Institutional Effectiveness Report

Department of Biology

Academic Year 2014-2015

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Chair and Professor of Biology

I. Mission

The Department of Biology supports the mission of the Francis Marion University (FMU) in the following areas:

1) To provide all baccalaureate degree students with proficiency in the use of scientific methods in a particular discipline, including the ability to understand the core concepts and the expertise to apply the core methodologies of that discipline.

2) To offer programs of study that encourage students to think critically and creatively and to acquire the ability to access information.

3) To emphasize an individualized approach to education through personalized attention to academic advising and career development and to develop skills for more advanced study in professional or graduate schools.

4) To provide a learning-centered environment.

5) To support scholarly pursuits by students and faculty and promote academic development and intellectual stimulation.

6) To render academic assistance to regional schools and other organizations and build a more culturally enriched region.

7) To engage in continuous evaluation of all its activities in order to improve quality and efficiency and to place the highest priority on excellence in teaching and learning.

II. Learning Outcomes - General Education (Science-Related):

A. Learning Outcomes

There are three learning outcomes of general education that are science-related:

1. The student will have an understanding of the natural world.
2. The student will be able to think critically and to apply scientific principles to reach conclusions.
3. The student will be able to use technology.

The Department of Biology offers two courses that non-majors may take to complete science-related requirements of general education at FMU (Biology 103 and 104). To assess student success in meeting the science-related learning outcomes listed above, a course-specific cumulative quiz (multiple choice format) was given at the end of the Spring semester 2015 in Biology 104. The table below lists the quiz questions that apply to each learning outcome and summarizes the results for each learning outcome.

In addition to the cumulative quiz questions, student use of technology (LO 3) is incorporated into the required laboratory portions of the non-majors courses. All students gather data and use technology and instrumentation in a variety of laboratory exercises in these courses. For example, students use scientific instrumentation to gather data and do statistical testing, use spreadsheets, and create graphs to evaluate the data collected. The process of gathering the necessary data for each laboratory exercise requires accuracy in taking measurements and using the technology and instrumentation correctly. In addition to data collection required all laboratories, specific instrumentation is used in 30% (3/9) of Bio 104 laboratories and in 17% (2/12) of Bio 103 laboratories.

Access and use of technology is imbedded into biology courses in a variety of ways. Refer to Table 6 for a list of the technology used in courses and laboratories.

Table 1. Summary of results of the cumulative quiz administered in Spring 2015.

Learning Outcome	**Assessment** (Quiz question that pertains to each learning outcome)	**Result** (Mean percent correct)
1. The student will have an understanding of the natural world.	1, 2, 4-8,10	76%
2. The student will be able think critically and to apply scientific principles to reach conclusions.	9, 12, 13	69%
3. The student will have the ability to use appropriate technology.	3, 11	61%
Number of students		69
Overall mean		70.7%

B. Benchmarks: Students are expected to achieve a score of 60% or higher on the cumulative quiz. We regard the mean percent score of the quiz results to be a reasonable indicator of student-success in meeting the two science-related general education learning outcomes and the use of technology.

C. Results: The overall mean percentage and the means on the quiz questions that assess each learning outcome were above our benchmark of 60 %.

D. Action Plan:
An action plan that addresses the following areas is being developed for implementation during the next academic year:

1. We will administer the cumulative quizzes in both semesters (Bio 103 Fall, Bio 104 Spring) and to as many sections of the courses as possible.

2. We will evaluate the quiz content. Because the quizzes have not been reviewed for a few years and the courses are being revamped for 2015-2016 and because content may have changed since the last review or with the new design, we will evaluate the quizzes for appropriate content and for balance between learning outcomes.

3. We will discuss the feasibility of administering pre- and post- quizzes at the beginning and end of the courses.

III. Learning Outcomes - Biology

1. The student will have an understanding of major concepts in the biological sciences.

2. The student will be able to think critically and to apply scientific principles to reach conclusions.

3. Students will be able apply the process of science; Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.

4. Students will be able to use technology and instrumentation as they gather data and analyze results to complete laboratory exercises.

A. Learning Outcomes 1 and 2:

1. The student will have an understanding of major concepts in the biological sciences.

2. The student will be able to think critically and to apply scientific principles to reach conclusions.

1) Assessment:

We assessed how successful students were in meeting learning outcomes 1 and 2 with a cumulative exam administered in the Senior Seminar course (Bio 499). Students take this course in one of their last two semesters at FMU. The exam (multiple choice format) was given at the end of each semester (Fall 2014 and Spring 2015).

2) Benchmark:

Students are expected to achieve a score of 60% or higher on the exit exam. We regard the mean percent score of the exam results to be a reasonable indicator of student-success in meeting the learning outcomes.

3) Results:

Table 2 lists the questions in the exam that pertain to each learning outcome and summarizes the results for each learning outcome.

The mean on the exam met the benchmark for the Fall semester group but did not for the Spring group (Table 2). This resulted in the average for the year falling slightly below the benchmark. The results for learning outcome 1 exceeded the benchmark in both semesters but learning outcome 2 did not. The overall mean results have been hovering near the benchmark for several years.

Table 2. Summary of results of the cumulative exam given to seniors in Bio 499 in Fall 2014 and Spring 2015.

Learning Outcome	**Assessment** (Exam question that pertains to each learning outcome)	**Results** (Mean percent correct)		
		Fall 2014	Spring 2015	Year
1. The student will have an understanding of major concepts in the biological sciences.	1, 2, 5, 6, 10, 11, 12, 15-17, 21, 22, 26, 28, 32, 34, 36, 40, 41, 43, 47, 48, 49	63.4%	62.2%	62.8%
2. The student will be able to think critically and to apply scientific principles to reach conclusions.	3, 4, 7, 8, 9, 13, 14, 18, 19, 20, 23, 24, 25, 27, 29, 30, 31, 33, 35, 37, 38, 39, 42, 44, 45, 46, 50	57%	54.6%	55.8%
Number of students		38	46	42
Overall Exam Mean		60%	58.5%	59.4%

4) Action:

To address the following concerns we are developing an action plan to be implemented during the next academic year.

Several factors may be responsible for the exam mean results hovering around 60%. One potential issue is with administering the exam in the Senior Seminar course. Students are allowed to take the Senior Seminar course where the exam is administered in one of their last two semesters prior to graduation. Thus, they may be taking the exit exam a semester before the one they are going to graduate and therefore they may not have completed all their course work at the time of the exam. A second issue is that some questions in both learning outcomes assessed by the exam may cover content from courses that the student may have completed early in their course progression or are based on material in a subject area that is not reinforced in subsequent upper level courses (e.g., plant biology, animal diversity). In addition, results show that students performed better on the content-based questions (LO 1) than they did on the critical thinking questions (LO 2). However, that is not unexpected as critical thinking questions are more difficult. Additionally, poor performance on the critical thinking questions may be exacerbated if a critical thinking question combines content not yet covered or is from an early course and is not reinforced later.

Action 1: Evaluate the content and questions used in the exit exam. We evaluate the exam every 5 years and therefore it is due to be evaluated this next academic year (2015-2016). We will review the exam for distribution between the core areas (plant biology, ecology, genetics,

and evolution), for concepts used in critical thinking type questions, and for balance between content vs critical thinking. We will also consider more case study questions and data analysis questions to address the concerns with the material covered and to better assess Learning Outcome 2 (critical thinking and the application of scientific principles) unrelated to content.

Action 2: The department will address the timing of exam administration to determine how we can better assess only seniors in the semester in which they are graduating and so therefore have completed all relevant course work.

Action 3: The department will investigate external, standardized exams to determine the feasibility and practicality of use so as to compare FMU biology students with students at comparable universities nationwide.

B. Learning Outcome 3: Students will be able apply the process of science; Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.

1) Assessment:

Not only do students apply the process of science in the laboratory portion of courses in our Biology curriculum but there are multiple opportunities to apply the process of science through research projects outside of class. Students may complete independent research projects and receive credit (e.g., Bio 497, Honor's Thesis) or they may take part in projects and not receive credit but receive a stipend (e.g., BREP fellows (Biology Research Experience Program) that are supported by our INBRE grant and REAL, the University's quality enhancement program).

After completing their project students may write a report, a thesis, or a paper on their work or they may produce a poster or do an oral presentation. FMU has two venues on campus for presentations. One is PURE, the Biology Department's research symposium held once per semester. Another is the campus-wide Research and Exhibition Day held every spring. On occasion students may also have the opportunity to travel and attend scientific association conferences.

We used two measures to assess Learning Outcome 3:

1. Courses with assignments that apply the process of science.

2. Independent research projects including:
    a. the number of students participating in research projects,
    b. the type of product completed,
    c. the proportion of faculty members mentoring projects.

2) Benchmarks:

1. Courses with assignments that apply the process of science: 75% of the students will earn at least 70% on the assignment.

2a. Proportion of students involved in projects: 3 - 4% of juniors and seniors; students in their junior and senior are primarily the ones that we involve in research projects. This benchmark also incorporates the proportion of faculty mentors available and the likelihood that each would mentor one student (see further explanation in *d. Proportion of faculty mentors* below). We have 16 full-time faculty in the department. If half had projects available that would be 8 possible projects for students. If junior and senior enrollment averages around 180-200 students, then 8 possible mentors means about 4% of juniors and seniors may be involved in a project with a mentor.

2b. Type of product completed: All students will complete a product showcasing their work if they are receiving Bio 497 credit or are supported by a REAL grant. These products may include such things as: a report, a scientific paper, a thesis, a poster, or a presentation.

2c. Proportion of faculty mentoring projects: 35 - 40% of faculty will mentor a student project. The benchmark was set at this level to compensate for the historical variability in both student and faculty participation. Student projects are not required in our curriculum except for honors theses. In addition, the interest to do a project, and therefore the need for involved faculty varies each semester. There is also variability in the number of faculty available. There are some semesters when faculty are unable or do not want to mentor because they are devoting time to other duties (e.g., writing or sabbatical). Also, faculty generally only mentor one project per semester or year therefore the number of available projects for students can be limited.

3) Results:

Results 1. Courses with assignments that apply the process of science.

In all courses except one at least 75% of the students earned an average of 70% or higher on assignments that required them to apply the process of science (Table 3). Even in the course that averaged below our benchmark (Bio 411) the averages on the assignments in that course steadily increased to a high of 92% on their final assignment thus demonstrating overall improvement. In addition, students demonstrate improvement from lower to upper division majors courses with a trend toward a higher proportion of students earning >70% in the upper level courses.

Table 3. Courses where assignments were incorporated that required students to apply the process of science. These assignments include, but are not limited to lab reports and projects.

Topic	Course	Number of sections	2014-2015 Enrollment (approximate)	Average number of assignments	Average Proportion of students that earned ≥ 70%
Non-majors	103 & 104	13	230	2	80
Majors	115	10	220	1.5	76
Ecology	317	2	29	1.5	95
	306	1	9	15	80
	308	1	24	2	81
	411	2	36	3	60*
Cell	301	2	32	1	90
Genetics	401	2	34	1	97
Electives	311	1	19	1	84
	406	2	38	1	90
	413	1	9	1	89

* averages on each of the reports in the order they were completed during the semester: 36, 53, 92

Results 2a. Number of students participating in research projects:

We had an average of 214 junior and senior biology majors this year. The number of individual students involved in research projects represents 13% of our juniors and seniors this year (Table 4). We exceeded our benchmark of 3-4% of Junior and Senior level students involved in independent research projects. This was a very good year for student research projects with a high volume of student interest.

Table 4. Number of students participating in research projects from Summer 2014 – Spring 2015. Some students participate in multiple semesters or in different opportunities in multiple semesters.

- "No credit" is the number of students that worked on projects but did not receive credit, salary, nor compensation of any kind.
- "Total individual students" is the number of individuals doing projects and adjusts for students enrolled for more than one semester or in more than one type of research opportunity.

Research Opportunity	Summer 2014	Fall 2014	Spring 2015	Total enrolled	Total individual students
Bio 497	0	7	10	17	13
REAL	5			5	5
BREP	4	7	6	17	8
No credit			2	2	0*
Honors	1		2	3	1
Total enrolled	10	14	20	44	27

* The total number of individual students in the "no credit" category is 0 because these students had been involved in a different research opportunity at another time and they are counted in that category

Results 2b. Products of student research

We were very close to meeting our benchmark of all students completing a product of their work if they were participating in a Bio 497 or REAL project (Table 5). Only one of 13 students in Bio 497 did not do a product of her work. This student had previously been a BREP fellow. Although they are encouraged to do so, there are currently no requirements in place for students on a BREP fellowship to do a product at the end of their project. The differences in the requirements between BREP and Bio 497 led to some confusion about what she was to do and she graduated in the Fall semester just after completing the Bio 497 so we were unable to have her participate in the end of the year (Spring) events.

Overall most students, no matter what the opportunity category completed at least one product showcasing their work. Only two students did not complete a product, the one described above and another student in the "no credit" category. This student was continuing to work on a project that he had already received Bio 497credit in a prior year. He chose to continue working on the project this year because he enjoyed it so much. Therefore the mentor did not require that he complete a product.

Table 5. Products of student research projects by type of research opportunity. Individual students may have done more than type of product or presented at more than one venue.

	Product Type						
Research Opportunity	PURE	Research & Exhibition Day	Thesis	Paper or Report	Present at meeting	No Product	Total
Bio 497	4	4		5	3	1	17
REAL	3	2		5			10
BREP	1	5					6
No credit						1	1
Honors			2				2
Total	8	11	2	10	3	2	36

Results 2c. Proportion of faculty members mentoring projects:

The department exceeded the goal for the number of faculty mentoring student research projects outside the classroom and the proportion of junior and senior students involved in research. 69% (11/16) of full-time faculty members mentored student projects outside of the classroom this year. (Note: there were a total of 18 full–time faculty in the department this year but because two retired at the end of this academic year and were not active in research for the past several years they were not included in the total.) Two faculty are "target faculty" on the INBRE grant we have and receive course release to mentor students. Four faculty mentored more than one student this year and three mentored multiple students in a semester. However, typically faculty will mentor only one project per semester. This was a very good year for student research projects with a high volume of student interest.

4) Action: To address the concerns below we are developing an action plan to be implemented during the next academic year.

1. The department will discuss developing a writing assignment program likely using a scaffolding approach to be used in the freshman course sequence. In an effort to increase consistency across all lab sections we will also discuss grading rubrics for the program.

2. We will discuss ways to incorporate more assignments that require students to apply the process of science into our courses.

3. We will discuss ways to encourage faculty to mentor students in research projects outside of the classroom.

4. We will examine how we notify students of research opportunities and explore different methods. We will continue to use the *Research Opportunities* section of the bulletin board

outside the biology office where faculty post projects and will evaluate the frequency of updating of our website section on research.

5. We will discuss guidelines for what is required by students at the end of student projects for each type of research experience.

C. Learning Outcome 4: Students use technology and instrumentation as they gather data and analyze results to complete laboratory exercises.

1) Assessment:

We assess learning outcome 4 by the proportion of courses that incorporate technology in some from. Access to and use of technology is imbedded into biology courses in a variety of ways. Student use of technology is incorporated into both lectures and the laboratory portions of the biology courses.

All students gather data and use technology and instrumentation in a variety of laboratory exercises in these courses. For, students use scientific instrumentation to gather data, and software to use spreadsheets, and do statistical testing, and create graphs to evaluate the data collected. The process of gathering the necessary data for each laboratory exercise requires accuracy in taking measurements and using the technology and instrumentation correctly. In addition to data collection required all laboratories, specific instrumentation is used in lecture sections and laboratories.

2) Benchmark: 90% of our courses use at least one form of technology. This benchmark adjusts for courses that may not lend themselves to use of technology such as diversity of organism courses.

3) Results:

A variety of technology is incorporated by instructors into our courses at all levels into both lectures and laboratories (Table 6). The types of uses vary including posting grades and assignments, on-line quizzes, and use of software programs and instrumentation in laboratories. In addition to the listings below, Excel and Prism (graphing program) are the programs that the department recommends students use and are used routinely by courses that require data analysis and graphing.

The majority of lectures and labs (fall: 13/16, 88%; spring: 18/22, 82%) have some exposure to technology imbedded into them. Thus we were close to meeting our benchmark. The courses that did not use technology were diversity courses and those taught by senior faculty two of which retired at the end of this academic year (one also taught an organism diversity course).

Table 6. Types of technology, the uses, the courses this technology is incorporated.

Program	Use	Course number
Blackboard	posting grades, announcements, resources, course notes, homework	103, 104, 105, 106, 201, 202, 205, 210, 301, 305, 306, 308, 311, 317, 318, 401, 406, 409, 411, 413,
	On-line quizzes	103, 105, 104, 202, 305, 308, 312, 401
	Submit assignments	306, 406
Textbook/publisher website/resources	Homework, assignments, quizzes	105
	Virtual labs, exercises	205, 401
Other programs	Symbio	106, 210, 308, 317,
	ArcGIS	202, 308, 411
	Mesquite	106, 306
	Image analysis	301
iPads		306, 411
Instructor created websites	Course resources, grades	213, 215, 236
Vernier and Pasco Probes (various), O2 & pH meters	Lab data collection	103, 115, 236, 406 308, 317

4) Action: To address the following concerns we are developing an action plan to be implemented during the next academic year.

1. We will discuss ways to encourage faculty to find methods to incorporate technology into their courses.
2. We will have a dedicated time for discussion of the topic at a department meeting where instructors may showcase ways they currently use the various features of Blackboard (for example).

Professional Development

<u>Overview</u>: 14 Respondents (76% of 17 full-time faculty)

Faculty in the department of biology are involved in a wide range of research projects, with:

1) 93% of survey respondents reporting involvement in new or continuing projects.
2) In total, survey respondents reported 9 new and 27 continuing research projects underway.
3) 79% of respondents are members of at least one professional society,
    - 82% of those having membership in 2 or more professional societies.
4) 79% of respondents attended at least one professional meeting, conference, or off-campus workshop in the past academic year,
5) 100% of respondents attended the PULSE workshop within the Department of Biology.
6) Survey respondents reported 4 published and 1 submitted peer-reviewed articles or book chapters for the previous year, 1 submitted peer-reviewed article, and 6 articles in preparation.
7) 6 professional presentations and 3 public outreach presentations in the past year,
8) numerous members of the department engaged in self-study in the past year related to his or her research project(s).

Biology Department Initiative: Transformation

In the past several years members of the department had been discussing our program and teaching including issues such as: examining our learning outcomes, how to better serve our students, how to improve our curriculum and the major, how to improve assessment of our program, and how to improve retention. Below is a timeline of events that address this concerns and document the department's action on these concerns.

Timeline:

April 2014:

The Biology Department Chair and a faculty member attended a session by Partnership for Undergraduate Life Sciences Education (PULSE) at the American Society of Biologists meeting in mid-April. PULSE was formed from program directors at HHMI, NIH, and NSF to implement the recommendations put forth in the 2011 publication "Vision and Change in Undergraduate Biology Education: A Call to Action" a document produced by the American Association for the Advancement of Science. One goal is for the "*transformation of life science departments as part of a national effort to retain and advance students of the life sciences, prepare them for professional programs and careers, and help develop a scientifically literate citizenry."*

Because this session seemed to offer direction and guidance in the areas that members of the department had been discussing about our program and teaching, the department chair decided to present what they had learned about PULSE and the "Vision and Change" with the department to gauge interest in further research along this line.

April 22, 2014:

The department began discussion of PULSE at its April 22nd department meeting. Members completed one of the PULSE rubrics prior to the meeting. This rubric provided us the opportunity to evaluate ourselves as a department. They helped us reflect and discuss topics relevant to transforming the program and to determine our current level of adoption of the principles of "Vision and Change." We identified areas of strengths and priorities and allowed us as a department to begin discussions as to how to move forward. After compilation and discussion of the preliminary results, the department voted to contact the PULSE group and request a site visit to our campus.

April 23, 2014:

The department Chair completed and submitted the on-line questionnaire and application to the PULSE Ambassador Inquiry requesting a site visit.

October 14, 2014:

A PULSE ambassador contacted the chair about having a site visit in January 2015.

Dec. 11, 2014: Biology Department held a "pre-visit" workshop.

All full-time faculty in the department participated in this all day workshop. We completed two PULSE rubrics that the fulfilled the "pre-site visit" assignment. The PULSE Vision & Change rubrics evaluated our strengths and areas of specific needs or concerns. The results were shared with the PULSE team and gave the team information about where we in the process.

On Jan 8 - 9, 2015: PULSE site visit

All full-time biology faculty participated in a workshop lead by a team of "ambassadors" from PULSE. FMU was selected as one of only 8 institutions to take part in this NSF (National Science Foundation) funded pilot project.

A team of three Ambassadors came to campus for a 2 day workshop. During the visit, the Ambassadors facilitated activities to engage, support, and guide the department in developing an action plan for change in our teaching and course content in order to implement the recommendations of "Vision and Change in Undergraduate Biology Education".
The focus of their visit was to:

(1) Engage the department in critical dialog about our vision for the implementation of these recommendations and our goals for change over time and

(2) Connect us with key resources of the PULSE community at large.

During the visit we worked on team building and identified areas that we want to improve and work on and them prioritized them. We developed goals, objectives and preliminary action plans.

The PULSE team also met with an upper administrator (Keith Best, Associate Provost for Academic Affairs and Associate Dean of the College of Liberal Arts) to make the Provost's office aware of what the Biology Department was working on and to gage support, endorsement, and encouragement.

After the visit, the Ambassador team has continued to interact with the department from a distance to track our progress, assist in connecting faculty with resources, and support our work towards change.

January 13 – April 2015: Department meetings throughout the Spring semester:

Two committees were formed to begin working on two of the priorities we identified during the PULSE workshop as the first steps in our change process. One committee examined learning outcomes for our majors. This committee first developed a list of characteristics and skills that we would like that a FMU biology student should have on completing our program. The second committee researched the design of biology majors at other universities (our program has not had a major change since 1987). The committees reported back to the department at our monthly meetings during the semester and presented final reports at the last meeting of the semester.

Action: This work will form the foundation for the department's continued development of our learning outcomes, curriculum revision, integration of the core concepts and competencies in "Vision and Change" throughout the curriculum, and focus on student-centered learning in our strategic planning in the next academic year.