PREDICTING SUCCESS FOR COLLEGE STUDENTS ENROLLED IN AN ONLINE, LAB-BASED, BIOLOGY COURSE FOR NON-MAJORS

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PREDICTING SUCCESS FOR COLLEGE STUDENTS ENROLLED IN AN ONLINE, LAB-BASED, BIOLOGY COURSE FOR NON-MAJORS

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Online education has exploded in popularity. While there is ample research on predictors of traditional college student success, little research has been done on effective methods of predicting student success in online education. In this study, a number of demographic variables including GPA, ACT, gender, age and others were examined to determine what, if any, role they play in successfully predicting student success in an online, lab-based biology for non-majors course. Within course variables such as participation in specific categories of assignment and frequency of online visits were also examined. Groups of students including Native American/Non-Native American and Digital Immigrants and Digital Natives and others were also examined to determine if overall course success differed significantly. Good predictors of online success were found to be GPA, ACT, previous course experience and frequency of online visits with the course materials. Additionally, students who completed more of the online assignments within the course were more successful. Native American and Non-Native American students were found to differ in overall course success significantly as well. Findings indicate student academic background, previous college experience and time spent with course materials are the most important factors in course success. Recommendations include encouraging enrollment advisors to advise students about the importance of maintaining high academic levels, previous course experience and spending time with course materials may impact students' choices for online courses. A need for additional research in several areas is indicated, including Native American and Non-Native American differences. A more detailed examination of students' previous coursework would also be valuable. A study involving more courses, a larger number of students and surveys from faculty who teach online courses would help improve the generalizability of the conclusions.

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CHAPTER I

GENERAL NATURE AND PURPOSE OF THE STUDY

Online education has recently exploded in popularity. According to Allen and Seaman (2010), over 5.6 million students took at least one online course during the fall of 2009 – nearly one million more students than had taken an online course in 2008. While overall higher education enrollment increased by 2 percent during the past year, online enrollment increased by twenty-one percent, more than ten times the rate of the traditional enrollment increase. Today, nearly thirty percent of higher education students are enrolled in at least one online course (Allen & Seaman, 2010). Though online instruction is popular, it is still a relatively new instructional approach that lacks the rich research history associated with traditional instructional methods.

The research presented here focused on a community college population where online enrollment has increased from 19 students in Fall 2002 to 1,259 students in Fall 2011. This represents 50% of the total enrollment of 2500 students during the Fall of 2011. More and more students are continuing to choose the online approach. Online coursework is convenient and can be taken by students who are working full time or who are place-bound by either geographic or socioeconomic circumstances. The importance

of predicting student success in online coursework continues to increase as access to the infrastructure that makes online instruction possible becomes more widely available. Limited existing research in this area leads to inadequate student advisement for selecting one course format over another. Proper advisement in course selection can maximize the potential for students' success.

Science instruction, in particular, has been challenging to implement online due to the laboratory component. This hands-on component has presented unique challenges to an online interpretation. Research has not yet determined a way to successfully implement an online science course that includes an online laboratory component. In general, the current research is particularly limited when it comes to predicting which student demographics or skills preclude student success. The focus of this research was an online science course which required a lab component. This focus was intended to identify success predictors for this student population.

Traditional Success

Success prediction in traditional college students has been extensively studied. There are a number of studies documenting high school GPA, ACT score, age, SAT score, class rank, involvement in extra-curricular activities, attendance, and socioeconomic level as success predictors when students matriculate to the college campus (Cubeta, Travers, & Sheckley, 2000-2001; Hoffman & Lowitzki, 2005; Hoschl & Kozeny, 1997; Kanoy, Wester, & Lata, 1989).

Cubeta et al. (2000-2001) indicated several factors can be used to predict success among older and non-traditional college students. In their study, which looked at 542 randomly selected students who had attended both 2-year and 4-year colleges, some

factors seemed to influence students in different ways. African American students' success was influenced significantly more than Caucasian students by academic self-efficacy. Twelve percent of variance associated with GPA was explained by academic self-efficacy as measured in a survey instrument as compared to only eight percent of variance within the Caucasian student population. For credit ratio (the ratio of credits attempted to credits completed) the concept of help seeking explained a larger portion of the variance among African American students (29%) as compared to Caucasians (3%). Help seeking was defined as the degree to which students sought help from the instructor. This seems to indicate students of color benefit much more from this behavior than their counterparts.

Hoffman and Lowitzki (2005) found that some factors were better predictors for certain populations. Their study examined a college student population at a predominantly White, Lutheran university. Campus involvement was a better predictor for success among minority student populations than among the majority student populations. Campus residence influenced campus involvement more for students of color. The researchers concluded that minority students' feelings of involvement helped to mitigate their cultural differences and minority standing among the majority populations.

Hoschl and Kozeny (1997) attempted to predict success in medical students during their first three years. They found variables such as high school performance, written entrance examination scores and admission interviews could be significant predictors of academic success during the first three years of study.

Success Online

There are fewer studies predicting success among online students (Limniou & Smith, 2010; Liu & Cavanaugh, 2011), and fewer still existing studies specifically predicting success among online biology students. Though numerous studies identify successes with specific online learning activities, (Bonham, Deardorff, & Beichner, 2003; Chen & Howard, 2010; Dale, Nasir, & Sullivan, 2005; Doiron, 2009; Gilman, 2006), there are almost no studies specifically addressing biology courses that are taught exclusively online (Johnson, 2002). Given that online education is growing in popularity, it is essential to try to maximize student success so that students can be advised appropriately as to the wisdom of taking online classes particularly in areas such as science.

Johnson (2002) compared on-campus students at a community college to online students. Both groups of students were taking an introductory non-majors' biology course. In this study, based on post-tests, online students were as successful as their on-campus counterparts learning the basic biology content skills that were measured. This is one of the few studies currently in existence that pertains specifically to online biology instruction. This course did have a lab component which included a lab materials kit that was issued to students who participated in the course. Labs were of the learning cycle style. Briefly, the learning cycle begins with active engagement of students investigating natural phenomena. As students explore, the teacher serves as facilitator. Exploration is followed by discussion and additional activities to apply newly discovered information (National Research Council, 1996).

In this study, data was examined for students who had completed an exclusively online biology for non-majors at a small, regional community college affiliated with a larger comprehensive, Midwestern state university. For the purposes of this research, the school was referred to as ABCU. Students were all enrolled in the course as a result of their major courses of study and were at all levels in their educational careers, with some being first time college students and some having already earned many college credit hours. Students ranged in age, but were slightly older than traditional college students in freshman level courses. There were also a higher percentage of minorities and lower socioeconomic students than in standard community college freshman populations in this area of the country. Selection of this student sample from just one campus did limit the applicability of this study to other colleges of a different size and nature than this one.

Digital Access to Information

Today's students have easy access to a plethora of electronic devices such as wireless-equipped lap tops, personal data assistants (PDAs), smart phones, and thus easy ability to participate in new instructional modes. "No longer do students need to go to a specific place, or even be seated, to use a computer" (Oblinger & Oblinger, 2005, p. 6.4). I recently witnessed this first hand. Due to a professional commitment, I had to miss an on-campus laboratory session with a Microbiology class. I had a substitute monitor the lab and went through all procedures the day before so that everything would run smoothly. My plan had been for students to examine growth on their culture plates and make sketches for me since I was not going to be there to view the plates first-hand. One lab group initiated a PowerPoint presentation of their plates including photos taken by their smart phones of each and every plate, labeled and inserted into the presentation, and

then sent me the presentation electronically that afternoon. This "serendipitous event" evidenced the power of this new electronic age. As faculty, we may not be taking full advantage of this potential with current instruction practices. This event also suggested additional possible directions to take in online classes.

The line between face-to-face and online classes continues to blur. The newest iterations are "blended" courses where a portion of the course is on-campus and a portion is online (Limniou & Smith, 2010). With science classes, this usually means the lecture portion is online and the lab portion is in person, on-campus. There is a general feeling among faculty that actual hands-on labs are more successful than "virtual" online versions. This idea isn't completely supported in the research, as some studies previously discussed determined no significant differences between online students and on-campus students in this respect (Johnson, 2002; Limniou & Smith, 2010).

Additionally, once traditional face-to-face courses now use university-provided online platforms to add to their instructional content. At ABCU, it is common for on-campus teachers (including this researcher) to use a number of online classroom components within their traditional classes. Discussion Boards, posting of notes and class materials, online exams and drop boxes for homework are all aspects of the online environment used extensively within many face-to-face courses. This continued blurring and blending of course components results in a student population with completely different experiences and needs from previous students in terms of exposure to and efficient use of technology.

Statement of the Problem

Due to limited research correlating student characteristics with online students' success or failure, there is no accepted way to predict success within the online lab biology for non-majors program at ABCU.

Purpose of the Study

The purpose of this quantitative predictive correlational research was to identify academic and socioeconomic variables that correlate with course success, and then using regression analysis, determine which variables predict success in an online non-majors, lab-based, biology course. Once these variables are identified, college enrollment personnel will be better able to predict students' success in this online method of instruction. Results might guide a useful tool for: (a) recognizing student characteristics that lead to a successful online student experience, and (b) advising students about appropriate course choices. Determining factors that result in online student success will help potential students and enrollment advisors make informed decisions about enrollment choices. This research then, explored a variety of demographic and behavioral characteristics to enable accurate prediction of student success.

Variables used in this study included demographic data as well as an exploration of online student behaviors. Demographic data included students' current college grade point average (GPA), American College Testing (ACT) score, federal aid status, age, ethnicity and gender. Online student behaviors which were correlated to *within course* success included: frequency of online visits; completion of online activities like discussion board posts, homework assignments and laboratory activities; and online quiz

performance. This *within course* success served as the dependent variable and was measured via students' final numerical unit exam scores and numerical course grade.

Research Questions

Course success was examined in two ways: within-course success and overall-course success. Within-course success was based on individuals' average unit exam scores. Overall-course success was based on the final course grade. Examining both within-course and overall-course success allowed a complex interpretation of data as it pertained to students who may have stopped participating at some point during the course, but remained enrolled and displayed traits that predicted success within the parts of the course they did complete. The following research questions served as a guide in the examination of these variables.

1. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with each of the following demographic variables: GPA, ACT, age, and previous hours of college credit earned?
2. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with student online behaviors: frequency of online visits, completion of discussion board posts, completion of homework assignments, and completion of laboratory activities?
3. Is there a significant difference in final course success as measured by course grades in an online laboratory-based biology course for non-majors between the following groups: Digital Immigrants/Digital Natives, male/female, Native American/Non-Native American, and financial aid qualifiers/non-qualifiers?

4. Which of the following variables predict student success as measured by course grades in an online laboratory-based biology course for non-majors: GPA, ACT, federal aid status, age, gender, ethnicity, previous hours of college credit earned, frequency of online visits, completion of discussion board posts, completion of homework assignments and completion of laboratory activities?

Definition of Key Terms

The nature of this study involved the use of many acronyms and terms familiar to some readers that need to be defined for the convenience of other readers. Thus, this section identifies and explains the determination and definition of key terms referenced later in the research study.

ACT (American College Testing) and SAT (Scholastic Aptitude Test) refer to examinations students take prior to admission to the university. This study took place in a mid-western state and the required admissions exam was the ACT. Students occasionally have SAT score data as well as they come from other states, but for the purposes of this study, primarily the ACT data was used.

In this study, *Age* was defined as the student's age while enrolled in the online course in question.

BOL – This acronym represents the biology online course platform used at ABCU. This is an online platform that includes access to a number of areas described further in the terms section and is the platform in which students interact with the instructor and each other during the course.

Digital Native / Digital Immigrant – Mark Prensky (2001) coined this set of terms. Digital Native describes those born into a world that included computers and

electronic devices and Digital Immigrant designates those who lived in a world without computers and saw their development and extensive use begin within their lifetimes. For the purposes of this research, Digital Immigrants were identified as those born before 1980 and Digital Natives were those born after 1980. While there is some debate about the exact division between these groups, 1980 has been used previously as an acceptable dividing line between these generations (Oblinger & Oblinger 2005).

Discussion Board Posts are message board posts on given topics that students are required to produce as a part of the course. For the purposes of this research, posts were counted, but not evaluated on quality.

Federal Aid Status refers to the ability of the student to receive federal aid and is based on economic characteristics of the student. In the case of dependent students, federal aid status is based on their parents. Students were coded using information in the student data system as either "yes" for eligible for student aid, or "no" for not eligible. There are many levels of federal aid available, but it was beyond the scope of this study to consider the varying levels of aid received.

GPA refers to the overall Grade Point Average of the student. In this study, GPA was used to refer to the cumulative grade point average of completed college coursework at the time the student took the online biology course unless otherwise noted. This included any coursework previously completed at other institutions and transferred to ABCU, as well as all courses completed at ABCU.

Homework Assignments Completed within this course consisted of writing assignments given on topics covered during the course. The number of writing

assignments varied but there have been a minimum of two assignments in each section of the course analyzed for this study.

Laboratory Activities Completed are activities requiring active participation at home. There are ten laboratory activities required in this course.

Online Quizzes are the examinations given throughout the course. The scores from these examinations help to measure student success within the course.

Overall Course Grade includes all student scores and will help to measure overall success in the course. This is a traditionally graded course and a total-points-accumulated method is used to determine a final letter grade based on a percentage of points accumulated.

Frequency of online visits was measured using data collected automatically within BOL. The most reliable estimate of which students accessed course materials online ultimately was measured using the number of visits students made to areas within the course. Students can be logged on and leave their computer to do other things which artificially inflated time measurements. This fact caused the researcher to conclude number-of-visits was a more accurate representation of which students actually accessed the material.

Theoretical Framework - Interaction

This research relied on the theoretical framework of interaction levels. The lens or framework of *interaction levels* enables a researcher to consider the overall dynamics of online learners and their communication with each other, the online course format and the instructor, and the ways in which these interactions affect their ultimate success or

failure in online environs (Moore, 1989). This framework provided the reflective lens needed to interpret relationships and correlations observed in this research.

A number of interaction levels have been identified in online instruction. Learner-content interaction refers to the contact the learner has with curricular materials and the topic of studies. Moore (1989) identified three categories of interaction among online learners: 1) learner-content interaction, 2) learner-instructor interaction, and, 3) learner-learner interaction. Additionally, Hillman, Willis and Gunawardena (1994) identified a fourth category, learner-interface interaction. According to Moore (1989), learner-content interaction is an important concept of online environments because it changes learners' behavior. Learner-instructor interaction occurs between learners and instructors or other experts. Instructors are responsible for motivating students to learn and providing the appropriate materials and environment to make learning possible. Learner-learner interaction occurs among leaners of an online environment with or without the presence of an instructor (Moore, 1989). Learner-interface interaction is defined as "a process of manipulating tools to accomplish a task" (Hillman et al., 1994, p. 34).

A number of researchers have investigated interaction in distance education in the past and found it to be an important factor that can influence student success (Falloon, 2011; Jung, et al, 2002; Keegan, 1988; Moore, 1989; Ross, 1996; Tsui & Ki, 1996). In this study, several interactional variables will be analyzed in this research including: frequency of online visits (learner-content and learner interface) and discussion board participation (learner-learner).

Limitations of the Study

This study involved a limited student population at ABCU. One major limitation was the ability to generalize results to other schools. As well, it was impossible to apply conclusions to student groups of different socioeconomic status other than the group studied. In the interpretation of the data, general trends were observed that can serve as markers for areas for future research to provide broader generalizability of the data.

Research data included historic data available on the college computer system including ACT, GPA, financial aid status, gender, age, and previous hours of credit completed. Additionally, data available within the BOL system included the clock time students spent online, the number of times students visited different areas of the online course, grades within each unit, and the overall course grade. There were, however, inherent problems with some of the types of data collected. The metric used to explain students interactions with course materials was defined by the number of visits students made to the various regions of the course, not the amount of clock time they spent online with the materials. This metric was a simple count of the number of times students accessed the materials and did not account for the quality or types of interactions students had with the materials.

With regard to financial aid status, students were simply coded as either "receiving aid" or "not receiving aid." There was not enough detail to truly analyze the financial need of the students and this factor needs to be explored further.

Significance of the Study

The results of this study can be used by enrollment advisors to assist students in deciding whether or not to take online courses. This could prevent the practice of

enrolling students into online coursework despite indications that online courses may not be the right choice for them. Additionally, factors brought to light by this research could help online instructors facilitate success among the various populations of students found in their online courses. Ultimately, the designers of online courses might be influenced by understanding student characteristics and behaviors which seemed most correlated to success within these courses.

Summary

Online science courses are growing in popularity. The ability of instructors and enrollment advisors to successfully predict which students benefit most from online instruction is still essential. The activities students need to engage in to insure online success are also not clearly understood. Enrollment continues to increase in online classes at colleges. Much research has been done on predicting success among traditional, on-campus college students, but less research pertains to online college instruction. Specifically, limited research pertains to online, lab-based, biology instruction. Identifying factors that lead to success in online, lab-based, biology courses would address this research gap. Using interaction theories, this research attempted to add to the existing research in this area.

In the following chapter, current literature pertaining to success prediction with traditional instruction, online learner characteristics, online science instruction and the theory of interaction will be presented. Research questions are framed to address gaps in this current literature. Research methodology will appear in chapter 3, followed by a presentation of results in chapter 4 and a discussion of the analysis of those results and conclusions in chapter 5.

CHAPTER II

REVIEW OF RESEARCH AND RELATED LITERATURE

Identifying the success-predictors of students enrolled in an online, lab-based biology course is an important goal of this study. Literature reviewed will introduce prediction measures, outline characteristics of today's online learners, summarize current online activities that have shown success, and examine existing research specifically addressing the laboratory concerns of online lab science coursework.

Success Prediction in Tradition Instruction

There are a number of studies examining success prediction among college students. Some existing studies document the reliability of various variables including high school GPA, ACT score, age, SAT score, class rank, involvement in extra-curricular activities, attendance, socioeconomic level, etc. as predictors for success in students as they matriculate to the college campus (Cubeta et al., 2000-2001; Hoffman & Lowitzki, 2005; Hoschl & Kozeny, 1997; Kanoy et al., 1989).

Cubeta et al. (2000-2001) found successful college students tended to be older and reported having had prior experiences in education that were positive. Students who were more successful showed higher levels of academic self-efficacy as learners. Students who perceived their environments in college as more tolerant of diversity tended to be more successful. Some results were dynamic; for example, married females of all races earned higher GPA's than their unmarried counterparts, but married African American males earned lower GPA's than their unmarried counterparts.

Hoffman and Lowitzki (2005) studied college success aligned with high school grades and test scores among 2- and 4-year college students. The limitations of these correlations for minority students indicate several interesting areas of connection between high school success and collegiate success for both minority and non-minority students. High school grades were shown to be a signficant predictor of academic achievement for both minority and non-minority students. Additionally, these researchers determined weaker relationships existed between standardized test scores (SAT) and student academic achievement across all racial categories.

Older and non-traditional college student success prediction differs from success prediction among traditional and younger students. As an example, the Cubeta et al. (2000-2001) study determined that the relationship between age and GPA is not a simple one. Cubeta's study used data collected from college students via the Risk and Promise Profile©, an assessment designed and tested by Sheckley, Cubeta, and Travers (1998) and others in a previous study. The Profile is a seventy-eight item, self-report, paper-and-pencil questionnaire designed to assess issues that influence successful adults in college. Attributes assessed included attitudes about college, prior educational experience, help-seeking behavior, motivation, academic self-efficacy, impact of attending college and locus of control.

According to Sheckley et al. (1998), academic success is related to age; older students tend to be more successful than their younger cohorts. This correlation is most robust for individuals with an above average GPA. However, age and GPA may correlate in some way. Older students who have higher GPA's also had higher self-efficacy; this seems to be indicative of better performance according to Bandura (1995).

Older students with lower GPA's often have transcripts with course grades from previous semesters they must overcome. These course grades are sometimes decades old. As a result, these students have bigger barriers to overcome, they start from behind. In turn, this may have a negative impact on their ultimate success.

Rather than focusing on student GPA, Hoschl and Kozeny (1997) suggested admission committees would be wiser to attempt to predict success of students based on course completion, suggesting GPA's are primarily of "theoretical and illustrative significance only" (Hoschl & Kozeny, 1997, p. 91). Hoschl et al., (1997) studied medical students' success during the first three years of medical school and found high school performance, written entrance examination performance, admission interview, and personality traits were significant predictors of academic success during the first three years.

In summary, one of the ways students are evaluated for enrollment in online coursework for the first time at ABCU is to look at their current GPA, and, in fact, continued academic eligibility is based on GPA. In the case of online coursework, however, GPA does not always seem to be a reliable predictor of future student performance. Students with both high and low GPA's show both success and a lack of success in online coursework. The complete picture does not seem to be visible. One goal of this current research study was to determine which, if any of these factors impact online student success and determine if there are other factors that might predict success of these students more effectively than traditional measurements such as GPA and ACT.

Online Learner Characteristics

The literature reviewed pertaining to characteristics of online learners also included research concerning methods of online instruction. This research led to a more complete understanding of the current state of online education, specifically biology education, and indicated gaps in existing research to be addressed by this study.

One issue with current methods of online instruction noted by Limniou and Smith (2010) involved student feedback and its roll in college student success. Over a period of two years, engineering students and faculty at the University of Manchester participated in an investigation into the degree of integration of online courses and teaching approaches and how that integration related to teacher characteristics and perceptions of teaching. Additionally, they examined the notion that teacher and learner expectations for learning were not synchronised. Students were surveyed about their perception of an online class. Student comments pointed to a lack of individual feedback throughout the online course which made course assessments more difficult. Surveys indicated online teachers believed online methods were effective in communicating information to students. These teachers also believed by using learning modules, assessments and announcements they could cover their teaching needs. The online instructors, however, did not indicate awareness of the importance of individual feedback to students. This illustrated a disconnect between student and teacher perceptions in these online courses.

In an examination of a high school biology course taught online, Liu and Cavanaugh (2011) noted a number of student characteristics that correlated with ultimate success in the course. The amount of time spent in the online system was found to be positively and significantly correlated to success within the course. Researchers

concluded online students need sustained time on task to complete the course successfully.

Liu and Cavanaugh (2011) noted that socioeconomic status (as defined by eligibility for free or reduced lunches) seemed to have a significant negative correlation on student success among younger students (first semester high school biology), but had almost no correlation to success in older students (second semester high school biology). This trend has been cited in previous research as well and seems to support findings that socioeconomic levels have less impact on academic success in older students (McLoyd, 1998). Other success factors examined by Liu and Cavanaugh included: the existence of an Individualized Education Plan (IEP), positive correlation but not significant; grade level, not significant; race, white students perform better than minority students as a whole (Liu & Cavanaugh, 2011).

An examination of the research literature based on other online courses gives interesting views of online learners. Some research suggests online instruction improves student interest and motivation toward science and science learning (Thompson, Nelson, Marbach-Ad, Keller, & Fagan, 2010). Numerous studies suggest learners today might be more comfortable and successful with online methodology due to their life-long experiences with computers and virtual environments (Hoschl & Kozeny, 1997; Sanders & Morrison-Shetlar, 2001; Thompson et al., 2010). Thompson et al., (2010) studied college undergraduate biology students participating in a program using an online supplement to traditional on-campus instruction. In this case, supplemental online mathematics modules were added to a traditional biology course in an effort to increase understanding and comprehension of mathematics concepts in biology. Results showed

significant improvement in quantitative skills over the course of the semester. Findings indicated that computers assisted with active learning and increased student interest and motivation as measured by a post-course survey.

Sanders et al. (2001) studied 110 students enrolled in general biology for nonmajors at a midsized rural university. Students participated as part of an ongoing class. Students were exposed to a web-enhanced curriculum. Using a course platform very similar to the one used at ABCU, students participated in supplemental online curriculum while enrolled in a traditional course. A web-based instructional attitude scale (developed by the researchers) found student attitudes were generally positive. Most students were comfortable with the course format and resources with two exceptions. Students seemed to overwhelmingly prefer having the syllabus handed out in person and discussed in class as opposed to accessing it exclusively online. Students also preferred one-on-one conversation to online discussion board and chat. Overall, however, students had highly positive attitudes toward web-enhanced instruction. Females were more positive toward the format than males. Students younger than 20 were more positive than those over the age of 23. Racial groups did not significantly differ in their attitudes toward online instruction in this study. Authors noted the study was limited by its narrow scope of participants and location.

While little research pertains directly to college students and online biology, Johnson (2002) completed a study comparing a traditional on-campus college biology class with an online class held at the same time. Based on post-test scores, online students were just as successful as on-campus students at acquiring an understanding of biology content, with developing graphing skills, enhancing reasoning ability, and

developing positive attitudes toward science. Both sections of online students (N = 66) and on-campus students (N = 50) shared the same instructor and were assessed in the same way. Regardless of the small sample size, results seemed to indicate online methods were comparable to on-campus methods in enhancing student learning.

Online Science Activities

This section presents a review of the different styles of online learning activities. There were several research studies dealing with specific learning activities. A number of online activities have been shown to either provide the same student learning gains or greater learning gains than traditional methods (Bonham et al., 2003; Hew, Cheung, & Ng, 2010; Kibble, Kingsbury, Ramirez, Schlegel, & Sokolove, 2007; Lents & Cifuentes, 2009; Yu, She, & Lee, 2010).

Yu et al. (2010) compared web-based and non-web-based problem-solving instruction in middle school students and found no significant differences between the two methods. Lents and Cifuentes (2009) compared traditional lectures and PowerPoint with Voice Over lectures provided in an online environment and found no significant differences in student achievement. Bonham, Deardorff and Beichner (2003) found no advantage to paper-based homework over web-based homework in calculus and algebra-based physics programs.

In Yu et al. (2010) researchers noted no statistically significant difference in middle school students' final success measures when comparing students who used online problem-solving methods and students who used traditional in-class problem-solving methods. However, the results of a retention test given some time after the completion of the experiment showed an advantage for the online instructed group. This

seems to indicate something about the longer-lasting effect of the online approach over the on-campus approach. These researchers hypothesized the careful steps students were instructed to follow in the online method were easily committed to memory and therefore easier for students to recall at the time of the retention exam. In the end, Yu et al. (2010) determined problem-solving instruction within a web-based learning environment improved students' ability to identify the essential information and improved their use of the concepts they had learned. Improvements, however, did not appear immediately, but rather sometime after the initial instruction.

Lents and Cifuentes (2009), in an examination of web-based learning environments, looked at college freshmen enrolled in a second biology course. Findings seemed to indicate some advantage for self-selected students within their online comparison groups when using the web-based learning approach. Since this research population primarily included commuter and low income student populations, authors concluded web-based modes of learning might be particularly advantageous for this demographic. Researchers further suggested that biology, being more information driven and less quantitative than other science topics, may adapt particularly well to the online approach.

Kibble et al. (2007) found an advantage to online methods when teaching anatomy and physiology using an online site to add to the traditional curriculum. Students who participated in the online component actually showed more learning gains than those participating on-campus only. Researchers noted specific online advantages such as including the ability to efficiently distribute learning materials, improved communication and collaboration among students and faculty members and the ability to

perform a repetitive task [in this case, dissection] outside the scheduled laboratory session. Researchers went on to recommend, "Our research strongly suggests that the use of computer software and hardware is as effective, and perhaps preferable to, traditional cadaver-based exercises in achieving course goals and objectives" (Kibble et al., 2007, p. 379).

Hew et al. (2010) pointed to participation in online discussion boards as a valuable tool for online students in that it adds to the social learning environment for students. This addresses one criticism of the online platform; that it serves as a means of isolating students and limiting social learning. In the Hew et al. (2010) study, researchers reviewed a number of other studies involving discussion board use and implementation, and they specifically examined factors leading to limited student participation in discussion boards and attempted to establish guidelines to encourage student participation. Additionally, previously existing dilemmas surrounding establishing discussion board guidelines were addressed. Specifically, using boards with no moderator seemed to decrease participation. While a faculty moderator might also intimidate and discourage student participation, these authors suggested enabling peer moderators and discussion leaders as a way to maximize the learning and participation within the discussion board forum. In their analysis of others' research on student contribution, Hew et al. (2010) recognized seven factors limiting student contribution: (a) not seeing the need for online discussion, (b) behavior of other participants, (c) personality traits, (d) keeping up with the discussion, (e) not knowing what to contribute, (f) lack of critical thinking skills, and (g) technical aspects.

In blended courses students did not perceive the need for online discussion board participation due to the fact that blended courses also included a face-to-face meeting time each week. Students may also feel discussion topics are not interesting and not worthy of discussion. If no expectations were given, or if no reward (in the form of grades) was offered, discussion participation also declined. Other participants can intimidate some students from participating by making inappropriate comments or demonstrating bad behavior on boards. Students who were classified as extroverts were more likely to participate. Some students experienced information overload and simply could not keep up with discussions (Hew et al., 2010).

Online Laboratory Science

A large concern in moving specifically to online science education is the loss of the ability to teach the laboratory portion using inquiry-based approaches. Inquiry methods are widely considered among the most successful methods for teaching scientific concepts (Lord & Orkwiszewski, 2006). Additionally, the National Science Standards advocate the use of inquiry methods in the teaching of science (National Research Council, 1996). Some current research suggests, however, that online science instruction can meet these goals and is, in fact, more useful in some cases in the development of inquiry activities than on-campus lab sessions (Dale et al., 2005; Doiron, 2009; Gilman, 2006). Dale (2005) studied students in a molecular sciences program for first- and second-year veterinarian students. One student who was frustrated by the time commitment of on-campus labs commented:

> "There was one practical we had…and it just—we were there for over two hours and all we did was pipette a few things, you know, if you got to do that, and that was it really. And if that had been on a CAL [the online program being evaluated in this research] package it would have

> taken half an hour, be a lot less expensive, it was such a waste of time" (Dale et al., 2005, p. 134).

To resolve student frustrations, Dale (2005) developed an online learning resource for teaching veterinary bimolecular sciences. This online curriculum was organized into computer-aided learning (CAL) modules. Evaluations of the resulting CAL modules indicated they could serve as a useful resource and act as a template for other courses within the veterinary medicine undergraduate curriculum. Data indicated the lab package compared well with instruction students had previously experienced in the same topics.

Doiron (2009), as a part of her dissertation, evaluated a section of an online introductory college biology lab course. This study was one of the few cited that specifically focused on online lab biology. However, Doiron's sample consisted of only one course section and the number of subjects was very small (N = 16). This resulted in a study of limited applicability to other situations. Doiron did find students preferred the online format due to a number of real-life concerns such as children, work schedules, flexibility in timing for course work and others. Students were bothered by the lack of an instructor to answer questions immediately but in the end, both instructors and students found the experience to be positive and beneficial.

Gilman (2006) examined students in a college freshman biology class and the effectiveness of an online lab exercise. This study examined just one exercise, not an entire course, but did show some student and instructor characteristics that contribute to success within the online environment. Students who completed the online version of the lab were compared to students who completed the traditional version. Overall, students who performed the online lab exercise performed significantly better on the content quiz the following week. Some students who completed the online activity did comment they

missed the traditional, hands-on approach. Overall, however, student understanding of the lab content following their work was slightly better when they completed the activity online.

Other virtual and online activities have been shown to increase students' knowledge in biological fields (Rodriguez, Ortiz, & Dvorsky, 2006). In this study, several online activities in evolution and genetics were compared and found to be equal in increasing learner knowledge of these topics. Additionally, this research addressed assigning teams within the online environment to enhance the social learning aspect of online coursework. The team activities led to debates that went beyond the authors' initial objectives and online collaborative teams communicated successfully within the online environment.

At this point, it is necessary to distinguish between "virtual" and "hands-on" online laboratory activities. For purposes of this project, labs that exclusively involve computer activities and online simulations will be classified as *virtual online labs*. Labs requiring hands-on manipulation of materials by online learners will be classified as *hands-on online labs*. John Dewey suggested experiences with objects such as what takes place in a hands-on laboratory environment lead learners to remember more of content covered (Dewey, 1963). There is supporting evidence for labs containing active components as opposed to virtual labs (Barak, 2004). Even with this evidence, Barak still argued some virtual laboratory experiences in his field of electronics would improve the overall learning experience for students. This would be particularly true in areas where it is not possible to perform the actual experiences in a hands-on fashion.

In online biology courses, for example, labs predicting inheritance of traits or genetic coding might be examples of activities that would need to be done with virtual methods rather than hands-on style. Also, labs such as dissections that could not be completed in a student's home might be completed in this way.

Theory of Interaction

The lens through which data collected in this research will be examined is the theory of interaction levels (Moore, 1989). Jung, Choi, Lim, & Leem (2002) used the Moore (1989) framework specifically to analyze types of interaction in a web-based instruction environment. They concluded that different types of interaction in web-based courses may differ in terms of their effects on the learning achievement, satisfaction, and participation of participants in the course. Social interaction was more related to learning outcomes than to learner satisfaction. Collaboration among learners was more related to learner satisfaction than to learning outcomes (Jung, et al, 2002).

Falloon (2011), in research looking at groups of post-graduate students enrolled in an online, graduate teacher preparation course suggested relationships formed online are hindered by a lack of face-to-face contact, but still can form (even asynchronously) online. Video capture methods can improve social connections formed between students and address this concern. In this research, there were both synchronous and asynchronous elements to the course in question and students were somewhat critical of the synchronous element as it interfered with the flexibility of their course schedules. Participants noted less collaboration between class members than they had previously observed in traditional course settings. Participants noted the efficiency of using the virtual classroom for information communication. The main factors affecting student

engagement were technical in nature suggesting the importance of the learner-interface interaction (Falloon, 2011).

Summary

Literature reviewed for this study included research on characteristics which can be used as prediction measures for student success, characteristics of online learners, online activities that have proven to be successful, literature specific to online laboratory activities, and finally, literature related to interaction levels and their connection to online education. The overall goal of this current research study was to address gaps in the existing literature in the area of predicting success in online, lab-based, biology instruction.

The following chapter will discuss the research methodology used in the completion of this study. It is followed by chapters outlining the data collected and the results of tests on that data. Finally, analyses and conclusions will be discussed that were formed from this analysis and suggestions for further research will be given.

CHAPTER III

METHODOLOGY

The purpose of this quantitative, predictive correlational research study was to identify behavioral, cognitive, and socioeconomic variables that predict student success in general in online courses and more specifically student course success in online biology for non-majors students. Given that some students are more successful than others, predicting student success with this method of instruction could provide a valuable tool to admissions and enrollment personnel when placing prospective students into courses at the community college level and advising students about possible course choices. Determining factors that result in success among enrolled students could help with course design and structure to maximize student success.

Variables examined in this study included current college grade point average (GPA), American College Testing (ACT) score, federal aid status, age, and gender. Additionally, some behaviors of students enrolled in online lab biology were correlated to success within the course. Information about online activities and behaviors most closely associated with course success can guide prospective online instructors in planning effective online courses and in making decisions regarding careful monitoring of activities, assessments, and options when working with online students. Characteristics of

online students that factor into their course success included: frequency of online visits, participation in discussion boards, participation in homework assignments, laboratory activities, and online quiz performance. Success in the course served as the dependent variable and was measured using the final course grade for prospective students and unit exam scores for within course variables.

Research Problem

Due to limited research correlating student characteristics with online students' success or failure, there is no accepted way to predict success within the online lab biology for non-majors program at ABCU.

Research Questions

1. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with each of the following demographic variables: GPA, ACT, age, and previous hours of college credit earned?
2. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with student online behaviors: frequency of online visits, completion of discussion board posts, completion of homework assignments, and completion of laboratory activities?
3. Is there a significant difference in final course success as measured by course grades in an online laboratory-based biology course for non-majors between the following groups: Digital Immigrants/Digital Natives, male/female, Native American/Non-Native American, and financial aid qualifiers/non-qualifiers?
4. Which of the following variables predict student success as measured by course grades in an online laboratory-based biology course for non-majors: GPA, ACT,

federal aid status, age, gender, ethnicity, previous hours of college credit earned, frequency of online visits, completion of discussion board posts, completion of homework assignments and completion of laboratory activities?

Research Design

According to Creswell (2008), an explanatory research design is a correlational design in which the researcher is interested in the extent to which two variables (or more) co-vary, that is, where changes in one variable are reflected in changes in the other (Creswell, 2008). The intent of this research was to examine a number of variables and determine if they correlated either positively or negatively with the success of the students enrolled in this course. Additionally, existing group means in the research population were compared to determine if being a member of one group or the other gave students any advantage in success in this program. This is a non-experimental design that treated all participants as one group. Statistical testing was done comparing variables to final course success variables of overall course grade, for final course success, and within course unit grades, for within course success.

The Program

The biology program examined in this study was a non-majors lab-based, online biology course. This four-credit hour course included a lab component that was taught using a fully online format with hands-on labs that could be completed at home using household chemicals and materials. Students who enrolled in this class were attending ABCU (current enrollment 2,500). Primarily, this college functions as a two-year, community college; however, there are three campus programs that do offer Bachelor of Science degrees. The remaining programs are all at the associate degree level.

Non-majors lab biology online curriculum included materials from a text by Sylvia Mader (Mader, 2012). Lecture presentations were posted online using the BOL course platform which is similar in structure to Blackboard or Web CT platforms in use at other universities. In addition to lecture presentations, students were given periodic writing assignments throughout the semester, weekly laboratory assignments and discussion boards which required participation for students to receive full credit for the class. Exams were taken online and students were permitted to use reference materials and textbooks during the timed exams. Exams were not proctored and accounted for roughly 60% of the points in the course. Students participated in a laboratory safety unit during the first week of the semester and were required to submit an online safety quiz with a satisfactory score prior to receiving credit for any laboratory work. Laboratories made up roughly 25% of the course grade. The remaining 15% of the course grade was based on writing assignments and discussion board participation.

At-home laboratory examples included: an acid base lab (using purple cabbage extract), an enzyme lab (using gelatin, fruits and meat tenderizer) and an osmosis lab (using eggs with the shells removed). Additionally, some laboratories were pencil and paper activities involving population biology, genetics, and the scientific method. There were also virtual labs available through the text book web site that had been used in this program previously.

Writing assignments included current topics wherein students were assigned to write brief (two page) papers. Topics were assigned and approximately 2 to 3 writing assignments were completed by students in the course each semester. Topics included acid rain, climate change, China's one-child policy, and species extinction. Grading was

done using a grading rubric which was distributed to students as a part of the original assignment.

Discussion board topics were generally related to materials currently being studied and students were required to make one detailed post and then respond to at least one of their classmates' posts on the discussion board each week. Full points were earned based on one complete post and one post to a classmate. Students were able to post as many times as they would like, however, and often posted in addition to the required posts.

Grades were posted on BOL for students to access throughout the semester. Email updates were frequently sent out regarding upcoming assignments. Additionally, assignments were posted on the integrated calendar within BOL.

The Students

Many of the students could be considered non-traditional since most of the students were older, were often just beginning college, or were returning to school to change careers. Minority students included African American students, Native American students, and a small number of International students. Students in this online biology class were not required to participate on campus and many lived long distances from the campus. Some of the students were enrolled in technical programs at the university and participated in internships out of the area during some semesters; these students take online science classes to meet curricular requirements while they are assigned to internships. Other students were full-time employees who were part-time students completing general education requirements in transfer degree programs such as pre-education and business. Many students had children and other obligations outside of

college. Some students experienced difficulties with online access availability as this is primarily a rural area and the online infrastructure is somewhat limited. The college provides Internet access on-campus for local students, but for those students who live at a distance from the campus, this isn't a practical solution.

In the fall of 2010, the student population at ABCU was 62.1 % male and 37.9% female. The total enrollment was 3,018 with 2,113 of these students attending full-time and a population of 905 part-time students. Students living on-campus comprised 27.13% of the student population. The other 72.7% were commuter students. A large percent of the student body resided in Oklahoma, 92.7%, with only 6.9% from other states within the United States and a mere 0.4% of the students were International students. The student population was 62.7% white, 24.7% Native American, 7.3% black, 1.0% Asian, 2.4% Hispanic and 2.1% unknown ethnicity. Average student age on this campus was 24.41 years; the male average was slightly younger at 23.7 years with the female average being 25.6 years. Married students comprise 14.8% of the current student population and 85.2% were listed as single (archival data from ABCU's web site demographics).

Participants

Participants included all students who completed the non-majors lab biology course online during the Summer and Fall, 2009; Spring, Summer and Fall, 2010; Spring, Summer and Fall 2011; and Spring 2012. The total number of students was 229. Depending on the variables being examined, actual participant number varies slightly as not all pieces of data were available for all participants.

Researcher Background

The choice of this research topic was based on three years of experience teaching this course and over 20 years of experience teaching biology. This research direction was selected following observations made regarding various experiences with student success. For example, one group of students registers for the course and never communicates with the instructor in any way though they complete all assignments and make acceptable grades, often A's and B's in the course. These students seem to follow the syllabus, and independently complete the course. A second group of students seems to need continuous assistance with every step of the course, even though they are working from the same materials as the previously mentioned group. This group often does well in the course. A third group of students has been unsuccessful with completion of materials and generally does poorly in the course. The final group never makes contact, never seems to turn in any materials, but also does not drop the class. These students do not take advantage of evaluation feedback from the teacher and subsequently fail the course. All students receive periodic emails regarding assignments and due dates.

These observations of varying student success led to a curiosity about what differences existed between these groups of students and their varied responses to the course work. Were there ways to predict which students might fall into which groups? Thoughts about these questions informed the proposed design and methodology of this study.

Data Sources and Collection Methods

Data sources included the Student Information System for the ABCU and class records of the online, non-majors, lab-based, biology course accessible to the instructor.

Data was compiled maintaining anonymity for all participants. Extensive efforts were taken to insure no student could be identified based on the data used in this research study.

Data collected within the BOL platform included existing historic data for all students who had completed the online, non-majors lab-based, biology course within the prescribed time period. Data included all grading information for the following categories: discussion boards, homework assignments, laboratories, and exams. Additionally, BOL includes information on the amount of time students spend online, the number of visits they make to each section and topic within the course, and the dates they access information. The final numerical course grade was also obtained via BOL.

Data collected via the ABCU Student Information System (SCT) included student age at the time they took the course, birth year, gender, ethnicity, participation in federal student aid (simply coded as yes or no), enrollment status (full time or part time), the number of college credit hours earned prior to taking the non-majors lab biology online course, cumulative college GPA when the course was taken, and ACT score where available.

Data from BOL and SCT were matched using student identification number then identification numbers were removed and another number assigned.

Data Analysis

Data were collected and compared using scatterplots, t-tests when appropriate; associations between sets of data were calculated using software to determine correlation coefficients. Some correlations were examined in detail; some indicated lines of future research on this topic. In other cases, group means were compared to determine whether

or not significant statistical differences existed. In a few, step-wise correlations were performed to adjust for some variables and examine the effect of others.

Using the SPSS software package, correlation coefficients were calculated between all continuous variables and the final numerical course grade. All data was interpreted using a $p = .05$ confidence level. Additionally, correlation coefficients were calculated on continuous student variables within the course and unit exam scores. For example, correlations were examined between student online visits within units and the subsequent score of the student on the exam testing specifically for that unit. Continuous data sets were examined for correlation within each of the 9 semesters of BIOL 1014 and overall correlations using all participants were also examined. Multiple regression techniques were used to determine predictive value of calculated correlation coefficients where warranted.

Group means were compared using t-tests to determine if they differed significantly. Group comparisons included: Digital Natives and Digital Immigrants; males and females; Native American and Non-Native American students; and those who received financial aid and those who did not. While group sizes were not equal, they did compare favorably with the actual population percentages at ABCU. Additionally, during analyses these differences were addressed by using Levene's Test of Homogeneity.

Some data was converted into coded data to facilitate its use for comparison purposes. For example, grade point averages represent a continuous scale, but ethnicity must be coded via discreet categories. Data analysis procedures took data coding into account. Age was analyzed as both a continuous variable and as a group designation.

The generation born after 1980 has been characterized as Digital Natives (Prensky 2001). Prensky (2001) states, "Our students today are all "native speakers" of the digital language of computers, video games and the Internet" (p. 1). To address this difference in generations of students noted in the literature, age was coded to indicate Digital Natives (born after 1980) and Digital Immigrants (born before 1980). Complete data analysis procedures are outlined in Tables 1 - 4.

Table 1

Data Collection and Analysis Procedures for Research Question 1

Dependent Variable	Independent Variable	Statistical Test
Overall Course Success Ordinal – measured using numerical final course average	GPA Ordinal – actual GPA	Pearson's Product-Moment Correlation Coefficient
Within Course Success Ordinal – measured using numerical unit scores	ACT Ordinal – actual ACT Score	Pearson's Product-Moment Correlation Coefficient
	Age Ordinal – actual age at the time they took the course	Pearson's Product-Moment Correlation Coefficient
	Previous Hours of College Credit Ordinal	Pearson's Product-Moment Correlation Coefficient

Table 2

Data Collection and Analysis Procedures for Research Question 2

Dependent Variable	Independent Variable	Statistical Test
Overall Course Success Ordinal – measured using numerical final course average	Frequency of online visits Ordinal – actual number of visits to online materials	Pearson's Product-Moment Correlation Coefficient
Within Course Success Ordinal – measured using numerical unit scores	Completion of Discussion Board Posts Ordinal Calculated using total number of posts divided by number of required posts	Pearson's Product-Moment Correlation Coefficient
	Completion of Homework Assignments Ordinal – total number of homework assignments completed divided by total number possible	Pearson's Product-Moment Correlation Coefficient
	Completion of Laboratory Activities Ordinal – total number of lab activities completed divided by total number possible	Pearson's Product-Moment Correlation Coefficient

Table 3

Data Collection and Analysis Procedures for Research Question 3

Dependent Variable	Independent Variable	Statistical Test
Overall Course Success Ordinal – measured using numerical final course average Within Course Success Ordinal – measured using numerical unit scores	Digital Native vs Digital Immigrant Dichotomy 0 – Digital Native (born after 1980) 1 – Digital Immigrant (born before 1980) Federal aid status Nominal – dichotomous 0 – did not receive financial aid 1 – received financial aid Gender 0 – Female 1 – Male Ethnicity 0 – Non-Native American 1 – Native American	T-test to compare means

Table 4

Data Collection and Analysis Procedures for Research Question 4

Dependent Variable	Independent Variable	Statistical Test
Overall Course Success Ordinal – measured using numerical final course average Within Course Success Ordinal – measured using numerical unit scores	Variable groupings ACT and Ethnicity ACT and Participation	Stepwise Multiple Regression

There were some inherent methodological limitations to this study. For example, this study was based on one science program at one institution which has been taught exclusively by the author/researcher for the semesters studied. This limits the applicability of any findings and a further, larger study will be needed to confirm any relationships observed. The sample size was somewhat small and some data was not available for all students. For example, transfer students do not have ACT scores available if they transfer in more than a minimum number of hours. ACT correlations were only completed on students who began studies at this institution or who otherwise provided ACT scores.

Summary

There is currently a lack of research correlating student characteristics with students' success or failure in an online biology program at ABCU. Research questions establish the measurable variables to determine their value in predicting student success. Socioeconomic, demographic and online behavioral variables were examined. The research design followed an explanatory design that is correlational. The program was described in detail along with the demographics of the college population and the demographics of the participants in this study. Additionally, data sources were indicated and data analysis procedures were defined.

According to research previously cited, online approaches can be as effective, sometimes even more effective, as face-to-face course offerings. The demand for online course offerings has grown considerably at ABCU during the past few years. In the science area alone, enrollment has increased in online science offerings from approximately 40 students enrolled per semester to nearly 100 students per semester in

the past 3 years. This continues to be a choice students demand, and with more working students and commuters on this campus than ever before, we must meet this demand or student will go elsewhere for their educational choices. Our challenge is to make sure our offerings are high quality and students are advised during the enrollment process adequately to make good choices.

The goal of this research was to add to the body of knowledge currently existing in the area of online science coursework. Specifically, the research intended to address factors that influence success for students taking these courses.

The following chapter will present the results from the statistical analysis of the collected data. Finally, the last chapter will provide an interpretation of those results and make suggestions for further research.

CHAPTER IV

RESULTS

With an increased expectation and demand of online coursework by students, institutions of higher education are finding online courses an important part of their institutional offerings. While researchers have explored a variety of variables that impact student success in traditional, on-campus courses (Cubeta et al., 2000-2001; Hoffman & Lowitzki, 2005; Hoschl & Kozeny, 1997; Kanoy et al., 1989), few research studies have specifically considered the student characteristics that might influence students' success in online, lab-based biology coursework. Specifically, in terms of online science offerings, there is little research to indicate which students are the most successful within online parameters. Research does suggest some variables that can be used to predict success in traditional on-campus students. Variables such as GPA, ACT score, age and others have been extensively examined (Cubeta et al., 2000-2001; Hoffman & Lowitzki, 2005; Hoschl & Kozeny, 1997; Kanoy, Wester, & Lata, 1989). Fewer studies link traits to success in online courses (Limniou & Smith, 2010; Liu & Cavanaugh, 2011). Even fewer studies attempt to link student characteristics to success in online science courses (Johnson, 2002). This study was intended to address the gap in current literature.

The purpose of this quantitative, predictive correlational research was to identify academic and socioeconomic variables that correlated with course success, and then use regression analysis to determine which variables might predict success in an online non-majors, lab-based, biology course. Groups identified within the subject participants were compared to identify any significant differences between the group means. Currently, due to limited research relating student characteristics with online students' success or failure, there is no way to predict success within the online lab biology for non-majors program at ABCU.

In this research, students who had completed the online laboratory-based biology course within the past three years were studied in an effort to determine factors that may have contributed to their success or failure in the course. Both participant demographics and course characteristics were examined. Data was obtained from course data collected within the online classroom and from ABCU's student database. All identifying student characteristics were removed to insure anonymity.

This sample represented an approximation of the demographics of the population of ABCU as depicted in the demographic data comparisons in Table 5. The participant sample contained slightly more Native American students than the ABCU population (35% Native American within the sample to an overall average of 24.7% Native American) and was slightly younger than the ABCU population (24.41 years for participants versus an overall average student age of 27.38 years). Additionally, sample consisted of about half males (51%) and half females (49%) while the overall university population was comprised of nearly two-thirds males (62.1%) and one-third females (37.9%). This difference is due to the nature of the degree programs on ABCU's campus.

While this course appears in the Arts and Sciences Division as a general education course – ABCU offers a large number of technical degree programs (with higher male enrollment) and not all of these programs require students to take a science general education course. This phenomenon guides a higher percentage of females into science courses as compared to the university as a whole.

Sample demographics in comparison to campus demographics can be seen in the Table 5. Notably this sample population also contained more Native American Students and females than the total campus population and the average age of sample population was slightly younger than the ABCU population. Additionally, fewer of the on-campus students (30%) as compared to the sample students (34%) were considered part time students.

Table 5

Demographic Data Comparisons

Statistic	ABCU Student Body	Sample
Gender		
Male	62.1%	51%
Female	37.9%	49%
Ethnicity		
Non-Native American	75.5%	65%
Native American	24.7%	35%
Age	27.38 Years	24.41 Years
Enrollment Status		
Full Time	70%	66%
Part Time	30%	34%

In most calculations for this research, n = 229 except in the tests involving ACT scores. For calculations involving ACT, n = 130. Participants who transfer into the program or who already have multiple hours of college credit earned are not required to

provide ACT scores and do not have them on file. Thus ACT calculations were done on a subset of students within the 229, all of which had provided ACT scores.

Data analysis was performed using SPSS software. For continuous data, two tailed, Pearson's Product-Moment correlation coefficients were calculated. According to Huck (2000), the Pearson's product-moment correlation is designed for situations where each of the two variables is quantitative in nature and each variable is measured so as to produce raw scores. To compare group means, t-tests were performed. To further compare groups, stepwise regressions were used. For the purposes of interpretation of results, p was set equal to .05 in the examination of this data.

Data analysis is presented here in order according to the following research questions:

Research Questions

1. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with each of the following demographic variables: GPA, ACT, age, and previous hours of college credit earned?
2. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with student online behaviors: frequency of online visits, completion of discussion board posts, completion of homework assignments, and completion of laboratory activities?
3. Is there a significant difference in final course success as measured by course grades in an online laboratory-based biology course for non-majors between the following groups: Digital Immigrants/Digital Natives, male/female, Native American/Non-Native American, and financial aid qualifiers/non-qualifiers?

4. Which of the following variables predict student success as measured by course grades in an online laboratory-based biology course for non-majors: GPA, ACT, federal aid status, age, gender, ethnicity, previous hours of college credit earned, frequency of online visits, completion of discussion board posts, completion of homework assignments and completion of laboratory activities?

Collected data was examined with the goal of answering the research questions above. All data is presented organized in terms of the research question it addressed.

Success and Demographics

To answer the first research question regarding student success and demographics, variable factors were analyzed as they might contribute to student success. In this data analysis, the impact of students' GPA, ACT, age, and previous hours of college credit earned was considered.

To examine relationships between GPA, ACT, age, and previous hours of college credit earned with final course grade, two-tailed Pearson's product-moment correlations were calculated. While correlation alone cannot indicate causation, examining correlation in numerous variables can allow for causal models (Shavelson, 1996). The Pearson product-moment correlation coefficient is defined as the covariance of X and Y divided by the product of the standard deviation of X and the standard deviation of Y. Correlation coefficients (r) are a measure of the strength of association between two variables. Additionally, using correlation coefficients the coefficient of determination can be calculated (r^2). This value is a measure of the strength of the relationship between two variables (Shavelson, 1996).

Table 6

Course Success: Pearson's Product Moment Correlations

Measure	Final Grade	Previous Credit	Age	GPA	ACT
	r r^2	*r* r^2	*r* r^2	*r* r^2	*r* r^2
Final Grade	---	.314* .099	.061 .004	.666* .444	.202* .041
Previous Credit		---	.192* .037	.388* .151	-.030 .001
Age			---	.127 .016	-.371* .138
GPA				---	.348* .121
ACT					---

* Correlation is significant at the 0.05 level (2-tailed).

All Pearson's product-moment correlation coefficients are presented in Table 6. In the following sections, each factor will be addressed using these calculated values.

GPA and course success.

Using a 2-tailed Pearson's product-moment correlation, student GPA was found have a significant ($p < .05$) positive correlation with final course grade. This comparison produced an r^2 of .444 suggesting that differences in GPA could be responsible for up to 44.4% of the variance in final grade. This finding indicates that students with higher incoming GPA's (calculated at the time of enrollment) were more successful in the course. It should be noted here that non-traditional students at ABCU often have widely varying hours of college credit on their transcript. This variable was impacted by the varying numbers of previous college credit hours this student sample had earned. This

number ranged from 0 to nearly 200 hours of previous credit. The mean number of previous credit hours earned by participants was 70.69.

ACT and course success.

Using a 2-tailed Pearson's Product-Moment Correlation, student ACT was found to have a significant ($p < .05$) positive correlation with course success. This comparison produced an r^2 of .041 suggesting that differences in ACT could be responsible for up to 4.1% of the variance in final grade. This finding indicates students with higher ACT scores were slightly more successful in the course.

Age and course success.

Using a 2-tailed Pearson's Product-Moment Correlation, student age at the time they took the online biology course was not correlated with course success as measured by the final grade in the course.

Previous hours of credit and course success.

Previous hours of earned college credit were calculated using the number of credit hours students had completed prior to the semester in which they enrolled in the online biology class being studied. All previous hours were included, even those earned at other institutions. Students in the study showed a wide variance in the number of hours they had accumulated prior to taking this course. Completed hours numbers varied from 0 to more than 200 earned hours. Using a 2-Tailed Pearson's Product-Moment Correlation, hours earned were found to have a significant ($p < .05$) positive correlation with the final course grade Additionally, this comparison produced an r^2 of .099 suggesting that 9.9% of the variance in final course grade could be attributed to previous course credit. This

finding suggests students with more previous college credit hours were more successful in this course.

Course Behaviors and Success

As for the second question regarding success and online behaviors, within-course student behaviors were analyzed to determine their correlation with course success. Variables included frequency of online visits and participation in various online activity categories. Success within each course area was calculated by dividing the number of possible discussion board posts, homework assignments and laboratory activities within an area by the number of each activity the participant completed, resulting in continuous scores from 0-1 in each activity for each participant.

Table 7

Frequency of online visits: Pearson's Product Moment Correlations

Measure	U1G	U2G	U3G	U4G	U5G	Final Grade
	r r^2	*r* r^2	*r* r^2	*r* r^2	*r* r^2	*r* r^2
U1P	.013 .000					
U2P		.184* .034				
U3P			.232* .054			
U4P				.243* .059		
U5P					.200* .040	
Total Participation						.184* .034

* Correlation is significant at the 0.05 level (2-tailed).

Frequency of online visits and course success.

The first component of this research question involved the amount of time students spent with course materials as measured by a count of their number of visits to each section of the course. Table 7 summarizes the calculated correlations comparing participation in each section of the course (U1P, U2P, etc.), again, measured by counting visits to that section of the course, and the grade students scored on the exams at the end of each section of the course (U1G, U2G, etc.). Additionally, the total number of course visits was compared with overall course success.

A 2-tailed Pearson's Product-Moment Correlation showed significant positive correlation ($p < .05$) between overall frequency of online visits and overall course success. Additionally, Pearson's product-moment correlation coefficient indicated frequency of online visits had a significant positive correlation in units two through five (all $p < .05$) to within course success as measured by individual unit exam scores. The r^2 values were small, ranging from .034 to .059 suggesting a small (3.4% - 5.9%) but statistically significant impact of participation with course materials on success within individual units and overall success in the course. However, for unit 1 no significant correlation was found between number of online visits and course success.

Course activity participation and course success.

The second component of this research question focused on the individual activities students completed as they progressed through the online course. These included participation in discussion boards, homework assignments completed, and laboratory activities completed. These variables were measured by dividing the number of activities within each category a student completed by the total number of activities in

each category that were required components of the course. Again, two-tailed Pearson's product-moment correlation coefficients are summarized in Table 8 below.

Table 8

Course Activities Completed: Pearson's Product Moment Correlations

Measure	Discussion Board	Homework Assignment	Laboratory Participation
	r r^2	r r^2	r r^2
Final Grade	.480* .230	.787* .619	.919* .845

* Correlation is significant at the 0.05 level (2-tailed).

The 2-tailed Pearson's product-moment correlation indicated each category of activity participation had a significant positive correlation (all $p < .05$) to overall course success. Discussion board participation alone resulted in an r^2 of .230, the lowest coefficient of determination of the three variables. Both homework assignments (r^2 = .619) and laboratory participation (r^2 = .845) showed very strong correlations and high coefficients of determination. Thus, participation in course activities was a strong indicator of course success.

Participatory variables of discussion boards, homework assignments and laboratory assignments were not tracked within the online data program in such a way as to allow correlations to be calculated within course units, so this part of the question could not be answered.

Group Comparisons

To identify significant differences between group affiliation (Digital Immigrants/Digital Natives, males/females, Native Americans/Non-Native Americans, financial aid qualifiers/non-qualifiers) and final course success as measured by course

grades in an online laboratory-based biology course for non-majors, independent sample t-tests were used to compare means.

Several group categories aided comparison of the means. The age of participants was further coded into Digital Natives (born after 1980, n = 153) and Digital Immigrants (born before 1980, n = 76). Gender comparisons included males, (n = 117) and females (n = 115). Ethnicity was coded using Native American (n = 78) and Non-Native American status (n = 148). Finally, financial aid was categorized according to those students who received financial aid (n = 169) and those students who did not receive financial aid (n = 60).

Independent sample t-tests were used to determine if a statistical difference existed between the means of each of the groups compared. Since members of each assigned group were uncorrelated and unpaired samples, the independent samples test was appropriate. Independent samples t-tests are considered appropriate statistical tests for comparing means between groups (Huck, 2000).

Independent sample t-tests involve several assumptions. First, students self-selected into the online Biology program and were not randomly assigned. This introduces the potential for serious violation of independence and increases the chances for a type I error. Additionally, there is the potential for a violation with homogeneity of variances. These error risks were addressed by using Levene's Test of Homogeneity. In the test comparing Digital Natives and Digital Immigrants, Levene's F = 2.158 with a significance of $p = .143$ (which is $p > .05$). Thus, these variances were not found to be statistically different. In the financial aid/non-financial aid test, Levene's F = 1.749 with a significance of $p = .187$, (again $p > .05$), indicating no statistical difference in variances.

For gender, Levene's F = 1.984 with a significance of $p = .160$, ($p > .05$), also indicating no statistical difference in variances.

For Native Americans/Non-Native Americans, however, Levene's F = 39.042, ($p < .001$) indicates a violation in the homogeneity of variance assumption and the correction unequal variances between these groups was employed in SPSS. Although the t-test is robust to violation when samples have equal n, when sample sizes are different, t-tests are sensitive and an adjustment is required. The adjustment utilizes more conservative degrees of freedom in the t-test. It should be noted (n = 226) in the Native American/Non-Native American comparison because 3 students did not self-identify ethnicity in the data system and are omitted from the data analysis for that reason.

Table 9

Differences Between Groups in Course Success

Groups	N	Final Score Mean	Standard Deviation	*t*	df	*p*
Digital Natives	153	72.17	24.18			
Digital Immigrants	76	77.04	22.13	-1.475	227	.142
Female	112	70.98	23.97			
Male	117	76.47	22.99	-1.769	227	.078
Native American	78	61.67	28.31			
Non-Native American	148	80.41	17.63	*5.328	109.311	.000
Rec'd Financial Aid	169	73.60	22.96			
Did Not Rec Financial Aid	60	74.32	25.46	.202	227	.840

* Unequal variances not assumed

Table 9 summarizes the independent sample t-test data collected when comparing each of the assigned groups. Discussion of each examination follows and is presented in the same order as identified the research question regarding group comparisons.

Digital Natives and Digital Immigrants student differences.

Course success did not vary significantly ($p > .05$) between the Digital Natives and Digital Immigrants. Considering that it was possible for students of each group to have had differences in exposure to technology due to differences in socioeconomic status as well, a regression analysis was helpful in estimating if larger differences in means might have been due to socioeconomic status. By using this analysis to remove any differences, a clearer picture of differences due to generation membership became apparent. This additional statistical test, run using federal aid status as a control for socioeconomic status, determined that course success still did not vary significantly ($p > .05$) between these two groups.

Gender differences.

According to the t-test analysis, male and female students' course success did not differ significantly ($p > .05$). The calculated power of this test was .74. This indicates a moderate probability that there were no significant differences between the groups. Even though group sizes were comparable and there were no significant statistical differences observed between the male (76.47) and female (70.98) means, there were practical differences between these means. An effect size was calculated and results determined that 1.4% of the variance in course performance was associated with gender. The ABCU campus actually has a larger percentage of males to females, but due to the nature of this course, residing within the Arts and Sciences division, a larger percentage of female students were included. While in this test no differences were observed between the two groups, males did have an somewhat higher mean (76.47) than females (70.98) which approached statistical significance.

Native American and Non-Native American student differences.

Due to the geographic location of ABCU, the Native American population is higher than many other institutions of similar size. Within this research sample, group sizes for Native American (n = 78, 35%) and Non-Native American (n = 148, 65%) students approximated the same percentages present in the ABCU campus population (24.7% Native American and, 75.5% Non-Native American). A significant difference ($p < .05$) was observed between the final course grades. Native American students (n = 78) had an average final grade of 61.7 and Non-Native American students (n = 148) had an average final grade of 80.4.

Levene's Test for Equality of Variances indicated a significant violation for this group comparison. Therefore, the values used to compare the groups were not assuming equal variances. However, even with the more conservative degrees of freedom the adjustment entails, there was still a significant difference between the groups indicated.

The possibility existed that the Native American and Non-Native American students differed academically prior to beginning this program. Since ACT score is considered by multiple researchers as a valid predictor of academic readiness (Cubeta et al., 2000-2001; Hoffman & Lowitzki, 2005), a regression analysis using ACT scores as a predictive academic variable was examined. This still resulted in a significant difference ($p < .05$) in mean scores and an r^2 value of .073 indicating 7.3% of the variance in the final grade is due only to ethnic group identification (see Table 10).

Financial aid participation and success.

There were no significant statistical differences in course success between students who received financial aid and those who did not ($p > .05$). Financial aid

recipients were identified based on whether the student had participated in any form of aid including student loans. While this was the only practical method given the data available to the researcher, it was not the best indicator. Many students of widely varying socioeconomic backgrounds take advantage of federal student loan programs, so this may not have been a clear indicator of financial need.

Interactions

To answer the fourth question regarding interactions, the researcher hoped multiple regressions could be used to determine which factors contributed most significantly to success within the online biology program. This would have made it possible to identify a definite set of predictors. While some individually strong factors emerged, the high degree of collinearity of the data made step-wise multiple regressions a non-feasible method of examination. There were a couple of areas where regression was used, however, to control for one factor while examining another. This data analysis will be described in Tables 10 and Table 11 summarizing the results of these regressions and further analysis.

Native American and Non-Native American additional differences.

Native American students and Non-Native American students may have differed from each other in academic background prior to participating in this course. Analysis of variance and regression can control for previous academic standing and determine how much, if any, course success can be attributed to ethnicity. In this research, after adjusting for previous academic level using their ACT score, Native American students had a 7.3% variance in course success that could be attributed to their membership in the

Table 10
Summary of Hierarchical Regression Analysis for Variables Predicting Course Performance – ACT Composite and Ethnicity

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
ACT Comp	1.287	.531	.210*	1.153	.514	.188*
Ethnicity				-13.763	4.261	-.271*
R^2		.037			.103	
F for change in R^2		5.873*			10.432*	
R^2 Change		.044			.073	

*ρ < .05

Native American group and was not due to differences in their academic ability prior to beginning the program.

Frequency of online visits and course success – additional differences.

The frequency of students' visits to various areas of the course was strongly correlated with course success and ACT scores were also strongly correlated with course success. It was possible that the students who visited the materials the most often online were the ones with the highest ACT scores. To attempt to answer that question, analysis of variance and regression were used to control for ACT scores and determine how much of the correlation between frequency of online visits and course success was due to the time online.

The results clearly indicated that 89.3% of the variance in course grade was explained by participation regardless of the incoming ACT score. This seems to indicate participation in course materials was strongly related to course success on its own merit.

Table 11

Summary of Hierarchical Regression Analysis for Variables Predicting Course Performance – ACT Composite and Course Participation

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
ACT Comp	1.246	.533	.202*	.660	.141	.107*
Course Participation				22.657	.547	.950*
R^2		.041			.934	
F for change in R^2		5.461*			1717.265*	
R^2 Change		.041			.893	

*$\rho < .05$

Summary

The data collected show a number of positive correlations between demographic variables and course success including GPA, ACT and previous hours of course credit earned. Additionally, positive correlations were found among course behavior variables including frequency of online visits and participation in all categories of course activities. Means were compared between various groups of participants and significant differences were found between the means of Native American and Non-Native American students. Further testing was done on some significant relationships to attempt to hone in on actual variable contribution to course success including an additional analysis of ACT and Native American and Non-Native American status, and ACT and course participation amounts. Both additional tests resulted in showing indicators clearly due to ethnic group and the amount of frequency of online visits respectively.

The following chapter will present an analysis and interpretation of the data collected. Additionally, suggestions for further research will be made.

CHAPTER V

ANALYSIS AND CONCLUSIONS

At ABCU, the demand for online course offerings has grown considerably during the past few years. In the science area alone, online science enrollment over the last three years has increased from approximately 40 students per semester to nearly 100 students per semester. This continues to be a preferred student choice, and with more working students and commuters on this campus than ever before, we must meet this demand or students will choose to go elsewhere. Our challenge is to make sure the offerings at ABCU are of a high quality and students are adequately advised during the enrollment process.

The goal of this research was to add to the body of knowledge currently existing in the area of online science coursework. Specifically, this research intended to identify factors that influence success for students taking these courses. Both student characteristics (GPA and ACT) and course characteristics (frequency of online visits and number of activities completed) were examined and compared to course success as measured by course grades. Additionally, groups of students (males and females, Digital Natives and Digital Immigrants, Native Americans and Non-Native Americans and financial aid recipients and non-recipients) were compared as to their overall success in the course.

This study was undertaken at ABCU, a small, regional community college located in a rural area of a Midwestern state. The researcher has taught this program for the past three and a half years for ABCU. This research sample was chosen due to the availability of the data to the researcher. The convenience sample included students who had completed the non-majors lab biology online course within the past 3 academic years. Available data included student demographics and within course participation data on each student involved. Quantitative methods allowed the researcher to compare demographic data and participation data with student success measures. Table 12 summarizes the sample population and compares the sample population to the entire student body at ABCU.

Table 12

Demographic Data Comparisons

Statistic	ABCU Student Body	Sample
Gender		
Male	62.1%	51%
Female	37.9%	49%
Ethnicity		
Non-Native American	75.5%	65%
Native American	24.7%	35%
Age	27.38 Years	24.41 Years
Enrollment Status		
Full Time	70%	66%
Part Time	30%	34%

By addressing each of the following research questions, it has been the intent of this researcher to shed light on the variables that contribute to online student success in the online, lab-based biology for non-majors course.

Research Questions

1. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with each of the following demographic variables: GPA, ACT, age, and previous hours of college credit earned?
2. How does success as measured by course grades in an online laboratory-based biology course for non-majors correlate with student online behaviors: frequency of online visits, completion of discussion board posts, completion of homework assignments, and completion of laboratory activities?
3. Is there a significant difference in final course success as measured by course grades in an online laboratory-based biology course for non-majors between the following groups: Digital Immigrants/Digital Natives, male/female, Native American/Non-Native American, and financial aid qualifiers/non-qualifiers?
4. Which of the following variables predict student success as measured by course grades in an online laboratory-based biology course for non-majors: GPA, ACT, federal aid status, age, gender, ethnicity, previous hours of college credit earned, frequency of online visits, completion of discussion board posts, completion of homework assignments and completion of laboratory activities?

The framework of interaction theory guided the researcher's selection and analysis of data. Interaction theory suggests there are multiple levels of interaction in any online course including learner-content interaction, learner-instructor interaction, learner-learner interaction, and learner-interface interaction (Moore, 1989). This research would identify those variables correlated to online, lab-based biology course success. The following

discussion presents analysis of the findings and their interpretation, the progression of the analysis follows the order of the research questions.

Success and Demographics

To better understand the relationship between course success and student demographics, various demographic variables (including GPA, ACT score, age, and previous hours of college credit) were examined and their relationship to final course success analyzed using correlation.

GPA and ACT score

Not surprisingly, GPA (r^2=.444) and ACT (r^2=*.041)* scores were found to positively correlate with success within the online program. Numerous researchers have positively correlated GPA and ACT scores to on-campus course success (Cubeta et al., 2000-2001; Hoffman & Lowitzki, 2005; Hoschl & Kozeny, 1997; Kanoy et al., 1989). The study further confirms these traditional predictors of course success do still apply in this online environment. GPA showed a higher correlation than ACT. Though it seems GPA and ACT remain reliable predictors of student success both on-campus and online, they may not always tell the entire story.

Age and course success

Age alone was not correlated with course success. However, the average age of the student population within the sample was slightly younger than the average age of the ABCU student body. This was likely due to enrollment of on-campus students in major fields of study that take the online biology course. Majors who took this course were enrolled in the Arts and Sciences division of the campus. This division contained students who were new to the campus, concurrently enrolled high school students, and

also transfer degree program students who tend to be younger than the total campus population. There were no correlations between students' age and final course success, however.

Recent research indicated older students do better in traditional, on-campus classes (Cubeta et al., 2000-2001). Numerous other researchers have suggested today's students might be more comfortable with online methods due to their experiences with computers (Hoschl & Kozeny, 1997; Sanders & Morrison-Shetlar, 2001; Thompson et al., 2010). Results in this study did not support these conclusions regarding online learners.

Previous hours of credit and course success.

There was a significant, positive correlation between the number of college credit hours previously earned and course success (r^2=.099). The number of earned hours among participants ranged from 0 to over 200 college credit hours. There was, however, no possible distinction made between hours earned previously with ABCU and with other institutions that were transferred into ABCU. Students with the highest number of previously earned credit hours also had the highest final course grades. This could be a reflection of their familiarity with the college system, or even their familiarity with the online system since it was not possible to make a distinction between traditional, on–campus hours and previous online course work. Another study specifically examining a relationship between previous online coursework and success could be very useful in indicating whether online experience improves performance, although conventional wisdom would suggest that would be the case.

Course Behaviors and Success

This research also examined the relationship between within-course behaviors and online-course success. Multiple variables including the frequency of online visits, the number of visits to each unit of the course, and completion of activities within the course including discussion boards, homework assignments and laboratories were examined to determine their relationship to course success.

Frequency of online visits and course success.

Without question, the variable that seemed to have the greatest impact on student success in this online program was frequency of online visits. All students showed a positive correlation between the number of visits they paid to the course and their final course grade. This correlation was also clearly apparent in each individual unit within the course and their unit exam scores except in the case of Unit 1. Generally, those students who visited the material more frequently also scored higher on unit exams and performed better on the course overall. Number of visits to online material appeared to account for 3.4% of the variance in final course grade. Within each of Units 2-5, accounted variances were 3.4%, 5.4%, 5.9% and 4.0% respectively. While these percentages are not high, there was clearly a connection between number of times a student visited material and their success with the material.

The lack of a positive correlation in Unit 1 was probably due to the fact that even students who ultimately did very poorly in the course also visited the materials in Unit 1. This seemed to inflate the activity count for unit 1 as some of those students never visited any subsequent units in the course. Possible reasons students did not continue include deciding the course was "too much work," experiencing life obligations that prevented

them from continuing the course, or coming to understand how much work was involved in an online class.

Course activity participation and course success.

Each examined area of course activity, including discussion board posts (r^2 = .230), homework assignments (r^2 = .619), and laboratories (r^2 = .845) showed positive, significant correlation with course success. This further suggests that involvement with the online materials ultimately led to course success for many students. While it is possible to see that visits to the course materials correlated positively with overall course success as mentioned above, it was not possible from the data available to determine if individual assignments within the course units contributed to or correlated positively with success within each unit. Another study looking at student course data, collected in such a way as to enable sorting of assignments and laboratories according to unit number and allocating scores accordingly, would allow this portion of research question two to be answered, but it was not possible to address it with the data collected for this research study.

All these examined categories involved learner-content interaction. The positive correlation between the number of visits students made to the materials and success in the course (r = .184, r^2 = .034) supports Moore's (1989) position, that learner-content interaction is an important concept of online environments because it changes learners' behavior. The discussion board category particularly aligns with the theory of interaction involving learner-to-learner and learner-to-instructor interaction. Participation in discussion boards correlated positively with success in this online course. This suggests interaction with instructors and other students has a positive impact on ultimate course

success. Additional study analyzing discussion board posts and their quality could help to further define this relationship.

In all categories, the instructor provided individualized feedback to students (learner-instructor interaction). Therefore, the more students participated in course activities the greater the individualized learner-to-instructor interaction. Although all learners were given feedback, even if they did not turn in an assignment, it is possible the non-responsive students were not actually responding to the feedback provided, lessening learner-instructor interaction. A future study could be designed to survey students who had taken the course both successfully and unsuccessfully to determine the impact the instructor feedback may have had.

A number of researchers have documented the value of the levels of interaction to students' ultimate success within online programs (Falloon, 2011; Jung et al., 2002; Keegan, 1988; Moore, 1989; Ross, 1996; Tsui & Ki, 1996). This suggests the level of interaction between learners and content, with other learners and with the instructor should be carefully monitored in the online environment as it has such a large impact on student success. Clearly, in this study, those students who performed better in the course were those same students who interacted the most with the online content as measured by their number of visits to the course materials.

Group Comparisons

Several group means were compared to determine if there were significant differences between the groups in terms of course success. Groups analyzed included Digital Natives and Digital Immigrants; males and females; Native Americans and Non-Native Americans; and financial aid participants and non-participants in financial aid.

Digital Natives and Digital Immigrants and success.

Age categories of digital immigrants (born before 1980) and digital natives (born after 1980) were used and there was no significant difference between the two groups. Again, after adjusting for socioeconomic status, there was no significant difference between the two groups. This seems to indicate something other than age was ultimately involved in course success or failure. These findings were also counter-intuitive to others' studies suggesting younger students (Digital Natives) would more successful with online course technology due to their extensive experience with computers and virtual environments (Hoschl & Kozeny, 1997; Sanders & Morrison-Shetlar, 2001; Thompson et al., 2010). These results suggest that experience with technology, as measured by the number of visits these students made to the course materials online, can help one to overcome any potential age barriers. An area of possible future research would be to analyze how course success correlates with the number of online courses students have successfully completed. One might hypothesize students who have completed more online courses would have more experience with the technology and therefore would perform better than those who had completed fewer online courses. The question that cannot be answered from this data is whether it was the previous course experience in general or specific previous course experience with *online* courses that added to the students' course success.

Gender and differences.

Gender-related school science performance has been studied extensively. Studies from the 1990's by Boaler suggested minimal differences exist between males and females in science achievement. These studies drew on data from over 100 countries and

involved 3 million subjects. Authors argued any differences observed between males and females in science were too small to be meaningful and also suggested differences have been overplayed in the media to suggest greater differences in innate ability than actually exist (Boaler, 2006). Research on males' and females' math and science ability currently indicates that, while women may process and reason differently, they have equal innate abilities when compared to men (Spelke, 2005). In some cases, women have demonstrated greater ability to understand certain concepts than men. As Spelke further indicated, women and men use different strategies to solve problems.

While previous studies have indicated female students have more interest in and can be more successful in an online environment (Sanders et al., 2001), this study determined no significant differences between male and female course success. Importantly, however, the differences between the male and female means did approach significance ($\rho = .078$). The mean value of the males was observably higher than the mean values for the females. Further study might clarify these observed differences in online course success. A study involving gender differences in online classes in other disciplines could also provide useful data. The lack of a clearly statistically significant difference between these two groups suggests some traditionally held views on science instruction might not apply in the online educational environment. These views could be clarified with additional study of a variety of science courses taught by different instructors. Instructor differences could impact student involvement and all levels of interaction. Additionally, it would be helpful to look at online students in disciplines outside of science, such as mathematics or language.

Native American and Non-Native American differences.

While the population in this study had limited cultural diversity, there were a large number of Native American students. This led the researcher to examining ethnic differences by comparing the mean values of the Native American (n = 78) and the Non-Native American (n = 148) students.

Native American students are particularly underrepresented among those earning college degrees in this country (Benjamin, Chambers, & Reiterman, 1993; Guillory & Wolverton, 2008; Tinto, 1993). Recent data show Native American students made up less than 1% of all students enrolled in college as recently as 2002 (U.S. Department of Education, as cited in the Chronicle of Higher Education Almanac, 2005-2006). There is ample research to suggest Native American students are struggling to attain academic degrees and persist within academic arenas. Research indicates estimates of college attrition rates for Native American students range from 75 to 93 percent (Brown & Robinson-Kurpius, 1997).

In this study, Native American students' course success differed significantly from Non-Native American students. After adjusting for initial academic ability by factoring in the ACT scores of the students, 7.3% of Native American students' overall course success could still be attributed to their status as Native Americans. This seems to indicate inherent differences between Native American and Non-Native American students' online course experience that needs to be addressed in future research. Guillory and Wolverton (2008) found financial support and academic program availability were the main factors that led to persistence among this population. Major barriers to their success included inadequate financial resources and lack of academic preparation.

Further research into the backgrounds of this particular group could result in valuable information.

Financial aid participation and course success.

Liu and Cavanaugh (2011) had noted a negative correlation between socioeconomic status as measured by participation in federal free-lunch programs and course success among younger students who were in first year high school biology but showed no correlation in older students who were in second semester high school biology. This trend was supported in this research as no correlation was found for socioeconomic status as measured by participation in federal financial aid programs and course success.

Interactions

To answer the fourth research question, the researcher had hoped that multiple regression analyses could be used to determine which of the factors examined contributed most significantly to success within the online biology program. This would have made identification of a definite set of predictors possible. While there were strong factors, the high degree of collinearity of the data made using multiple regressions a non-feasible method of examination. Regression was used, however, to control for one factor while examining another. This data analysis will be described below.

Native American and Non-Native American success – further analysis.

The possibility existed that the differences observed between Native American and Non-Native American students were due to differences in their initial academic backgrounds. Because of this possibility, ACT scores were used to control for previous academic ability when examining the effect of ethnicity on course grade success. Even

after statistically adjusting for ACT scores, ethnic background still accounted for 7.3% of variance in final course grade ($p < .05$).

Numerous researchers have examined Native American students' challenges with respect to higher education (Brown & Robinson-Kurpius, 1997; Guillory & Wolverton, 2008). A study designed to look specifically at Native American students and online instruction methodologies would be useful to add to this existing data. This is particularly true in the case of colleges like ABCU, where a large percentage of the student population consists of Native American students. While outside the scope of this study, it would be useful to determine the quality and availability of access to technology for these students and also to evaluate their academic support system.

Course participation – further analysis.

The students with the highest initial academic preparedness could also have been the students who were making the most visits to the online materials. To try to account for this possibility, ACT scores were also used to control for previous academic ability when examining course participation. After adjusting for ACT scores, participation explains an additional 89% of variance in course grade ($p < .05$). Course participation had the largest impact on course success in the online environment. This underscores the importance of instructor/course design that leads to as much interaction and participation on the part of the student as possible.

Limitations

There were a number of limitations to this study. The sample size for all analyses was small (total enrollment in nine semesters of the course, n = 229). Additionally, all students took the same course from the same instructor. These factors limit

generalizability for any data collected and analyzed in this study. However, these factors insure a similar course experience for each of the participants. Unfortunately, ACT scores were not available for all students, thus limiting its use as a predictor variable by limiting sample size further.

Socioeconomic status was estimated using the determination of federal financial aid status. This was an imprecise way to estimate status as many students of varying actual financial status participated in federal student loan programs. Distinguishing between those students and students who participated in exclusively need-based programs relying on the data that was available for this study was not possible.

Estimates of student access to technology used in dividing students into the digital native and digital immigrant groupings could have been invalid due to the location in which this study took place. This region could be considered as socioeconomically disadvantaged which may limit students' access to technology and thus may inhibit the online success of the majority of these students. With regard to population demographics, this study involved students attending a small, rural community college and it would not be appropriate to assume data collected here would be similar in a larger, more urban environment.

Conclusion and Additional Recommendations for Research

Seemingly, the variable which had the most impact on the online, lab-based biology for non-majors course success was course participation. The importance of course participation cannot be overstated for the students in this program. Students of similar academic background when they began the program (as measured using ACT scores) performed differently in the program depending on their level of participation.

Those who had the highest number of visits to the course materials performed the best. This has implications for the design of future online courses. This finding can positively influence student advisement about enrolling in online courses as well as in the development of online courses. Another study using a larger sample size and courses taught by multiple instructors in a variety of content areas would help to determine if course participation is a constant variable across different online instruction styles and content.

Another factor of interest is the difference in course success between the Native American and Non-Native American students enrolled in program. There seems a strong indication that Native American students are uniquely struggling with the course material or online format. Further study analyzing other variables, such as family dynamics, cultural differences, first generation college student status, access to technology, academic support systems, and other possible variables might be helpful in recognizing and defining the struggles of this group.

Digital Immigrant and Digital Native status did not impact student success according to this study. Considering previous literature cited and current popular press articles about this generation, this is somewhat surprising. Factors other than age and digital generation status are better predictors of online success. Again, a new study that looked more critically at age and success is indicated by this data, particularly a study that considered the specific socioeconomic and cultural characteristics of this geographic region.

Prediction, as defined in this study, was divided into two categories: predicting success prior to student enrollment and predicting success within the course after student

enrollment. Looking at ACT (r = .202, r^2 = .041) and GPA (r = .666, r^2 = .444) as a way to predict success for online students, as these two factors were significantly correlated with success (ACT, 4.1% of the variance in final course grade, GPA, 44.4% of the variance in final course grade) within the program. Additionally, student experience as measured by the number of credit hours students had completed prior to taking this course could be a variable of interest to examine as a predictor in future research. This information could be used to provide a template for enrollment advisors to use when considering whether or not a student would be a good candidate for an online course. The interactions of these predictors are not clearly explained by this study and further study is needed to tease out the individual roles ACT, GPA and previously earned college hours have on online success.

An analysis of the previously earned coursework to determine if any of the courses were online in nature could allow a clearer interpretation of the value of previously earned credit hours. Distinguishing between general previous college experience and specific previous online course experience, could lead to a more definitive understanding of the previously earned credit hour variable.

Completion of course activities including discussion boards (r^2 = .230), homework assignments (r^2 = .619) and laboratory activities (r^2 = .845) showed strong correlations and significant predictive levels. This indicates the importance of course design requiring student participation and involvement in all of the levels of interaction: learner-content (course visits, completion of assignment categories), learner-learner (discussion board participation), and learner-instructor (feedback and interaction from all levels of participation). Increasing interaction in each of these areas can lead to more

success among students. This also opens up the possibility of dialog between enrollment and advisement and potential students regarding the importance of engaging with online materials during the course.

Implications for future research include examining factors affecting Native American student success in more detail. A larger sample size that involves courses taught by other instructors for variables such as course participation could help validate the reliability of this factor as a success predictor. Additionally, designing a study using socioeconomic status as a more reliable predictor would help to refine differences that may have been due to variables that were undetectable based on the data used in this study. A study designed to look at the effects of faculty staff development training on student online success would alert faculty to the characteristics of students. Faculty need to be made aware of the importance of their involvement with online course materials and the students to insure student success. Finally, a study examining the positively correlated demographic variables in more detail with a larger sample could help refine suggestions for advisement for students who are considering taking online courses.

Summary

In conclusion, multiple factors were examined to determine their contribution to the success of students enrolled in an online, lab-based college biology program for non-majors. Several factors were found to correlate positively with success in the course including GPA, ACT score, number of previous college credit hours earned, amount of time spent with online materials, and the level of participation within the course in various activity categories. Also, group means were compared and a significant difference was found between Native American and Non-Native American students in

online course performance. No significant differences in means were found for Digital Natives (born after 1980) and Digital Immigrants (born before 1980); male and female students; and student who participated in financial aid and those that did not.

Upon further examination, differences between Native American students and Non-Native American students were found to persist even when adjusting for previous academic level of the student. Also frequency of online visits was shown to be strongly positively correlated with course success even when taking into account students' initial academic ability using ACT score.

This information can be used to better prepare students to make educated choices regarding enrollment in online versus on-campus courses. College enrollment advisors and instructors can rely on traditional characteristics such as GPA and ACT and additionally advise students of the importance of online course involvement to help better prepare them for the realities of online course work.

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