Posting #3

Look at the histogram in figure 2.2 on page 55 of your text. Construct a box plot (refer to Sect. 2.7 of your text) of what the data in the histogram looks like. This might take you several tries. Would you expect long tails or short ones or no tails? Would you expect a big spread of the middle 50% of the data or a compressed box? Does it look like there are any outliers? Defend your answers.

Describe in detail what your box plot looks like as well as answer the questions above. Examine each other’s postings. See if you have different ideas. Find someone whose description is different from yours. Explain why you think yours is correct. If you think the other person’s is correct, then explain to that person what you think you did wrong. Based upon your description, another person should be able to draw your box plot. If everyone has very similar descriptions, you most likely have drawn your box plots correctly.

Posting #4

Think about two specific times that you based a decision upon chance. One event should be a time that you thought that there was a pretty high probability that something would happen, but the event did NOT happen. The other event should be when you thought that the probability was very low that something would happen, but it turned out that the event DID happen.

Describe HOW you determined the probabilities to be “high” or “low.” (You do not need actual numbers here.) Also, examine and explain why you think the outcome was not what you expected. Were your probability estimates wrong? If your probability estimates were wrong, looking back at the situation now, where did you make your mistake? Or, do you think your probability estimates were correct, but the outcome was not what you expected just by chance? If so, looking back, why do you think your probability estimates were correct, even though you did not get the result you expected? When you reply to a classmate, if the classmate did not explain in enough detail about the mistaken probability, ask questions.

Here is an example of when I thought that the probability was low, the event happened, and why I now know my probability estimate was off. (I am picking an event from twenty years ago, only because I am giving a high probability of none of you having been in this situation. Maybe I am wrong, again!)

Barbara’s “low probability” example:
I wondered if I was having twins in my second pregnancy, but by the day of the delivery, I gave it a low probability. (I was wrong!) Even though I often thought I was having twins, halfway through the pregnancy, my doctor performed a sonogram (ultrasound) to “shut me up” and “prove” to me that there was just one baby inside of me. The day before I delivered my twins, another doctor in the practice performed a different exam and said that he “guaranteed” me that there was only one baby.

Posting #5

Surprise! No posting this week!

Posting #6

Construct the PDF (probability distribution function) for the following distributions (get the values from your calculator for x going from 0 to n or from

Appendix A in the online textbook):
B(3, 0.3), B(8, 0.3), B(15, 0.3)

If you need to refresh your memory, go to Section 4.3 of the online textbook to start.

Next, draw (by hand) the three histograms for these distributions. On the horizontal axes, put X, the number of successes. On the vertical axes, put the probability. Analyze the three graphs.

For your posting, describe the shapes of the graphs (in words, as if you were talking to someone over the telephone) in complete sentences. For example, consider the following characteristics of the graphs:

At what value is the peak of the distribution located? Explain why.

For each graph, observe and describe the overall shape of the graph. (What is the overall pattern the bar heights follow? Is the graph skew or approximately symmetric?)

As n increases from 3 to 8 to 15, what happens to the spread of the data in the different graphs? (Do the graphs get more concentrated about a value or do they seem to spread out?)

Does the graph seem to fill the entire interval from 0 to n? As n increases from 3 to 8 to 15, what happens to the bar heights when X is near 0 or near n? Why?

Are the peak heights of the graphs all the same? Describe how they differ as n increases from 3 to 8 to 15?

Posting #7

This week's posting has two separate questions. You need to answer both of them.

1. Must mutually exclusive events must also be dependent events? (Another way of asking the above question is: Could mutually exclusive events be independent events, too?) Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to defend your answer in complete sentences.

2. Must dependent events must also be mutually exclusive events? Explain in great detail why or why not. You need to justify your answer. You may include an example, but you still need to defend your answer in complete sentences.

Posting #8

This week, you have just a posting without a response. Your posting is worth the entire 10 points.

I am interested in learning how the course is going for you – what is working, what is not working, how I can help you more. I am not grading your answers. I want you to be honest. The points are for answering thoroughly and in complete sentences. I have similar questions to answer in my graduate program at Capella University. I have found that they help me prepare for what I need to do for the second half of the course.

Discussion 1: Learning
a. What have you learned the most or the best in this course so far?
b. How would you evaluate your ability to learn Elementary Statistics via this distance learning course?

Discussion 2: Involvement
a. Compare your involvement level in this course, including the discussion area, to your involvement level in courses that meet on-campus.
b. How will you ensure that you achieve a high level of participation in the rest of the course?

Discussion 3: Success
a. What can I do to help you be more successful in this course?
b. What questions do you have questions for me?

Posting #9

Construct or observe graphs of the following distributions on the same axes:
t for a sample of size n=3, t for a sample of size n=12, N(0,1)
Note: they are on p. 346 in Section 6.4 (figure 6.5) of your text.

Describe in detail what happens to the shape of the student-t distribution as the degrees of freedom increase. Compare the student-t distribution graphs to the standard normal distribution graph.

Describe how the graph of the student-t distribution differs from the standard normal. How does the standard deviation of the t distribution change as the degrees of freedom gets larger? Explain how you can tell that from the graphs.

Some statistics texts give “permission” to use the standard normal distribution in place of the student-t when n>30. Give justifications for this approximation.

Posting #10

Surprise! No posting this week!

Posting #11

Post two questions that you have from chapters 7 and/or 8. You must be very specific. For example, you may not just write, "I don't understand hypothesis testing," even if you don't understand hypothesis testing. You need to find a specific question you have about the topic. For the above example, maybe you don't understand why a homework problem or a text example has the null and alternative hypotheses set up the way they do. Be sure to explain your question well so that someone else can answer it.

Then, you must explain the answer to at least one question that someone else has posted. Do not answer a question that another person has answered, unless you believe that the answer given is incorrect and you are posting a correction. If you do not know the answers to any of the posted questions, research them. Maybe you could ask at tutoring. You must be able to defend your answer.

The idea is that you will learn by writing out your two questions. You will learn even more by writing out, in detail, the answer to a question. When you are done, you might consider reading the questions and answers from the other groups to help you learn. For this assignment, you do not have a minimum number of words for your two questions. Your answer must be at least 50 words.

Posting #12

For Posting #12 (the last one!) all 10 points are for your posting. You do not need to post a response, although you are always welcome to. This posting is due on Sunday, Dec. 10, 9 pm.

Write AT LEAST 100 words (complete sentences, paragraph form) of thoughtful advice that you would give your “best friend” if he or she were taking this course next term. You can include what project or assignments you liked the best/least, study suggestions and strategies for your friend, how you helped yourself to complete the course, what you wished that you had/had not done this term and suggestions to me for improvement. Do you think about statistical information you read in the newspaper any differently as a result of this course? If so, explain how the course has affected you in that way.