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Success of Online Mathematics Courses at the Community College Level

Lisa S. Lee
Coastline College, U.S.A.

The purpose of this study was to investigate the factors that contribute to student success in online mathematics courses at community colleges. The non-experimental quantitative design began with descriptive statistics to explore the quantitative evidence and then applied multiple regression analysis to identify the significant predictors. A total of 135 students enrolled in three online math courses at a Southern California community college were invited to complete the Self-Assessment Questionnaire which was designed based on the seven principles of successful college teaching. The findings show that student success was associated with the following areas: Principle One –the interaction between students and faculty and Principle Three – use of active learning. Mastering online homework has a positive impact on students. Strategies should be developed to encourage interaction between faculty and students and promote active learning environments.

Keywords: success, online, math, interaction, active learning, community college

Although online course offerings have increased rapidly in higher education nationwide, student success is problematic. In the California Community Colleges, the student success rate in online courses is reported to be lower than onsite courses (Carr, 2000). For example, the student success rate, passing the course with a grade of "C" or better, for students enrolled in online mathematics courses in fall 2004 was only 41%, whereas the on-site course success rate was 54%. In fall 2008, the success rate for students enrolled in online mathematics courses was 42% versus an on-site course success rate of 54% (CCCS, 2009). The problem with the low success rates in online mathematics courses at the community college level has raised concerns about the effectiveness of online mathematics teaching. It is worthy and vital research in higher education.

With predicted growth in the number of California and U.S. community college students taking online courses, it is in the interest of faculty, administrators, and students to learn about the factors that contribute to student success in online mathematics courses at the community college level. The

purpose of this study was to investigate the factors that contribute to student success in online mathematics courses at community colleges. The research question was asked in this study: Is student success, as measured by course final grades, in an online introductory statistics course associated with the approaches addressed in the seven principles?

Theoretical Framework

Seven Principles for Good Practice in Undergraduate Education

The literature review for this research was guided by a theoretical framework found in the "Seven Principles for Good Practice in Undergraduate Education"(Chickering & Gamson, 1987). The American Association for Higher Education (AAHE) held a series of conferences in the mid-1980s and identified seven important principles that describe the practices of educationally successful undergraduate institutions. The seven principles were published in the bulletin of AAHE in March 1987 as guiding principles for instruction (Chickering & Gamson, 1987).

Chickering and Ehrmann (1996) recommended that distance learning instructors adopt the seven principles. Although they were originally developed for traditional on-site classroom instruction, Chikering and Ehrmann claimed that these principles are effective and appropriate ways for guiding the implementation of web-based instruction (Newlin & Yang, 2002). In this study, the principles are used as a model to examine the issues associated with online math course success. The Seven Principles for Good Practice in Undergraduate Education are:

Principle One: Encourages Contacts between Students and Faculty. Principle One can be applied to online courses by encouraging frequent contact between students and faculty. By using the easy access of the Internet, the faculty can strengthen the interaction with all students anytime and anywhere. For example, some students who are too shy to ask questions in a traditional on-site setting can freely communicate with their instructors by sending emails or posting questions on the online discussion board. It is critical to have contact between students and their instructors (McFadden & Patterson, 2009).

Principle Two: Develop Reciprocity and Cooperation among Students. Principle Two can be used in online instruction by developing reciprocity and cooperation among students. An online discussion board allows students to post questions on 24 hours a day and 7 days a week basis and to receive quick responses from their peers or the instructor. An online discussion board can promote collaborative learning and improves the interaction with classmates and the instructor (Moore & Kearsley, 2005*)*. Developing reciprocity and cooperation among students can be used as a practical strategy to help students learn more in online courses, specifically in online mathematics courses (Palloff & Pratt, 2005).

Principle Three: Uses Active Learning. Principle Three can be used to design online instruction promoting active learning. In an online course, those students who often participate in the discussion board or email instructors are more likely to stay in the course to the end of the semester and complete the course successfully (Angelino, Williams, & Natvig, 2007). The students may be required to post questions or answer questions posted by their classmates at the discussion board. The availability of various technologies allows students to engage in active learning by using multimedia or doing research through a virtual library before they post their answers.

Principle Four: Gives Prompt Feedback. Principle Four is one of the crucial factors contributing to student success in online environments. It can be used in online instruction to remove student learning anxiety and to retain students in the class. For example, a student in an online calculus class is confused with trigonometry-related questions and, after posting questions on the discussion board for a week or more, the student receives no responses from the instructor or peers. This student might delay his or her learning process or, the student might simply drop the class. Providing prompt feedback should be the norm in online courses, specifically mathematics courses (Morrison & Kemp, 2004)

Principle Five: Emphasizes Time-on-Task. *"*Time plus energy equals learning. There is no substitute for time-on-task. Learning to use one's time well is critical for students and professionals alike. Students need help in learning effective time management*"* (Chickering & Gamson, 1987, p. 5). When online students fall behind schedule and miss the due dates of quizzes or exams, they may just drop the class to avoid failing grades (McFadden & Patterson, 2009*).* One reason is that mathematics knowledge is sequential and cumulative Emphasizing time-on-task is vital to assist student learning effectively in online courses, specifically in mathematics courses (Allen, 2003).

Principle Six: Communicates High Expectations. Principle Six can be applied to online instruction for all students whether poorly prepared or highly motivated. Communicating high expectations with online students can encourage them to do better in the courses *(*Bart, 2010). Since online instruction lacks face-to-face interaction between students and instructors, posting messages about the high expectations of the instructor may encourage students to perform better in their courses. After the first test, an instructor may congratulate those who have earned high scores and encourage those who have done poorly to try harder on the second test *(*Mayer, 2008).

Principle Seven: Respects Diverse Talents and Ways of Learning. Principle Seven can be applied in online courses as well. It reminds the online course content developers and format designers to facilitate the learning environment for diverse learners–slow learners and quick learners. Visual learners can rewind the video repeatedly without feeling embarrassed as they may need to watch video lectures at their own pace (Hegeman, 2015*).* In applying Principle Seven, online instruction can provide additional learning

tools for mathematics such as online homework tutorial programs or an Interactive Java Applet (*Sun's Java Runtime Environment*) to assist the student's self-study and help him or her succeed (Gilbert, Goodwill, & Coffey, 2010*).*

Effective Faculty Roles in Teaching Math Online

Today, student academic success is focused, statewide and nationwide, by the higher education institutions, either supporting student learning outcomes or evaluating student performance (Prince, 2004). Success is not only the students' responsibility; it is also the college faculty's role (Bart, 2010.) In order to help student success in online math courses, effective faculty teaching plays an imperative role for leading students to success. Two types of effective faculty teaching online are: (a) the faculty member feels comfortable with technology, and (b) the faculty member wants to take risks and increase the teaching horizon (Li & Irby, 2008). Gilbert et al. (2010) claimed that math can be taught online and that it is often an effective and flexible choice for many learners. Innovative teaching strategies and technologies such as MyMathLab (Pearson Education, 2010) or MathZone (McGraw-Hill, 2010) course management system should be used in teaching math online and providing online homework, discussion boards, animations, and simulations. Gilbert et al. (2010) found that the tools, such as "View an Example" and "Help Me Solve," offered in MathXL- simulation software for online math course developed by Addison-Wesley, are very helpful to students (Gilbert et al., 2010).

In the past ten years, research on online mathematics education has been rarely conducted. The problems of retention and success in online mathematics have not been addressed as much as in other disciplines. According to Coastline College Chancellor's Office Data Mart, in spring 2009, the statewide success rate of distance learning in general math is 44.2%. Although online course enrollments have increased tremendously in higher education, the student success rate in mathematics is critically problematic.

In order to explore the factors of student success in online math courses, the voices of online students are very valuable. Their perspectives on the factors that are important to their success in online learning can contribute to the improvement of online math education. Their perspectives can also contribute research-related topics to the success of online learning.

This research focusing on investigating the factors related to student success in online mathematics courses at community colleges can contribute to policies aimed at increasing college level retention and the success rates in online math classes and the graduation rates for all college students. As colleges are suffering the budget cuts, the administrator needs to provide an effective learning environment designed to help students succeed.

Methodology

Participants

A Community College in the west coast of the United States has been offering distance learning education for more than a decade. It has a success rate as high as 61.7% in general math courses and has been offering online math courses since the year 2000. Founded in 1976, the College has an international reputation as one of the nation's most innovative institutions and it has main learning centers located in four different cities. The Mathematics Department offers 85% of its courses online and the other 15% are on-campus in the classroom and as off-campus Cable TV courses; mathematics courses are offered to all students including civilian, military, and incarcerated students nationwide and worldwide.

An email invitation with URL through Survey Monkey was sent to 130 students who were taking a mathematics course online – Introduction to Statistics at a community college in the fall, 2010. Among all recipients, 95 students completed the questionnaires yielding a response rate of 73%. 63 questions was included in the survey, 45 of them were intended to address the three research questions (noted above) and the remaining 18 questions were used to investigate the demographic background and preferences of students. The demographic information is presented using frequency distributions. Both descriptive and inferential statistics were adopted to analyze the data and to address the three research questions. There were sub-questions under each research question.

Instrument

Data collection strategy and tools. Data collection was conducted through an online, researcher developed, survey called Student Success Instrument. It consists of a Self–Assessment Questionnaire and a Demographic Survey. The Self –Assessment Questionnaire is designed to address three research questions (This study only reported the results of one research question): interaction with faculty and peers, technical competence, and tutoring services. The demographic survey includes personal information such as age, gender, and ethnicity, primary language, self-reported grade point average, and the units of other courses enrolled in. The URL created from Survey Monkey (a private American company that allows users to produce their own Web-based surveys.) was sent electronically to students who were enrolled in an online mathematics course, Math 160 – Introduction to Statistics, during the fall of 2010, at a community college in Southern California.

Self-Assessment questionnaire. An adaptation of a survey instrument developed by the College for the Mathematics Program Review (2010) was used in this research study. While the original instrument focused on all math courses offered in the math department including face-to-face (onsite) courses, hybrid, cable, and online courses, the adaptation was focused on online courses

only. The students enrolled in three online math courses were invited to complete the Self-Assessment Questionnaire that is designed to find the degree to which student success is associated with the following areas: Interactions with faculty and peers, tutoring services and technology competency with student success being measured by the final course grade. A 5-point Likert scale was used for responses to the items ranging from Strongly Disagree (1) to Strongly Agree (5).

The interaction with faculty and peers scale is in alignment with the theoretical framework – *Seven Principles for Good Practice in Undergraduate Education* (Chickering & Gamson, 1987), which includes: (1) contact between students and faculty, (2) reciprocity and cooperation among students, (3) active learning, (4) prompt feedback, (5) time on task, (6) high expectations, and (7) diverse talents and ways of learning. In addition, scales and items measuring access to tutoring services, technical competence, and general satisfaction were developed. A total of 45 multiple-choice questions that measured the scales were included in the survey.

Demographic survey. A demographic survey was developed for this study The items on this survey include personal information such as age, gender, ethnicity, and language, current classification in college, number of units being taken, self-reported grade point average, the highest level of parent education, annual household income, employment status, the highest education level, expected grade point average, and the persistence level for the online mathematics course. All these items were presented in a multiple-choice format.

Reliability and Validity of the Instruments

Reliability – a pilot study. A pilot study was conducted twice, first one in the spring semester, and the second one in the Summer session, to assess the instrument for internal consistency reliability. The pilot contributed to the refinement of the research instrument. One hundred and eighteen students enrolled in an online mathematics course in spring 2010 were invited to answer the questionnaire instrument. The result of the Reliability Test through SPSS 17 (Statistical Program for the Social Sciences version 17, 2010) showed that the Cronbach alpha coefficients were greater than 0.80 for the entire survey and by scale. The instrument was considered to have adequate internal consistency to be used in the research study. In the summer session, 2010, another pilot study of the Student Success Survey was conducted with 35 college students in an online statistics course. The instrument used for the second pilot study was found to be more reliable with a Cronbach Alpha of .91. In the second pilot study, a multiple-choice question was added to ask students to identify one of the Seven Principles (Chickering & Ransom, 1987) that would help students succeed in an online math course the most. Also, the response scales for agreement questionnaires were modified in ascending order: (1) strongly

disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree which is consistent with the scales of other non-agreement responses.

Validity. Researcher biases were reduced by having no interaction with students during student survey periods (online), and the researcher made sure that there were no cues to influence the behavior of the subjects on the instructions and directions of the survey. Content validity of the instrument has been verified by expert judges and is in accordance with existing research and theory – Seven Principles (Chickering & Gamson, 1987). The expert judges' suggestions were taken into consideration in refining the wording of the questionnaire.

The instrument used in this research study collected data through 45 items addressing or the independent variables of interaction with faculty and peers, assistance from tutoring services, and computer competence. The dependent measure, final course grade, was collected by the end of the semester. The final grade results from scores on homework assignments, quizzes, discussion board participation, a midterm exam, and a final exam.

Data Analysis

Data collected from the survey was organized in an Excel file and uploaded to SPSS, Windows, version 17.0 to run the data analyses. The descriptive statistics, mean and standard deviation were computed for each independent variable used in the research question. The results of the inferential statistical analyses were used to address the research question. A significance level of 0.05 was adopted for hypothesis tests.

Results

The Seven Principles

Seven sub-questions corresponding to the seven principles were used to address Research Question: Is student success, as measured by course final grades in an online introductory statistics course, associated with the approaches addressed in the seven principles? For each of the seven principles, there were 3 to 9 sub-questions (survey items).

Principle One - Research Question (a). "Is student success, as measured by course final grades in an online introductory statistics course, associated with Principle One – Contact between Students and Faculty?" The final course grades were entered in SPSS as the dependent variable (criterion), and four survey questions (- communicate with my instructor by email, IV2 - interact with my instructor at online discussion board, IV5 - answer questions posted by my classmates in discussion, and IV6 - check homework solutions at the discussion board) were used as independent variables – predictors. Multiple Regression analysis was conducted. A scale from 1 to 5 was adopted: 1 = 0 times per week, 2 = 1 to 2 times per week, 3 = 3 to 4 times per week, 4 = 5 to 6 times per week, 5 = 7 times or more per week. The result shows that the

regression model constructed by these four items had a value of $R^2 = 0.13$, which was considered a medium effect size (Cohen, 1988). The four predictors accounted for 13% of the variance in final course grades.

From the summary of correlations, the predictors had no significant correlations with the criterion. The predictors are only correlated with each other. The values of the linear correlation range from .308 to .672 (see Table 1).

Table 1

Summary of Correlations between the Criterion and the Predictors

Variable	DV	IV1	IV2	IV5	IV6
DV		-.168	.093	.120	-.148
IV1			.490**	.455**	.308*
IV2				.672**	.371**
IV5					.477**

Note. $N = 95$. $*p < .01$. $**p < .001$.

Since the P-Value from ANOVA is less than .05, the overall model, formed by these four predictors, is significant at $F(4, 90) = 3.337$ (see Table 2).

The predictor collectively accounted for a significant amount of variance in final course grades. Students reported that communicating with the instructor by email, interacting with the instructor on the online discussion board, answering questions on the discussion board, and checking homework solutions on the discussion board collectively and significantly affected their final course grades.

Table 2

Analysis of Variance for Regression Model with 4 Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	26.031	4	6.508	3.337	.014*
Residual	175.506	90	1.950		
Total	201.537	94			

*Note. N = 95. *p < .05.*

The summary of multiple regression analysis for Principle One is shown in Table 3.

Two predictors: (1) communicating with my instructor by email and (2) checking homework solutions on the discussion board were found to be significant. Each of them had a P-Value less than .05. This result reflected that Principle One (contact between students and faculty) significantly associated with the students' final course grades. The multiple regression equation is Y= 3.889 + (- .385) (IV1) + .190(IV2) + .384(IV5) + (-.277) (IV6).

Table 3
Summary of Multiple Regression Analysis for Principle One

Variable	*B*	*SE B*	β	*p*
Constant	3.889	.441		.000
Communicate with my instructor by email	-.385	.156	-.285	.015*
Interact with my instructor in an online discussion board	.190	.186	.141	.311
Answer questions posted by my classmates in discussion	.384	.202	.270	.061
Check homework solutions on the discussion board	-.277	.130	-.241	.035*

*Note. N = 95. *p < .05.*

The fact that the regression weights for these two predictors are positive (such as .384) means that a one-point increase in IV5 (answer questions posted by my classmates in discussion) would result in a .384 point predicted increases in final course grades, indicating that the more often students interacted with the instructor in online discussion boards and answered questions in the discussion board, the more their final grades would increase. Conversely, for another two negative coefficients, students communicated fewer times with the instructor by email and checked homework solutions less often at the discussion board and still tended to have better course grades. In fact, these students could follow the online instructions by utilizing learning tools working independently in their studies.

Overall, there is a combination of statistically significant variables predicting students' final course grades: from communicating with the instructor by email, interacting with the instructor at online discussion board, answering questions in the discussion board, and checking homework solutions on the discussion board. Note that communicating with my instructor by email and checking homework solutions on the discussion board significantly predicted students' final course grades when all four variables were included. The percentage of variance explained in the linear regression (R^2 = 0.13) corresponded to medium effect size (Cohen, 1988). The predictors accounted for 13% of the variance in final course grades.

Principal Two - Research Question (b). "Is student success, as measured by final grades in an online introductory statistics course, associated with Principle Two – Reciprocity and Cooperation among Students?"

The final course grade was entered in SPSS as the dependent variable (criterion), and five items survey responses were used as independent variables (predictors). Multiple Regression analysis was conducted with scales from 1 to 5. The result shows that the predictors accounted for 7.1 of the variances in the final course grades, R^2 = .071, which was between a small and medium effect size (Cohen, 1988). The summary of correlations between the criterion and the predictors is shown in Table 4.

Table 4

Summary of Correlations between the Criterion and the Predictors

Variable	IV3	IV4	IV7	IV9	IV10	IV11	IV26
DV	-.137	.018	-.135	-.070	.017	-.058	-.182*
IV3		.455***	.751***	.167	.144	.357***	.224*
IV4			.470***	.074	.120	.208*	.205*
IV7				.238*	.168	.428***	.215*
IV9					.697***	.673***	.104
IV10						.667***	.113
IV11							.319**

Note. $N = 95$. *$p < .05$, **$p < .01$, $p < .001$.

From Table 4, only the predictor IV26 (Classmate's supports) correlated with the criterion significantly since the P-value was less than .05. It was a negative correlation; apparently, students who received the higher course grades did not need support from their classmates. All predictors correlated with each other, the values of linear correlations range from 074 to .751. The result of the analysis of variance for the regression model with five predictors is displayed in Table 5.

Table 5

Analysis of Variance for Regression Model with Five Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	14.271	7	2.039	.947	.475
Residual	187.266	87	2.152		
Total	201.537	94			

Since the P-Value from ANOVA was greater than .05 (Table 5), the overall model using seven predictors was not significant, $F(7, 87) = .947$, $p > .05$.

Table 6

Summary of Multiple Regression for Principle Two

Variable	*B*	*SE B*	β	*p*
Constant	5.079	1.264		.000
Read information posted by my instructor	-.135	.213	-.101	.528
Post questions seeking help on the discussion board	.169	.156	.130	.283
Read postings from my classmates on the discussion board	-.124	.212	-.098	.561
Classmates' responses to questions on the discussion board	-.269	.291	-.147	.357
Instructor's encouragement for participation	.029	.337	.098	.537
Reading discussion board postings from classmates	.140	.281	.086	.618
Classmate's supports	-.355	.211	-.189	.096

In addition, all the coefficients of the regression model were not significant as displayed in the summary of multiple regression for Principle Two in Table 6. The result showed that Principle Two: Reciprocity and Cooperation among students did not significantly associate with the students' final course grades. It seemed

that students with higher final course grades tend to study independently. Therefore, Principle Two had no significant association with final course grades.

Principal Three - Research Question (c). "Is student success, as measured by course final grades in an online introductory statistics course, associated with Principle Three – Student Active Learning?" The final course grades were entered in SPSS as the dependent variable (criterion), and responses from nine items of the survey were used as independent variables (predictors).

Table 7

Summary of Correlations between the Criterion and the Predictors

Variable	IV8	IV12	IV13	IV14	IV15
DV	.215	-.031	-.124	-.200*	-.059
IV8		.190*	.158	.187*	.190*
IV12			.370***	.443***	.272**
IV13				.362***	.364***
IV14					.190*

Note. *p < .05, **p < .01, ***p < .001

Multiple Regression analysis was conducted with measure scales from 1 to 5. The results show that among five predictors, only one item had a significant correlation with the criterion, IV14, which was reading instructor's description about each assignment. Statistically significant correlations were found within all predictors with each other; except for two items, IV8 and IV13, that had insignificant correlations (See Table 7).

However, all the predictors accounted for 12% of the variance in the final course grades, $R^2 = 0.12$, which was very close to medium effect size, 0.13 (Cohen, 1988). The summary of ANOVA for the regression model is presented in Table 8.

Table 8

Analysis of Variance for Regression Model with Five Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	23.706	5	4.741	2.373	.045
Residual	177.831	89	1.998		
Total	201.537	94			

From the table above, ANOVA analyses showed that the regression model was significant with the value of F (5, 89) = 2.373, p < .05. In the regression model, two coefficients were significant: (a) IV8 - *Actively participate in the discussion board* and (b) IV14 - *read instructor's description*

about each assignment. Therefore, Principle Three was significantly associated with final course grades (see Table 9).

Table 9

Summary of Multiple Regression Analysis for Principle Three

Variable	*B*	*SE B*	β	*p*
Constant	4.087	.988		.000
Actively participate in the discussion board	.363	.139	.270	.010*
Watch videos provided by my instructor	.098	.164	.070	.550
Practice with examples before doing homework	-.150	.199	-.087	.453
Read instructor's description about each assignment	-.327	.157	-.240	.040*
Complete assigned homework exercises	-.094	.197	-.052	.636

Note. $*p < .05$

Principal Four - Research Question (d). "Is student success, as measured by course final grade, in an online introductory statistics course, associated with Principle Four – prompt feedback?" The final course grade was entered in SPSS as the dependent variable (criterion), and responses from five items of the survey were used as independent variables (predictors). Multiple Regression analysis was conducted with measure scales from 1 to 5. The scale indicated the amount of time before students received a response for homework questions. The scales were as follows: 5 = Less than 1 day, 4 = 2-3 days, 3 = 3-4 days, 2 = 4-5 days, 1 = more than 5 days.

The result showed that the regression model constructed by these five items had a value of $R^2 = 0$ .013, which corresponded to small effect size (Cohen, 1988), merely 1.3 % of variance had been counted in the final course grades.

Table 10

Summary of Correlations between the Criterion and the Predictors

Variables	IV17	IV18	IV19	IV20	IV21
DV	-.077	-.090	-.073	-.067	-.025
IV17		.691***	.522***	.325**	.350***
IV18			.341***	.313**	.278**
IV19				.200*	.308**
IV20					.596***

Note. $N = 95$. $*p < .05$, $**p < .01$, $***p < .001$

Among all the five predictors, none of them had a significant correlation with the criterion of the final course grade. However, significant correlations were found among all predictors within each other (see Table 10).

The ANOVA showed that using the regression model, $(F\ 5, 89) = .231$, $p > .05$ (Table 11), none of the five predictors had significant coefficients. It implied that Principle Four was not a significant predictor and has no significant association with final course grades. Thus, the instructor's prompt feedback was not significantly associated with final course grades.

Table 11
Analysis of Variance for Regression Model with Five Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	2.577	5	.5152.262	.231	.948
Residual	198.960	89			
Total	201.537	94			

Principle Five - Research Question (e). "Is student success, as measured by course final grades in an online introductory statistics course, associated with Principle Five – time on task?" The final course grade was entered in SPSS as the dependent variable (criterion), and responses from four items of the survey were used as independent variables (predictors). Multiple Regression analysis was conducted with scales of 1 to 5, which rated the extent of time on task, that helped students keep up with the course assignments: 1 = not applicable, 2 = not helpful, 3 = neutral, 4 = helpful, 5 = very helpful. The result shows that the regression model constructed with these four items showed a percentage of variance in final course grades, $R^2 = .073$, which corresponded to an effect size between small and medium (Cohen, 1988) with 7.3 % of the variance accounted in the linear regression.

Table 12
Summary of Correlations between the criterion and the predictors

Variable	IV22	IV23	IV24	IV25
DV	-.073	.182	.153	-.148
IV22		.228*	.406***	.281**
IV23			.744***	.072
IV24				.180*

Note. $N = 95$. $*p < .05$, $**p < .01$, $***p < .001$

Analyzing the correlations for predicting final course grade, none of the four predictors was significant (Table 12). ANOVA showed that the regression model was not significant, $F(4, 90) = 1.765$, $P > .05$ (Table 13). Neither predictor had a significant coefficient. This implies that Principle Five was not a significant predictor for predicting final course grades. There was no significant correlation between time on ask and final course grades. The result of ANOVA is shown in the table below.

Table 13
Analysis of Variance for Regression Model with 4 Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	14.658	4	3.6642	1.765	.143
Residual	186.879	90	.076		
Total	201.537	94			

Principle Six - Research Question (f). "Is student success, as measured by course final grades in an online introductory statistics course, associated with

Principle Six – instructor's high expectations? The final course grades were entered SPSS as the dependent variable (criterion), and responses from four items of the survey were used as independent variables (predictors). Multiple Regression analysis was conducted to measure scales ranging from 1 to 5: 5 = strongly agree, 4 = agree, 3 = neither disagree or agree, 2 = disagree, and 1 = strongly disagree. These scales measured the extent of students' agreement with high expectations from their instructor. The results show that the regression model constructed by these four items resulted in 5.3 % of the variance in final course grades ($R^2 = .053$) which corresponded to an effect size between small and medium (Cohen, 1988).

In examining the correlations for predicting final course grade, none of four items was significant since all the P-values were greater than .05. However, correlations between two of the four items were significant: (a) my instructor's clear instructions and high expectations, (b) the learning objective and outcomes are posted, (c) my instructor encourages me to do the best, and (d) instructor's high expectations motivate me to do well (see Table 14).

Table 14

Summary of Correlations between the Criterion and the Predictors

Variables	IV22	IV23	IV24	IV25
DV	-.129	-.062	-.008	-.124
IV22		.644***	.643***	.563**
IV23			.743***	.702***
IV24				.769***

Note. $N = 95$. ***$p < .001$

ANOVA showed that the regression model was not significant, $F(4, 90) = 1.271$, $p > .05$ (Table 15). None of the four predictors had significant coefficients. This result implies that Principle Six was not significantly associated with final course grades.

Table 15

Analysis of Variance for Regression Model with 4 Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	10.778	4	2.695	1.271	.287
Residual	190.759	90	2.120		
Total	201.537	94			

Note. N = 95.

Principle Seven - Research Question (g). Is student success, as measured by course final grades in an online introductory statistics course, associated with Principle Seven – respect for diverse talents and ways of learning? Final course grades were entered SPSS as the dependent variable (criterion), and responses from five items of the survey were used as independent variables (predictors).

Multiple regression analysis was conducted with scales from 1 to 5 to measure the extent of students' agreement: 5 = strongly agree, 4 = agree, 3 = either disagree or agree, 2 = disagree, and 1 = strongly disagree. The result showed that the regression model constructed by these five items had a significant percentage of variance in final course grades ($R^2 = .029$), which corresponded to small effect size (Cohen, 1988). Only 2.9 % of the variation was accounted of in the linear regression. In reviewing the correlations for predicting final course grade, none of the five items was significant since all the P-values of predictors were greater than .05. However, statistically significant correlations were found among predictors within each other. The summary of correlations between the criterion and the predictors is displayed in Table 16.

Table 16

Summary of Correlations between the Criterion and the Predictors

Variable	IV16	IV31	IV32	IV33	IV34
DV	-.014	-.119	-.102	-.129	-.011
IV16		.239*	.197*	.220*	.258**
IV31			.609***	.530***	.527***
IV32				.823***	.572***
IV33					.638***

Note. $N = 95$. $*p < .05$, $**p < .01$, $***p < .001$

The result of ANOVA showed that there was no significant predictor since the test statistic, $F(4, 90) = .670$, $p > .05$ (Table 17). None of the five predictors was a significant coefficient in the regression model. This implies that Principle Seven was not a significant predictor in final course grades. Thus, respect for diverse talents and ways of learning had no significant association with final course grades.

Table 17

Analysis of Variance for Regression Model with 5 Predictors

Model	*SS*	*df*	*MS*	*F*	*p*
Regression	6.932	5	1.386	.634	.674
Residual	194.605	89	2.187		
Total	201.537	94			

Note. N = 95.

Discussions

For the research question in this study, the results of analyses confirmed that Principles 1 (Good Practice Encourages Contact between Students and Faculty) and Principle Three (Good Practice Uses Active Learning) did affect students' course final grades in the introductory statistics course. Both principles were found to be significantly associated with student success in online mathematics courses. The other five principles were not found to be

statistically significant in this research study. The instructor in this study often interacted with students by emails and discussion board. Active learning activities were created by this instructor to challenge students on the course websites.

In this study, a quantitative approach was adopted to explore the factors that would help college students succeed in online mathematics courses. The findings showed that student success was associated with the following areas: Principle One – the interaction between students and faculty and Principle Three – use of active learning, tutoring services, and technical competence. Students who had the lowest final course grades reported a greater need for tutoring services. Mastering online homework had a positive impact on students

Chickering and Ehrmann (1996) recommended that distance learning instructors adopt the Seven Principles for good practice. Although they were originally developed for traditional on-site classroom instruction, Chickering and Ehrmann claimed that these principles are effective and appropriate ways for guiding the implementation of web-based instruction (Chickering & Ehrmann, 1996; Newlin & Yang, 2002). However, empirical studies about the application of the Seven Principles in online mathematics courses were rarely found. The findings from this study used multiple regression analyses to examine the Seven Principles one by one.

Student Success and the Seven Principles

Research Question asked whether there is any association between course final grades and the seven principles (Chickering & Gamson, 1987). Based on the result of multiple regression analyses, two principles were identified as significant predictors for the course final grades in this study: Principle One – Good practice encourages contact among students and faculty, and Principle Three – Good practice uses active learning.

Principle One - Good Practice Encourages contact between students and faculty. Students in this study reported that contact with the instructor such as communication by email and participation in the online discussion board to interact with the instructor and classmates were significant factors in helping them succeed in the course. Student engagement had been considered effective in helping students succeed (Astin, 1999; Kinzie, Kuh, Schuh, Whitt, & Associates, 2005). Chickering and Gamson (1987) suggested that maintaining constant contact between students and faculty was a good practice to motivate and engage students in undergraduate education. Principle One can be applied to distance education as well (Chickering & Gamson, 1999).

By using the easy access of the Internet, the faculty can strengthen their interaction with all students anytime and anywhere. For example, some students who are too shy to ask questions in a traditional onsite setting can freely communicate with their instructors by sending emails or posting questions on the online discussion board (Newlin & Wang, 2002). Although it is asynchronous communication, it can be performed 24 hours a day, 7 days a

week. In addition, online instructors can hold virtual office hours to keep communication with students synchronous (Newlin & Wang, 2002).

It is critical to have contact between students and their instructors (McFadden & Patterson, 2009). Instructors can show their concerns to students and students can gain the encouragement to progress in their studies. An email response from the instructor could help the student decide whether to continue or stop taking the online course. Specifically, students taking online mathematics courses might have questions on how to download specific software in order to view mathematics symbols and content on the course websites or on how to utilize the online tools to present their responses to homework questions.

Online learning management provided by the publisher or college allows the instructors and students to work together on the discussion board. Instructors can post a thread to explain the mathematical concepts by attaching graphs or detailed steps, such as using Windows Journal on a Tablet PC. According to Microsoft Windows Guideline (2011), Windows Journal allows instructors to use handwritten explanations and use colorful pens. In online mathematics courses especially, it is crucial to help students understand solutions by showing them the work, in detail, and clear diagrams.

Instructors can use a threaded discussion to provide instructions and interactions (Padavano & Gould, 2004). First, instructors can post guidelines to lead students to the learning objectives. Second, for each chapter, instructors can create a homework discussion forum and post questions to challenge students in critical thinking. Students can be encouraged to make comments and reply to their classmates' postings. Instructors can work as facilitators to supervise and direct discussions among students. Frequent contact with students is needed (Padavano & Gould, 2004).

Principle Three – good practice uses active learning. In this research study, students also reported that uses of active learning were effective to help them succeed in the online math class. The results of multiple regression analyses showed that students had higher final course grades if they participated actively in the discussion board for posting or answering questions.

Principle Three can be applied in distance education (Chickering & Gamson, 1999). In an online course, those students who participate most often in the discussion board or email instructors are more likely to stay in the course, to the end of the semester, and to complete the course successfully (Angelino, Williams, & Natvig, 2007).

Online instructors can develop course materials and assignments that challenge students to use critical thinking skills and focus on problem-solving (AAHE, 1998). Consequently, students can actively participate in online discussions to find solutions. Howell found that students cannot learn by only listening to lectures; indeed, they learn when they do their assignments (Howell, 2001).

Seven Principles Ranked by Students

In the last item of the survey, students were asked to select one of the seven principles that they believed would be best used to help them succeed in an online mathematics course. The results showed that Principle Three (Good Practice Uses Active Learning) ranked as first, Principle One (Good Practice Encourages Contact between Students and Faculty) as the second, and Principle Four (Good Practice Gives Prompt Feedback) as third place. The result of multiple regression analyses coincidently identified Principle One and Principle Three as statistically significant factors associated with student success in online mathematics courses.

Students thought that active participation in the learning environment was the best way to succeed. Second, frequent communication between students and faculty also increased the success of students. Last, the prompt feedback from the instructor was chosen by students. With these results, Principle One and Principle Three were strongly and significantly confirmed as factors that contributed to the success of mathematics students in the online introductory statistics course.

Urban Education and Equity Issues

Based on the nature of student demographics in this study, the percentage of participants working full time was the highest (41.75%) and working part-time was the second highest (37.1%). This reflects that most online students work hard and strive to complete their educational goals. Students indicated that they had limited time to study, especially those who worked full-time jobs. Online learning is an imperative solution for this group of students for them to move forward with their educational goals.

The descriptive statistics also showed that the ratio of female students to male students was 3 to 1. Thus, a gender inequity issue was observed. In addition, the ethnic data revealed that the White students had the highest percentage (42.4), American Indian was the lowest percentage (0.8), and African American was the second lowest in percent (4.5). This statistical analysis found a racial inequity about having online education, specifically in mathematics courses. It appears that problems related to computer competency and/or fears of taking mathematics online have been witnessed (William, 2010).

In conclusion, encouraging contact between students and faculty and using active learning techniques should help online mathematics students to succeed in introductory statistics classes. Colleges should provide tutoring services, online and in-person, to serve the different learning styles of students. Students' technology competencies should be focused on as competencies in this arena appear to be imperative. This study suggested that strategies should be developed to encourage the interaction between faculty and students and that active learning environment should be promoted.

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Author:

Lisa S. Lee
Coastline College, U.S.A.
Email: llee@coastline.edu