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Students' Assessment of Biology Education at Marshall University

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**Students' Assessment of Biology Education
at Marshall University**

**Thesis submitted to
The Graduate College of
Marshall University**

**In partial fulfillment of the
Requirements for the degree of
Master of Science
Department of Biological Sciences**

by

Chris A. Barker

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Marshall University

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ABSTRACT

Students' Assessment of Biology Education at Marshall University

**by
Chris A. Barker**

The purpose of this thesis research was to evaluate the quality of scientific education offered in the College of Science's Department of Biology at Marshall University. The objectives of this study were to emphasize the important aspects of higher education assessment, point out that a scientifically literate citizenry is imperative for society to function effectively, and to determine what factors contribute to differences among students with regard to their perception of the quality of scientific education they are receiving at Marshall. A survey questionnaire was administered to students in eleven biological science courses during the Fall semester of 2003 and the Spring semester of 2004. These courses spanned the biology curriculum and included the participation of freshman, sophomore, junior, senior, and graduate students. An outcome of the assessment revealed that completing or currently being enrolled in all three designated core courses (BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and BCS 324 Principles of Genetics) results in students rating the quality of scientific education they are receiving significantly higher than students who have not taken all three core courses. By including a selected complement of controls embedded within the administered assessment tool, completing or being enrolled in all three core courses was the only variable that was statistically significant and positively affected the students' perceptions of the quality of scientific education.

DEDICATION

To my parents,
they have given me the
prospect in life to attend
college and attain my aspirations

ACKNOWLEDGEMENTS

Thanks to the professors who allowed me to administer the survey to their classes so I could obtain the information needed for my thesis project.

I would also like to thank the students for their participation in the assessment.

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TABLE OF CONTENTS

Abstract	iii
Dedication	iv
Acknowledgements	v
Table of Contents	vi
List of Figures	vii
List of Tables	viii
Introduction & Review of Literature	1
Chapter 1 Student Assessment	1
Chapter 2 The Curriculum in Question.....	8
Chapter 3 Survey Methods & Measurement Approaches	11
Text of Investigation	14
Chapter 4 Assessment of Marshall University’s Department of Biological Sciences.....	14
Chapter 5 Materials and Methods.....	19
Chapter 6 Assessment Results	24
Chapter 7 Summary and Conclusions	38
Chapter 8 Recommendations	42
Literature Cited	45
Appendix	47

LIST OF FIGURES

Figure 1. Assessment Survey Questionnaire..... 47

Figure 2. Pie Chart..... 49

LIST OF TABLES

Table 1. List of Variables.....	24
Table 1A. Defining Variables.....	25
Table 2. Descriptive Statistics.....	26
Table 3. Science Principle Component Loadings.....	28
Table 4. Academic Principle Component Loadings.....	29
Table 5. Practical Principle Component Loadings.....	30
Table 6. Random Coefficient Regression Results.....	35
Table 6A. Variance/Covariance Parameters.....	35
Table 7. Random Coefficient Regression Results.....	36
Table 7A. Variance/Covariance Parameters.....	37

INTRODUCTION
Chapter 1
Student Assessment

Over the past decade, colleges and universities in the United States have come under increasing pressure from government officials, policymakers, administrators, and other authority figures. These people of authority assert that educational performance, at all levels, is not meeting nationally established minimum standards they have set for students. The National Center for Public Policy in Higher Education issued a 50-state report card in the Fall of 2002 titled “Measuring Up 2002”. This resulted in The National Center for Public Policy in Higher Education assigning a grade of “Incomplete” to all fifty states in collegiate student learning for the second time since the year 2000 (Ewell, 2003).

The general public, students, and parents of college students are demanding to know whether college and university systems are bringing forth a high quality student collegiate experience and producing first-rate college graduates. The questions of how much students are learning, improving, and intellectually growing have been gaining much momentum. This ever-increasing movement has led to institutions of higher education trying to demonstrate their accountability, effectiveness, and efficiency. As a result, many colleges and universities must embrace some form of an evaluation tool for students’ perceptions, outcomes, and performance in quantifiable, measurable terms (Cheng, 2001).

Dramatic changes in politics, the economy, technological advances, and society as a whole have impacted the state of education and how we perceive its

effectiveness or judge its shortcomings. These changes have led to teaching institutions, industries, and even the military to closely examine the capability and productivity that the role of higher education is playing on our future leaders and citizens. Congress is currently holding hearings on higher education's accountability and student performance. In Washington D.C., the Bush administration has made the evaluation of collegiate learning a prominent public policy issue. The Bush administration has intentions for improving educational performance and is planning a re-authorization of the Higher Education Act. This national "movement" has prompted college and university administrators and faculty to take on board the practice of assessment (Ewell, 2003).

Assessment is a "complex, systematic procedure for collecting and interpreting data". Assessment is the primary instrument for delivering feedback to students, professors, administrators, parents, and others in the learning community. Educational researchers, practitioners, and academic policymakers make use of the information to evaluate the impact a college or university is having on their students, in hopes of institutional improvement (Krueger *et al.*, 2001).

In a perfect world, an institution of higher education is supposed to move through a series of systematic steps including setting program goals and objectives, to assessing whether those goals and objectives are ultimately being met, to finally making adjustments or improvements to the program if deemed necessary. However, in the real world, institutions of higher education typically encounter many obstacles. These obstacles, for example, include limited

amount of time and money allotted to the assessment and evaluation process. More importantly, many colleges and universities have difficulty constructing a valid and reliable instrument that measures exactly what the goals or objectives of the college or university are trying to achieve (Cheng, 2001).

Thus, for the reasons stated above, many higher education institutions adopt external commercial survey instruments. External commercial survey instruments for assessment are, by and large, considered to be well tested and reliable. On the other hand, external commercial survey instruments are usually not unique to a particular academic institution or environment (Cheng, 2001).

So the question remains, what constitutes a useful, worthwhile assessment? First and foremost, an assessment project must produce relevant data and information about the issues facing an educational institution of today. Secondly, an assessment project must provide information about the students' ever-changing perceptions, competencies, and developments. Thirdly, the assessment project must present the information of a particular institution's student demographics and educational experiences. Lastly, the results of the assessment must be analyzed and presented in a method that will be utilized effectively by the particular college or university (Jacobi *et al.*, 1987).

Administrators, as well as people outside of higher education, tend to consider student performance indicators that are easily gathered, quantified, and appear objective. Some examples of these student performance indicators adopted by colleges and universities when performing an assessment include standardized test scores, grade point averages, college retention, and graduation

rates. Although these student performance indicators certainly measure various aspects of an institution's successfulness, they are unable to thoroughly provide significant information on the students' perceptions, attitudes, and personal development of their educational experience (Cheng, 2001).

Educational researchers and practitioners, to a large extent, disagree on what should or should not be included when evaluating students' perceptions of goals and skills gained throughout their collegiate experience. Many experts believe that these categories of measurement rely too heavily on subjective reporting. They feel that students' perceptions of collegiate experience are subjective in that they merely reflect the opinions of the students' feelings and are influenced by their emotions. The College Student Experience Questionnaire (CSEQ) and the College Student Survey are the most widely used assessment instruments that include these subjective items of student self-reported gains during college. The results of assessment research which uses these student self-reported gains in college are generally consistent with results of research which use objective categories of measurement (Cheng, 2001). According to the Association for the Study of Higher Education (ASHE), the fundamental aspect of selecting an appropriate assessment instrument is one which allows the researchers and practitioners to simply select categories or items of greatest importance that the college or university deems necessary to measure (Jacobi *et al.*, 1987).

So, colleges and universities must settle on what measures will work, and perhaps more importantly, how closely the selected measures are associated

with what students are learning and experiencing. Today, with the assessment frenzy in full swing, institutions of higher education may scramble to find and simply decide that almost any measure will do (Shavelson *et al.*, 2003). By doing so, however, the goals of students are being frequently overlooked. Understanding the educational goals and perceptions of college students is important to ensure a successful assessment project. There may be differences in what college faculty think that students should know and why they are taking a set of courses, as opposed to what students expect from classes and what they think they should know and achieve. Evaluators must learn to keep in mind the goals of the college or university that are established for the students, while considering the educational goals that the students set for themselves (Stark *et al.*, 1989).

The goals of the students are what they hope to accomplish and achieve during their collegiate experience. Many students attend college to increase their chances of finding employment, to get a better job, or to make more money. Numerous students seek training that is relevant to a specific career by acquiring the necessary skills in college. Other students attend college to prepare for additional educational opportunities such as graduate school, medical school, or other professional schools. Some students attend colleges or universities to gain a general education, to simply learn things that interest them, to make them a more cultured person, and to develop an understanding and appreciation of human diversity (Higher Education Research Institute, 2003). Hence, student outcomes such as satisfaction with academic courses, self-views of knowledge

and skills learned through coursework, and their future ambitions are valid educational goals that should be used when performing an assessment (Stark *et al.*, 1989).

College students of today have a broad range of goals for attending college, and narrower goals for what they expect from particular courses. In order to attain the full range of student goals, an ideal assessment should include such items concerning broad educational goals, educational expectancies, self-evaluation, and specific goals for individual course work. Also, many researchers believe that the assessment project might be measured more effectively at a particular program of study and course level, where the student is associated with their everyday educational environment (Stark *et al.*, 1989).

With the students' concerns kept in mind, there must also be careful consideration of the institution's goals, objectives, and expectations. Colleges and universities vary greatly in this respect. Many institutions of higher education hold that problem solving skills and an individual's thinking ability are absolutely essential for students to acquire from their collegiate experience. Other institutions have high regard for top-notch writing and speaking abilities for their students. Some colleges and universities place high technology skills as being most essential for their graduates (Shavelson *et al.*, 2003).

Higher education faculty differ with regard to what they consider should be measured in order to indicate student success and what outcomes they wish to bring about from their students. Higher education faculty may place emphasis on high grades, success on professional exams and standardized tests, job

placement of their students, or graduate and professional school acceptance of their students (Shavelson *et al.*, 2003).

An assessment project should also be based on the philosophy of the institution's and particular program of study's mission statement, with the results of the assessment project reflecting aspects of whether the mission statement is indeed effectively being met (Jacobi *et al.*, 1987). The fact that institutions of higher education are electing to adopt varying mission statements and differing philosophies of their students' learning goals, is giving way to a wide range of educational environments with a diverse curricula (Shavelson *et al.*, 2003).

Chapter 2 The Curriculum in Question

An institution's curriculum is the centerpiece for educating its students. The curriculum reflects the college's or university's educational disposition. An institution's curriculum represents the very essence of what the college or university faculty and administrators reason education is for. Higher education curricula are not only linked to an institution's overall philosophy for education, but to other, particular academic disciplines. Curriculum scholars and evaluators are becoming increasingly concerned with curriculum issues in the physical and biological sciences (Beyer *et al.*, 1996).

Much attention is being focused on biological science education because it is believed by government officials, industrial leaders, and people that hold positions of authority, that many people do not possess a thorough understanding of basic biological concepts (Siebert *et al.*, 2001). In today's society, people need a detailed understanding of many biological principles and concepts to identify with key issues facing them. This ultimately impacts many people's ability to make critical decisions that affect themselves, as well as others, in everyday life. Some examples of decisions that many people must make include decisions about healthcare and medicine, the well-being of others, the environment, work and industry, scientific advances and discoveries, school board decisions, and many political decisions (Cummings, 2002). At the very least, or perhaps more on a philosophical note, many people are unable to

appreciate the intricate wonders of our bodies, plants, animals, and our planet, without science education (Siebert *et al.*, 2001).

The important undertaking of transforming biological science education to achieve a scientific literate citizenry that understands the biological processes that characterize our world is essential for society to function effectively today and in the future. Our economy and productivity is becoming more and more based on biological and technological advances that stress the importance of science education (Siebert *et al.*, 2001).

Presidents and governors continue to set national education goals for science because of the importance of developing and sustaining economic growth in the United States. The American Association for the Advancement of Science (AAAS) published a study that encouraged the idea that all students should be expected to learn biological science. This has led to various movements such as the National Science Teachers Association (NSTA) working on curriculum reform in order to build a coherent understanding of the sciences. The National Research Council (NRC) of the National Academy of Sciences has begun to implement what is known as the national standards for science education. This committee, composed of teachers, administrators, and scientists, focuses their efforts on the content of science, the teaching of science, and the assessment of science. Thousands of teachers on all levels contributed to this project. Reportedly, *The National Science Education Standards* is the most contiguous document the United States has ever come to having a complete, national vision for biological science education (Siebert *et al.*, 2001).

Research from the Third International Mathematics and Science Study (TIMSS) has shown that most science curricula are lacking coherence and focus. According to the *National Science Education Standards*, a well-defined curriculum is one in which students learn more sophisticated scientific ideas as they continue their educational experience. The skills and knowledge gained in coursework should be learned in a logical progression (Krueger *et al.*, 2001). A successful assessment project could allow institutions of higher education to align such a curriculum. Through student assessment, biological science departments of colleges and universities can evaluate their courses and content of instruction in order to develop a coherent, conceptual framework for educating their students.

Chapter 3

Survey Methods & Measurement Approaches

Once an institution of higher education has conceptualized an assessment project, with careful consideration of what objectives and goals are to be measured, the college or university must decide on the best way to collect and gather the information. There are numerous procedures an institution may use to obtain the desired information. The most commonly used technique is collectively called the survey method (Anderson *et al.*, 1975).

The survey method of collecting information may involve the use of interviews or questionnaires. Some institutions may elect to interview a sample of the students or, if feasible, all of the students. An advantage of the interviewing process is that it may allow greater flexibility of the types of questions asked and information obtained. However, this survey method is extensively time consuming and may be subject to interviewer bias. In some circumstances, an interviewer may misinterpret the responses from the students, thus lessening the validity of the assessment. Therefore, institutions must conduct the interview with well-trained interviewers, which may not be readily available (Anderson *et al.*, 1975).

Many institutions elect to use the method of administering questionnaires to students. G. Stanley Hall developed the use of questionnaires in educational research. The use of questionnaires as a means of collecting information for an assessment project has many advantages. Generally, questionnaires are cheaper and easier to administer as compared to interviews. Questionnaires

typically maintain anonymity, which many researchers consider will promote greater honesty than an interview. Questionnaires can be quickly administered to a large, assembled group of students, such as during class. Questionnaires allow the students to self-report on questions concerning their personal background, knowledge, attitudes, perceptions, and opinions. Questionnaires can also be considered somewhat standardized, given that all the students are typically given the same set of printed questions to respond to. These advantages have led to the widespread use of questionnaires pertaining to educational assessment (Anderson *et al.*, 1975).

In many circumstances where the students are asked to self-report on their educational and collegiate experiences, measures are typically based upon ratings. Ratings are considered subjective assessments that are made from an established scale. A student assessment rating scale is typically comprised of various categories in which students evaluate their performance or perception on competency items. In order for the student assessment rating scale to be effective, students as well as faculty should participate in its design. This will ensure certain ambiguities will be avoided (Anderson *et al.*, 1975).

Sound conclusions from an assessment project about a college's or university's effectiveness must be drawn upon by well-founded results. The quality of techniques and instruments utilized such as the questionnaires and rating scales must prove to be valid. A valid assessment plan will ensure that the evaluators can be confident that their particular study adequately measures what it purports to measure. The validity of the evaluators' inferences will allow

administrators and faculty to determine whether a desired educational outcome was achieved, or perhaps how much of it was achieved (Anderson *et al.*, 1975).

TEXT of INVESTIGATION
Chapter 4
Assessment of Marshall University's
Department of Biological Sciences

As the need for research in college or university assessment continues to grow, it is inevitable that institutions of higher education are going to have to account for their programs of study, or curricula, effectiveness. Since there have been dramatic changes in how our society lives, works, and learns, biological science has become increasingly important. Science education allows students and citizens to solve personal, social, and economic problems of today and for tomorrow. The primary goal of science education is to prepare our future citizens for knowledgeable, informed decision making (Krueger *et al.*, 2001). Thus, for the aforementioned reasons, this project aims to assess the effectiveness of the Marshall University College of Science (MUCOS) program of Biological Sciences and the impact it is having on the students.

The institution studied, Marshall University (MU), is located in Huntington, West Virginia. MU is one of two West Virginia state universities. Marshall is known as a Primary Undergraduate Institute (PUI). MU currently has an enrollment of over 16,000 students and more than 600 full-time faculty. MU offers many undergraduate degrees in various areas such as liberal arts, healthcare and nursing, journalism, biology, chemistry, math, education, business, fine arts and humanities. MU also offers many graduate programs of study (Marshall University, 2003).

MU adheres to five general statements of purpose. The mission of MU is to have their college graduates (1) think logically and critically; (2) communicate

ideas effectively through speaking and writing; (3) evaluate other influences that shape our society; (4) understand various qualities of cultures; and (5) solve problems by appropriate methods (Marshall University, 2003).

MU also sustains seven statements of philosophy. MU is committed to (1) undergraduate education; (2) enhancing graduate education; (3) expanding knowledge and achievement through research; (4) society; (5) the diversity of students and faculty; (6) academic freedom and shared governance; and (7) the curriculum (Marshall University, 2003).

The MUCOS was established in 1976. The Biological Sciences is one of three divisions of the MUCOS. The other two divisions are the Division of Physical Sciences and the Division of Mathematics and Applied Science. The Department of Biological Sciences is one of six departments among the MUCOS. The other departments are Chemistry, Geology, Mathematics, Physics, and Physical Sciences. The mission statement for the Department of Biological Sciences emphasizes critical thinking and problem solving skills in order to prepare students for wide ranging careers in the biological sciences. The department is also committed to enhancing science literacy for majors, as well as non-majors, so students will be able to make well-equipped decisions for today and the future (Marshall University, 2003).

At the time of this research, the Department of Biological Sciences was in the process of adopting a revised mission statement. As of March 2004, the mission statement states "The Department of Biological Sciences at Marshall University offers state-of-the-art classroom instruction and independent research

experiences emphasizing critical thinking, problem solving, analytical skills, technology, and lifelong learning. Our department is committed to the preparation of both science and non-science majors for a wide range of careers in medicine, industry and government, with the primary goal of producing students adaptable to the changes and challenges of the future (Marshall University, March 2004).”

In order to attain a baccalaureate degree in the biological sciences from MU, students must meet many requirements. Students must have a cumulative grade point average of 2.0 or higher on all credit hours attempted at Marshall. Students must also have a grade point average of at least 2.0 in the biological science courses taken. Students must complete a minimum of 128 semester hours to be considered a candidate for graduation. Of those 128 semester hours, forty-eight hours must be earned at the 300 level or above. Forty credit hours are allotted to the biological science courses. Students are also required to earn at least twelve credit hours in a minor field of study. Of those twelve credit hours, only three credit hours are to be allotted at the 100 level courses (Marshall University, 2003).

Biology majors must complete many courses in other areas that support the College of Science degree requirements. Biology majors must complete nineteen credit hours in Chemistry, eight hours in Physics, and five to eight hours in Mathematics. Senior students are also required to complete a two credit hour capstone experience. During the capstone experience, students may elect to perform an independent study research project under the supervision of a faculty

member or complete an internship or community-based project (Marshall University, 2003).

Another requirement for the Biology undergraduates is the successful completion of two prerequisite courses and three core courses in biology. The prerequisite courses include Biological Sciences (BSC) 120 Principles of Biology and BSC 121 Principles of Biology. The three core courses include BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and BSC 324 Principles of Genetics. The non-majors courses BSC 104 Introduction to Biology and BSC 105 Introduction to Biology may be substituted for BSC 120 and BSC 121 if a student earns a grade of “A” or “B” and declares a biology major afterwards (Marshall University, 2003).

Marshall University is currently accredited by the North Central Association of Colleges and Schools. Higher education institutional accreditation is a voluntary process. Accreditation assures the general public and prospective students that an institution meets many requirements set forth by the accrediting agency. This provides assurance of educational quality and institutional integrity. The North Central Association is recognized by the United States Department of Education. North Central Association of Colleges and Schools accredits degree granting institutions of higher education in nineteen regional states, including West Virginia. North Central Association was founded in 1895 and is still committed to the improvement of education through evaluation (North Central Association official website, March 2004).

North Central Association's evaluation and accreditation process is carried out by several groups. These include more than 900 educators throughout the North Central geographic region that serve as Consultant-Evaluators (C-E's). C-E's conduct site visits to the educational institutions. An Accreditation Review Council (ARC) of sixty members participates in North Central Association's review process as readers and committee reviewers. The Institutional Actions Council (IAC) consists of twenty-six members who review evaluations referred by the ACR to make accrediting decisions (North Central Association official website, March 2004).

An institution who is currently accredited by the North Central Association Higher Learning Commission must adhere to many General Institutional Requirements (GIR). These include a formally adopted mission statement, a governing board, faculty that has earned degrees appropriate to the level of instruction offered at a particular institution, and that the institution confers degrees (North Central Association official website, March 2004).

An institution must also meet and satisfy Criteria for Accreditation. This is granted if an institution shows that it is accomplishing its educational purposes and can continue to accomplish its purposes and strengthen its educational effectiveness. An institution must also demonstrate integrity in its educational practices and relationships (North Central Association official website, March 2004).

Chapter 5

Materials & Methods

In order to assess whether the MU Biological Science department is effective at meeting the needs of the students and the expectations of the mission statements and the university's philosophy, an assessment project was initiated. The assessment project was conceptualized according to what overall skills the university and biology department is committed to educating to its students. The assessment project was also based upon the scientific and biological aspects of certain knowledge that a student is expected to attain. The assessment effort furthermore included the demographics of the students and opinions of what they believed were important for their general collegiate experience.

The use of a questionnaire was selected as the best means to attain the necessary information from the students. The questionnaire was designed by the researchers, which provided an opportunity for other faculty members to be involved in a collaborative effort. This ensured that aspects pertaining to biological concepts and general education skills were accurately reflected on the questionnaire. A standardized assessment instrument was not chosen because circumstances arose in which particular items of standardized instruments did not accurately reflect goals and philosophies of the university and biological science department. For examples, the standardized assessment instruments were typically time consuming and contained many items not pertinent to our research.

The questionnaire included a total of thirty-seven items (see Figure 1 pp. 47-48). Questionnaire items one through eleven pertained to the demographics of the students. These items included (1) sex; (2) major; (3) class status; (4) ethnicity; (5) parents approximat annual income; (6) parents education level; (7) approximat high school grade point average (GPA); (8) ACT score; (9) SAT score; (10) GRE score; and (11) current college GPA. The next seven items determined what biological science prerequisite courses and core courses the students had completed or were currently enrolled in. These included (1) BSC 104 Introduction to Biology; (2) BSC 105 Introduction to Biology; (3) BSC 120 Principles of Biology; (4) BSC 121 Principles of Biology; (5) BSC 320 Principles of Ecology; (6) BSC 322 Principles of Cell Biology; and (7) BSC 324 Principles of Genetics.

The final nineteen items assessed the general education skills attained by the students, the biological science knowledge gained by the students, and the practicality of their coursework. These questionnaire items were designed using a scale. The scale allowed the students to self-report on their general education skills, their scientific education, and the practical aspects of their collegiate experience. The scale consisted of five Likert items, commonly used in research of this kind (Pedhazur *et al.*, 1991). The general academic education skills' and biological science knowledge items' scale was constructed using the following Likert items (A) much stronger; (B) somewhat stronger; (C) a little stronger; (D) no change; and (E) diminished. The practicality scale used the following Likert

items (A) most important; (B) somewhat important; (C) a little important; (D) doesn't matter; and (E) least important.

The questionnaire was administered to currently enrolled students of eleven undergraduate and graduate biological science courses (see Figure 2). The undergraduate courses included (1) BSC 121 Principles of Biology, (2) BSC 302 General Bacteriology, (3) BSC 320 Principles of Ecology, (4) BSC 322 Principles of Cell Biology, (5) BSC 324 Principles of Genetics, (6) BSC 445 Microbial Ecology, (7) BSC 450 Molecular Biology, and (8) BSC 480 Genes and Development. The graduate courses included (9) BSC 545 Microbial Ecology, (10) BSC 550 Molecular Biology, and (11) BSC 580 Genes and Development.

The questionnaire was given to students in a paper/pencil format at the beginning of each of these classes during the Spring Semester of 2004, with one exception. A section of BSC 322 was conducted during the Fall Semester of 2003. The students typically finished the questionnaire within five minutes. The questionnaires were then collected and the students' responses were then entered into a computer using the Windows version of the statistical software package Statistical Package for the Social Sciences (SPSS). SPSS was developed in the late 1960's by political scientist Norman Nie (Harvard-MIT website, March 2004). SPSS is widely available and allows researchers to perform a broad range of statistical procedures including means, standard deviations, t-tests, analysis of variance, correlation, and multiple regression analysis (SPSS official website, December 2003).

The students' responses to the demographic information were entered as they appeared on the questionnaire with the exceptions of sex, major, class status, ethnicity, and parents' education level. For statistical purposes, sex was entered as a "1" for male and a "0" for female. The students' major was entered as a "1" for Biology, "2" for Chemistry, "3" for Math, "4" for non-science, and "5" for undecided. The students' class status was entered as a "1" for freshman, "2" for sophomore, "3" for junior, "4" for senior, and "5" for graduate student. One high school student was enrolled in BSC 121; this was designated as a "0". The students' ethnicity was entered as a "0" for white or a "1" for other. The students' parents' education level was entered as a "1" for high school, "2" for Associate degree or some college, "3" for Bachelor degree, "4" for Master degree, and "5" for beyond a Master's degree.

The section of the questionnaire pertaining to the biological science courses were entered as a "1" if the students had completed the course or were currently enrolled in the course. Courses not taken by a student were entered as a "0".

The final nineteen items containing the Likert items were also entered as a numeral corresponding to which item the student selected (see Figure 1 pp. 47-48). A value of "5" was assigned to the response of "much stronger"; a "4" was assigned to the response of "somewhat stronger"; a "3" was assigned to the response of "a little stronger"; a "2" was assigned to the response of "no change"; and a "1" was assigned to the response of "diminished". For the practicality of the students' coursework section, a similar scale was also assigned. A value of

“5” was assigned to the response of “most important”; a “4” was assigned to the response of “somewhat important”; a “3” was assigned to the response of “a little important”; a “2” was assigned to the response of “doesn’t matter”; and a “1” was assigned to the response of “least important”.

Chapter 6 Assessment Results

SAMPLE SIZE

The assessment survey's total sample size included the participation of 255 students. However, due to attrition or missing data on sixteen questionnaires, the sample size used for the statistical analysis of the assessment project totaled 239 students.

VARIABLES

Variable definitions and coding schemes are reported in Tables 1 and 1A.

**TABLE 1
LIST OF VARIABLES – SCIENCE EDUCATION**

CORE1	One 300 Level Core Course Currently Enrolled or Completed
CORE2	Two 300 Level Core Courses Currently Enrolled or Completed
CORE3	All Three 300 Level Core Courses Currently Enrolled or Completed
STATUS	Standing, from Freshman to Graduate
PATTERN1	Course Taking Pattern BSC 104 & 105
PATTERN2	Course Taking Pattern BSC 120 & 121
ACADEMIC	General Academic Education
SCIENCE	Scientific Education
PRACTICL	Practical Education
SEX	Gender
ETHNIC	Ethnicity
PARSED	Parents' Education Level
MUGPA	Current College GPA

**TABLE 1A
DEFINING VARIABLES – SCIENCE EDUCATION**

CORE1	Coded 1 if the sum of BSC 320, 322, & 324 equaled 1 and 0 otherwise
CORE2	Coded 2 if the sum of BSC 320, 322, & 324 equaled 2 and 0 otherwise
CORE3	Coded 3 if the sum of BSC 320, 322, & 324 equaled 3 and 0 otherwise
STATUS	Coded 0 for High School Through 5 for Graduate
PATTERN1	Coded 1 for Completed and 0 if not Taken
PATTERN2	Coded 1 for Completed/Enrolled and 0 if not Taken
ACADEMIC	Sum of Items for General Academic Education
SCIENCE	Sum of Items for Scientific Education
PRACTICL	Sum of Items for Practical Education Expectations
SEX	Coded 1 for Male and 0 for Female
ETHNIC	Coded 0 for White and 1 Otherwise
PARSED	Coded 1 for High School Through 5 for Beyond Master
MUGPA	4.0 scale rounded to nearest hundredths

Descriptive statistics are reported in Table 2. The mean, or average, and the standard deviation of the set of variables are reported. The composite variable SCIENCE could have a maximum value of 25, if a student reported that their scientific knowledge was much stronger as a result of taking courses. SCIENCE could have a minimum value of 5, if a student reported that their scientific knowledge had diminished as a result of taking courses. The mean for the composite variable SCIENCE was 19.67 and typically varied by 3.51 points. Items used in constructing SCIENCE are reported in Table 3, along with principal component loadings corresponding to each.

**TABLE 2
DESCRIPTIVE STATISTICS**

VARIABLES	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION
CORE1	.00	1.00	.17	.38
CORE2	.00	1.00	.23	.42
CORE3	.00	1.00	.27	.45
STATUS	.00	5.00	2.95	1.27
PATTERN1	.00	1.00	.11	.31
PATTERN2	.00	1.00	.79	.40
ACADEMIC	12.00	30.00	23.16	4.21
SCIENCE	10.00	25.00	19.67	3.51
PRACTICL	3.00	15.00	11.99	2.24
SEX	.00	1.00	.41	.49
ETHNIC	.00	1.00	.09	.29
PARSED	1.00	5.00	2.78	1.36
MUGPA	2.10	4.00	3.40	.42

N = 239

The composite variable ACADEMIC could have a maximum value of 30 if the student reported that their general academic education skills were much stronger as a result of taking courses. ACADEMIC could have a minimum value of 6, if the student reported that their general academic education skills had diminished as a result of taking courses. The mean for the composite variable ACADEMIC was 23.16 and typically varied by 4.21 points (see Table 2). Items used in constructing ACADEMIC are reported in Table 4, along with principal component loadings corresponding to each.

The composite variable PRACTICL could have a maximum value of 15, if the student reported that certain aspects of their collegiate experience were most important. PRACTICL could have a minimum value of 3, if the student reported that certain aspects of their collegiate experience were least important. The mean for the composite variable PRACTICL was 11.99 and typically varied by 2.24 points (see Table 2). Items used in constructing PRACTICL are reported in Table 5, along with principal component loadings corresponding to each.

The average MUGPA for the students was 3.40 and typically varied by .42 points (see Table 2). The average class status for the students was 2.95, or nearly a junior standing. The average students' parents' education level was 2.78 which is nearly equivalent to a Bachelor's degree.

Tables 3 through 5 include principal components results and Cronbach 's Alpha values for the composite variables SCIENCE, ACADEMIC, and PRACTICL.

TABLE 3
SCIENCE: PRINCIPAL COMPONENT LOADINGS

SCIENTIFIC METHOD	.703
CELLULAR	.823
MOLECULAR	.783
WHOLE	.788
ECOLOGY	.710

Variance Explained = 58.2%

Cronbach's Alpha = .82

N = 239

The composite variable SCIENCE incorporated survey questionnaire items that pertained to the students' scientific education. These items correspond to questions 26 through 30 on the survey questionnaire. Collectively, these items reflect scientific knowledge gained through taking the biological science core courses. These areas of scientific knowledge included the students' understanding of the scientific method, cellular, genetic, molecular, ecological, and whole organism aspects of biology.

The composite variable ACADEMIC, incorporated survey questionnaire items pertaining to the students' general academic education.

TABLE 4
GENERAL ACADEMIC EDUCATION: PRINCIPAL COMPONENT LOADINGS

PROBSOLV	.842
WRITE	.643
CRITHINK	.870
SYNTH	.867
COMPLEX	.742
SOCIETY	.676

Variance Explained = 60.7%

Cronbach's Alpha = .86

N = 239

These items correspond to questions 19 through 25 on the survey questionnaire. Collectively, these items reflect general academic skills attained by students during their collegiate experience. These areas included problem solving, writing, and critical thinking skills, the ability to synthesize information and plan complex projects, and understanding the role science has in society.

The composite variable PRACTICL incorporated survey questionnaire items that pertained to the practical aspects of the students' collegiate experience.

TABLE 5
PRACTICAL EDUCATION: PRINCIPAL COMPONENT LOADINGS

BROAD	.754
THINK	.828
RELWORLD	.840

Variance Explained = 65.4%

Cronbach's Alpha = .73

N = 239

These items correspond to questions 35 through 37 on the survey questionnaire. Collectively, these items reflect the students' aspirations for attending college. These areas included such things as acquiring a broad educational background in the biological sciences, enhancing critical thinking skills, and understanding the relevance or practical value of biology coursework to real world issues.

The composite variables were defined according to three criteria: face validity, principal component configurations, and Alpha values. The face validity criterion, means simply, that the survey questionnaire items constituting the composite variables made sense. The items were intuitively appealing and consistent with everyday knowledge for participants in an academic setting. A principle component analysis was performed to further ensure the validity of the composite variables. The principal components configuration specifies that all

variables used in constructing the composite loaded on the same principal component, and that all loadings were greater than the conventional cutoff value of .300. Finally, the Cronbach's alpha criterion requires that all alpha values be at least .700, meaning that no more than thirty percent of the variability in a composite is due to random error.

All other variables are coded as reported in Tables 1 and 1A. The dependent variable is SCIENCE, a measure of the degree to which students favorably evaluate the quality of the scientific education they are receiving at Marshall University. The independent variable of primary interest is CORE3, the variable which identifies students who have taken or are enrolled in three core courses of the biology curriculum which include BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and 324 Principles of Genetics.

SUBSTANTIVE RESEARCH QUESTION

When this research effort was conceived, we asked one basic question: what factors contribute to determining differences among students with regard to their judgment of the quality of the scientific education they receive as biology majors? This question was embodied in the items included on the questionnaire designed for data collection (see Figure 1 pp. 47-48). After data had been collected, preliminary analyses were performed, and the research question became more specific and concrete: ***does completion of all three core courses in the biology program improve students' evaluation of the quality of scientific education they receive at Marshall University?*** (Core courses

are BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and BSC 324 Principles of Genetics.)

STATISTICAL HYPOTHESES

Since the question is framed in a way which enables us to answer it as “improvement, yes or no”, the null hypothesis is that there has been no improvement in the students’ evaluation of the quality of scientific education they are receiving at Marshall University.

The null hypothesis is a basis for statistical comparison. We are asking if the relationship between CORE3 and SCIENCE is readily attributable to random error, or if it actually reflects a non-zero relationship in the population of interest. In this instance, the alternative hypothesis is that the relationship is really different from zero. Using null hypotheses and alternative hypotheses in this way is conventional in applications of multiple regression analysis (Schroeder *et al.*, 1986).

DECISIONMAKING

If the unstandardized regression coefficient corresponding to CORE3 is ***statistically significant and positive***, we will tentatively conclude that completion or enrollment in all three core courses, BSC 320, 322, and 324, in the biology program at Marshall University improves students’ assessment of the quality of scientific education offered at the university. Any other outcome will result in failure to reject the null hypothesis of no improvement.

REGRESSION RESULTS

Data were collected from students enrolled in eleven undergraduate and graduate biology courses (see Figure 2 p. 49). The possibility of contaminating group effects poses a threat to the accuracy of our regression coefficient estimates and the validity of our tests of significance. This occurs because participation in the same section of the same class over the course of a semester may give rise to within group commonality among students. Students within the same group may be more alike with regard to extraneous contaminating variables than students between groups. This gives rise to intra-class correlation, which artificially deflates standard errors of regression coefficients, increases the probability that null hypotheses will be erroneously rejected, and inflates R^2 values (Schroeder *et al.*, 1986).

As a result, random coefficient regression was used, along with restricted maximum likelihood estimators, as an alternative to usual ordinary least squares estimators. This accommodates troublesome intra-class correlation and contributes to assuring the accuracy of our coefficient estimates and the validity of our tests of significance.

All independent variables in Table 6, except CORE1, CORE2, and CORE3, serve primarily as controls. This is consistent with the fact that one of the primary virtues of multiple regression analysis is that each independent variable simultaneously serves as a control for all other independent variables (Schroeder *et al.*, 1986). For example, CORE3 might be confounded with STATUS, simply meaning that students who have been at Marshall longer are

more likely to have completed all three core courses. An association between CORE3 and the dependent variable SCIENCE, therefore, might be due to the fact that CORE3 is associated with STATUS. To guard against making erroneous inferences due to the uncontrolled influence of STATUS, this variable is introduced as an additional independent variable.

CORE1 and CORE2 are reference variables. Along with the suppressed category which contains students who took none of the core courses, CORE1 and CORE2 facilitate interpretation of the coefficient corresponding to CORE3 by enabling us to say the following: when compared to those who have taken none of the core courses, how much is the SCIENCE score increasing by taking one, two, or all three of the core courses. The answer is given, of course, with our complement of control variables in place.

TABLE 6
SCIENTIFIC EDUCATION AS DEPENDENT VARIABLE
RANDOM COEFFICIENT REGRESSION RESULTS

Variable	Estimate	Std. Error	t	Sig.
Intercept	6.79	2.11	3.23	.001
CORE1	-.57	.68	-.83	.394
CORE2	.51	.69	.75	.504
CORE3	1.12	.65	1.81	.039
STATUS	-.04	.21	-.20	.84
PATTERN1	.07	.61	.12	.892
PATTERN2	-.31	.4756274	-.59	.577
ACADEMIC	.44	.05	8.67	.000
PRACTICL	.13	.09	1.41	.161
SEX	.09	.38	.24	.814
ETHNIC	.64	.6	.93	.353
PARSED	.044	.14	.32	.750
MUGPA	.28	.46	.60	.540

$$R^2_L = 13.8\%$$

$$ICC = 0.112$$

Bold-Faced Coefficients Statistically Significant, $p < .05$, One-Tailed Test

TABLE 6A
SCIENTIFIC EDUCATION AS DEPENDENT VARIABLE
VARIANCE/COVARIANCE PARAMETERS

PARAMETER	ESTIMATE	STD. ERROR	WALD Z	SIG. LEVEL
CORE1	.4620502	1.1670094	.396	.692
CORE2	.7252023	1.4130675	.507	.612
CORE3	.1183650	.4723814	.251	.802

Table 6 shows us that the unstandardized regression coefficient corresponding to CORE3 is statistically significant and positive. In this instance, completing or being enrolled in all three core courses of BSC 320, 322, and 324, results in an increase of 1.12 points in the composite dependent variable,

SCIENCE. In other words, with a judiciously selected complement of controls in place, students who have completed or are enrolled in all three core courses score, on the average, 1.12 points higher on the SCIENCE rating scale than students who have taken none of the courses. The only other variable with a statistically significant coefficient is the ACADEMIC composite variable.

By way of further clarifying our results, in Table 7 we have combined CORE1, CORE2, and CORE3 into one variable, TOTCORE, which takes three values, from one to three. In this instance, instead of using three categorical independent variables, we use one variable. This means that the variables can take on values 0, 1, 2, or 3, but no other values.

TABLE 7
SCIENTIFIC EDUCATION AS DEPENDENT VARIABLE
RANDOM COEFFICIENT REGRESSION RESULTS

Variable	Estimate	Std. Error	t	Sig.
Intercept	6.82	2.10	3.25	.001
TOTCORE	.48	.19	2.43	.011
STATUS	-.13	.20	-.64	.528
PATTERN1	.03	.61	.05	.964
PATTERN2	-.33	.52	-.63	.538
ACADEMIC	.44	.05	8.67	.000
PRACTICL	.14	.09	1.50	.130
SEX	.11	.38	.29	.774
ETHNIC	.63	.68	.92	.357
PARSED	.06	.14	.44	.661
MUGPA	.22	.46	.48	.630

$$R^2_L = 13.7\%$$

$$ICC = 0.112$$

Bold-Faced Coefficients Statistically Significant, $p < .05$, One-Tailed Test

TABLE 7A
SCIENTIFIC EDUCATION AS DEPENDENT VARIABLE
VARIANCE/COVARIANCE PARAMETERS

PARAMETER	ESTIMATE	STD. ERROR	WALD Z	SIG. LEVEL
TOTCORE	.057935	.0770719	.752	.452

As with Table 6, Table 7 shows us that the more core biological science courses a student has completed, the higher his or her score on the SCIENCE composite scale. Construing the independent variable in this way indicates that each course completed, yields, on the average, a 0.48 point increase on the SCIENCE composite scale.

Our analysis does not enable us to distinguish among specific courses, BSC 320, BSC 322, and BSC324, with regard to their independent effects on SCIENCE. Instead, we are proceeding as if the effect of course taking is cumulative, without regard to the order in which courses are taken.

Chapter 7

Summary and Conclusions

The assessment project of the currently enrolled students of Marshall's Biology Department indicates that the students' are self reporting significant gains of the quality of scientific education they are receiving at Marshall.

Students who have completed or are enrolled in the core courses of BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and BSC 324 Principles of Genetics, do, indeed, have a more favorable assessment of the quality of the scientific education they have received at Marshall.

The results of the assessment project reflect that the mission statement for the Department of Biological Sciences is being supported by the students' responses, and thus, the faculty's teaching effort (see pp. 15-16). The students self reported significant gains in critical thinking and problem solving skills, and in increased understanding of the scientific method, cellular, molecular, genetic, ecological, and whole organism biological aspects. These aspects reflect knowledge acquired by students who are enrolled or have taken the core courses in the biology curriculum.

By controlling for various factors such as students' class status, gender, ethnicity, current grade point average, and parents' education level, the only thing that makes a significant difference in the students' perception of the quality of scientific education are the variables CORE3 and TOTCORE. Students' class status, gender, ethnicity, current grade point average, and parents' education level has no significant affect on how the students favorably evaluate the quality of science education at Marshall. Simply put, the three core courses of BSC 320,

322, and 324 are what is influencing or making a significant difference in the students' assessment of their scientific education. The assessment results also significantly demonstrate that the more core biology courses students have completed, the more the students favorably evaluate the quality of science education.

The assessment results also uphold the general statements of purpose found in the Marshall University mission statement (see pp. 14-15). Students' self reported gains pertaining to the composite variable ACADEMIC indicate that the goals of the MU mission statement are being maintained. Students reported significant gains in problem solving skills, critical thinking skills, writing skills, public speaking skills, expanding their ability to execute complex projects, and understanding the role science plays in shaping our society.

Students are benefiting from and appreciating their scientific education more through advanced biological coursework. This reiterates the statistical significance of the combination of CORE1, CORE2, and CORE3 into one independent variable TOTCORE. On the average, students who are enrolled or have completed all three, three hundred level core biology courses rated the quality of the scientific education they are receiving 0.48 points higher on the composite SCIENCE scale.

Ultimately, the null hypothesis was rejected since the variables CORE3 and TOTCORE were **statistically significant and positive** with p-values of .039 and .011 respectively. The independent variables CORE3 and TOTCORE significantly impacted the composite dependent variable SCIENCE. On the

average, students rated the quality of the scientific education they are receiving from the biology department at MU 1.12 points higher if they were exposed to BSC 320 Principles of Ecology, BSC 322 Principles of Cell Biology, and BSC 324 Principles of Genetics.

We might have constructed a variable called MAJOR, which would have enabled us to assess the effect of different majors, biology and others, on our dependent variable SCIENCE. However, since 85 percent of all respondents were biology majors, MAJOR would have been a variable which exhibited very little variability.

One may also take notice of the average grade point average for the currently enrolled students. As reported in Table 2 (see p. 26), the grade point average for the students falls between 2.92 and 3.82 with the mean average grade point average of 3.40. This may be considered somewhat high for a particular college or university department or program of study. However, Marshall's College of Science has somewhat higher admission criteria compared to the general admissions of the university. The College of Science requires a minimum mathematics score of 21 on the American College Test (ACT) and a minimum composite score of 21 on the ACT, instead of a composite score of 19 for general admission to the university (Marshall University, 2003). Thus, one can conclude that the higher ACT scores are a good predictor for academic performance in college (Bray *et al.*, 1987). This is reflected in the decision to not include composite ACT score in our analyses since it is closely associated with GPA.

Another finding that is intriguing was that parents' educational level was not significant and did not influence the dependent variable SCIENCE. Parents' educational background has been shown to be a predictor of student's academic success at the college level. As shown in Table 2 (see p. 26), the students' parents' education level ranged from 1.42 to 4.14. In other words, the parents' educational level was just beyond the high school level up to the equivalent of a master's degree. The average parents' educational level reported was 2.78 or nearly a bachelor's degree. The data reveals that the students are attaining academic success regardless of their family's educational background. I feel that the faculty can take pride in this finding, knowing that their efforts are having a positive affect on the students.

Chapter 8 Recommendations

The results of this research project revealed many positive outcomes for the Department of Biological Sciences. Faculty members of the Biology Department seem to be very committed to improving the quality of education that their students are receiving at Marshall. By the ongoing assessment that Marshall's Biology Department is currently conducting to continue accomplishing their missions and to maintain accreditation, an aspect that is being questioned is the current biology curriculum.

The current biology curriculum consists of two pre-requisite courses for three core courses, and many elective courses which satisfy the different areas of study the students elect to pursue. The elective courses are in the current areas of botany, environmental biology, microbiology, physiology, molecular biology and zoology (Marshall University, 2003).

This research project revealed that the three core courses have a significant effect on how students assess the quality of education they are receiving at Marshall. The results of this assessment project reflect that students indeed benefit from taking the same core courses. The core curriculum is designed to promote a more coherent set of learning goals (Ratcliff, 1992). The Department of Biological Sciences can benefit from this finding by maintaining these core classes as part of the curriculum. Students, who have taken these core classes, in their opinion, are rating their biological and general education skills significantly higher than those students who have not taken the core classes.

Perhaps, one may consider that the core classes be taken before any of the other elective classes. For the most part, students can currently take any elective with the only requirement of having successfully completed the two pre-requisite courses. Many students can benefit from taking the core classes early in their collegiate years at the sophomore or early junior level, rather than waiting until their late junior and senior years. Since students are rating their biological concepts and general academic skills significantly higher when they have taken the core classes, this reflects that the students are learning the necessary skills to become comfortable at attempting advanced coursework.

This research project may be continued in various ways. If the faculty finds it necessary to implement other classes into the core curriculum, perhaps the questionnaire may be utilized in a way as to further evaluate the educational experiences of the students who take such a class. For example, at the present time, BSC 302 General Bacteriology is being considered for implementation as a core class required for all Biology majors. The survey questionnaire was administered to BSC 302 General Bacteriology during this research project. However, with only nineteen BSC 302 student questionnaires collected, further administration of the questionnaire to students who take BSC 302 is necessary in order to obtain a larger sample size for analyses to be carried out.

Another consideration for the continuation of this research project may be to assess the changes and improvement of the students' rating of biology education from when they first entered Marshall and again upon graduation. An assessment of this type may help substantiate the findings of this research and

help identify other trends in how students rate their collegiate experience over time. For example, an assessment project conducted in such a way may help identify certain points during a student's collegiate years that the perceptions of their educational experiences change. This may help the faculty identify key times when academic advising can be most beneficial for the students. If a student is unsatisfied or is performing poorly academically, effective advising of the right courses and when they should be taken may improve the students' academic performance and satisfaction with their experiences in the Biology Department.

I believe that this research project proved to be worthwhile and will benefit the faculty and prospective students. Perhaps at the very least, this research effort may stimulate more ideas and raise more questions about the current state of education, biology, and how we as students and educators can continue to evaluate and improve our collegiate experience.

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**Assessment Survey
2004 Questionnaire**

Directions: Please answer all of the following questions.

1. Sex (male or female) _____
2. Major (Biology, Chemistry, Math, Non-science, or Undecided) _____
3. Class status (freshman, sophomore, junior, senior, or graduate) _____
4. Ethnicity (Asian, Black, Hispanic, White, or Other) _____
5. Parents approximat annual income \$ _____
6. Parents highest educational level (High School, Associate, Bachelor, Master, Beyond Master) _____
7. Your approximat high school GPA _____
8. ACT composite score (N/A for not applicable) _____
9. SAT composite score (N/A for not applicable) _____
10. General GRE composite score (N/A for not applicable) _____
11. Your current college GPA _____

Directions: Please check the following courses you have taken or are currently taking.

1. BSC 104 (Intro) _____
2. BSC 105 (Intro) _____
3. BSC 120 (Principles) _____
4. BSC 121 (Principles) _____
5. BSC 320 (Ecology) _____
6. BSC 322 (Cell) _____
7. BSC 324 (Genetics) _____

Directions : Please indicate one response for each question.

Compared with when you first entered college, how would you now describe your:

1. Problem solving skills
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
2. Writing skills
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
3. Public speaking skills
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
4. Critical thinking skills
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
5. Ability to synthesise/integrate ideas/information
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished

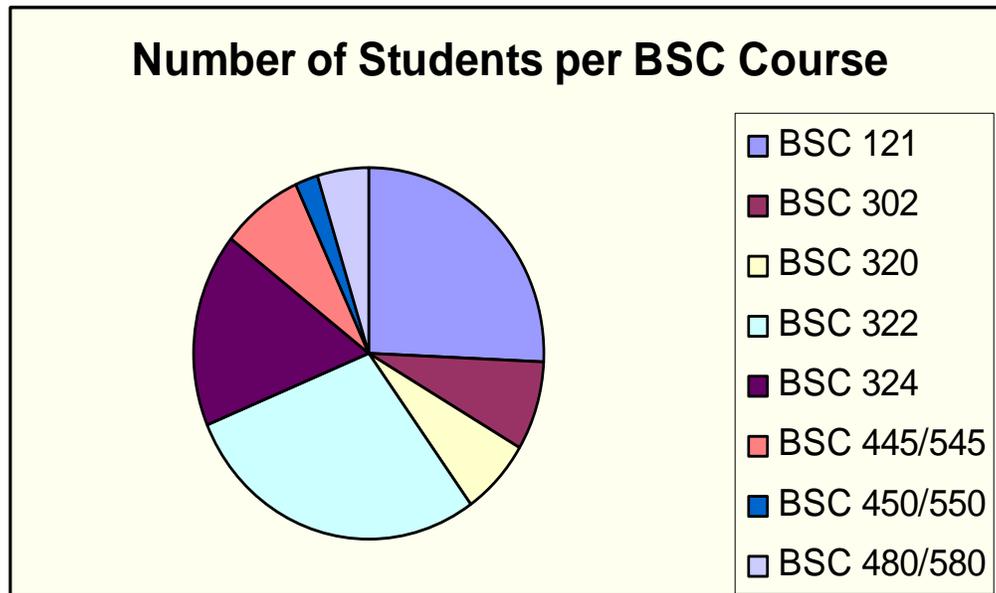
6. Ability to plan/execute complex projects
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
7. Understanding of the role science has in society
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
8. Understanding the application of scientific method
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
9. Understanding cellular aspects of biology
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
10. Understanding molecular/genetic aspects of biology
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
11. Understanding "whole organism" aspects of biology
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
12. Understanding ecological aspects of biology
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
13. Confidence in the ability to meet the demands of a biological related job
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished
14. Overall satisfaction with biology courses enhancing your college experience
(A) much stronger (B) somewhat stronger (C) a little stronger (D) no change (E) diminished

Directions: Please rate the following as to what is important for your college experience.

15. Acquiring knowledge/skills for a specific job/employment
(A) most important (B) somewhat important (C) a little important (D) doesn't matter (E) least important
16. Preparing for professional exams (GRE, MCAT, ect.)
(A) most important (B) somewhat important (C) a little important (D) doesn't matter (E) least important
17. Acquiring a broad educational background in the biological sciences
(A) most important (B) somewhat important (C) a little important (D) doesn't matter (E) least important
18. Enhancing critical thinking skills
(A) most important (B) somewhat important (C) a little important (D) doesn't matter (E) least important
19. Understanding the relevance or practical value of biology coursework to real world issues
(A) most important (B) somewhat important (C) a little important (D) doesn't matter (E) least important

Thank you for your time regarding this matter.

FIGURE 2



BSC 121 Principles of Biology	66 students
BSC 302 General Bacteriology	19 students
BSC 320 Principles of Ecology	17 students
BSC 322 Principles of Cell Biology	73 students
BSC 324 Principles of Genetics	43 students
BSC 445/545 Microbial Ecology	19 students
BSC 450/550 Molecular Biology	6 students
BSC 480/580 Genes & Development	<u>12 students</u>
	255