Program: Environmental Science B.S. (ENVS)

Learning Outcome: PLO1: Demonstrate an understanding of the process of science and of the concepts and theories of biology across a broad range of organizational levels: cellular, molecular, organismal, and ecological (population, community, ecosystem).

Outcome Measure: ETS Major Field Test in Biology

Criteria for Success: The overall group mean on the ETS exam will be ≥ 75th percentile and at least 50% of our students will have an overall score ≥ 60th percentile. Additionally, the same criteria established for the overall ETS score will be applied to each of the 3 sub-disciplines, which are 1) Cell, 2) Genetic & Molecular, 3) Organismal, and 4) Population, Ecological, & Evolutionary Biology.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

	2018, n=2	**2017, n=4**	**2016, n=6**	**2015, n=3**
Overall group mean	31st, 35th %ile	64h %ile	39th %ile	76th %ile
% above 60th %ile	0%	25%	33%	33%
Cell Biology mean	3rd, 33rd %ile	57th %ile	22nd %ile	14th %ile
% above 60th %ile	0%	25%	0%	0%
Genetics/Molecular mean	9th, 43rd %ile	29th %ile	3rd %ile	39th %ile
% above 60th %ile	0%	25%	17%	33%
Organismal mean	31st, 37th %ile	37th %ile	50th %ile	93rd %ile
% above 60th %ile	0%	25%	50%	67%
Pop/Eco/Evol. Biol. mean	39th, 73rd %ile	98th %ile	88th %ile	92nd %ile
% above 60th %ile	50%	75%	50%	100%

Conclusions Drawn from Data:
This exam was not given in 2019 due to a mishap with the new computer lab. We will administer the exam again in 2020.

In general, we have not had a large enough population of ENVS majors to get statistically meaningful data about their Biology content knowledge. However, we have noticed that some of the weaker students overall tend to self-select either into this major. (Gray numbers indicate criteria not met.)

Changes to be Made Based on Data: No changes to the program.

Rubric Used: ETS 2017 Comparative Data Guides – MFT for Biology

Learning Outcome: PLO2: Apply key concepts and principles in analytical chemistry including quantitative and instrumental analysis.

Outcome Measure: American Chemical Society (ACS) standardized exam in Analytical Chemistry and Senior Exit Survey

Criteria for Success: The overall group mean on the ACS Analytical Chemistry exam will be at or above the 35th percentile. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

ACS Standardized Exam*	2019	2018	2017	2016	2015
Analytical mean	28.4 out of 50, 56.8% (n=5)	27 out of 50, 54.0% (n=6)	28th %ile (n=5)	41st %ile (n=3)	19th %ile (n=6)

*ACS standardized exam in Analytical Chemistry first administered in spring 2015.

No ENVS majors took Chemistry Senior Seminar in 2015 – 2019, so there is no survey data.

Conclusions Drawn from Data: The percentiles from 2015 – 2017 are based on the entire exam score which is made up of 50 questions. Only 36 of the 50 questions were pertinent to the topics covered in this class, so the 35th percentile was chosen for the criteria for success. The criteria for success was met in 2016 but not 2015 and 2017. In order to have more questions from standardized exams that are pertinent to topics covered in this class on the final exam, questions were used from two standardized exams from different years in 2018 and 2019. The final exam included 24 questions from the 2013 ACS exam and 26 questions from the 2017 exam. Environmental Science majors' average final exam score was a 27 out of 50 or 54.0% in spring 2018 and increased slightly to 28.4 out of 50 or 56.8% in spring 2019. A percentile cannot be assigned since questions were taken from two different exams. As a reference, a score of 29.25 out of 50 or 58.5% would be the 50th percentile, so our students scored close to the national average.

Changes to be Made Based on Data: We will continue to administer final exams with questions from standardized exams each spring to obtain longitudinal data so better conclusions and necessary changes can be made.

Rubric Used: ACS National Normed Percentiles

Learning Outcome: PLO3: Use standard instrumentation and laboratory equipment to conduct scientific experiments and perform chemical characterization and analyses.

Outcome Measure: Faculty laboratory instructors' observation of students' use of various standard instruments in in Chemistry 370, Instrumental Analysis (see below) and Senior Exit Survey.

HPLC, ICP, IR, UV-vis: Chemistry 370 (Instrumental Analysis)

Criteria for Success: At least 80% of students will be able to use each of the various instruments with little or no guidance. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

% students able to use instrument with little or no guidance	Fall 2018	Fall 2017	Fall 2016	Fall 2015
HPLC CHE370	100% (n=4)	100% (n=2)	N/A	100% (n=5)
ICP CHE370	25% (n=4)	100% (n=2)	N/A	N/A
IR CHE370	100% (n=4)	100% (n=2)	N/A	100% (n=5)
UV-vis CHE370	100% (n=4)	100% (n=2)	N/A	100% (n=5)

No ENVS majors took Chemistry Senior Seminar in 2015 – 2019, so there is no survey data.

Conclusions Drawn from Data: Direct assessment using the rubric below began in Fall 2015 because this PLO was modified at the end of 2014 –2015 academic year. Fall 2016 data is not available because the instructor who taught the course is no longer at PLNU. The criteria for success were met on all three instruments that were assessed (HPLC, IR, UV-vis) in fall 2015 and on all four instruments that were assessed (HPLC, ICP, IR, UV-vis) in fall 2017. ICP was not assessed in fall 2015 because this new instrument was not installed in time for use. In fall 2018, the criteria for success were met for HPLC, IR, and UV-vis, but not ICP.

Changes to be Made Based on Data: No changes to the program.

Rubric Used: The following scale will be used.

Instrument	**4**	**3**	**2**	**1**
HPLC (CHE370)	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.
ICP (CHE370)	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.
IR (CHE370)	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.
UV-vis (CHE370)	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.

Learning Outcome: PLO4: Participate in the life of the Biology and/or Chemistry Department by involvement in one or more of the following areas: research, biology and/or chemistry clubs, and/or various positions of responsibility serving as graders, tutors, stockroom workers and/or teaching assistants.

Outcome Measure: Self-reported data of participation and Senior Exit Survey

Criteria for Success: At least 80% of our students will participate in one or more department related activities (research, science clubs, positions of responsibility) during their time at PLNU. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:
1 of 3 ENVS majors (33%) reported participation in clubs or positions of responsibility in 2019. One ENVS major did not take the survey (**criteria not met**).

Data for participation in clubs or positions of responsibility was not collected in 2018.

3 of the 4 ENVS majors (75%) reported participation in clubs or positions of responsibility in 2017 (**criteria met**).

5 of the 6 ENVS majors (83%) reported participation in clubs or positions of responsibility in 2016 (**criteria met**).

All 3 of the ENVS majors (100%) reported participation in clubs or positions of responsibility in 2015 (**criteria met**).

In 2014, of the 2 students who took the survey, 100% reported participation in clubs or positions of responsibility (**criteria met**).

No ENVS majors took Chemistry Senior Seminar in 2015 – 2019, so there is no survey data.

Conclusions Drawn from Data: In general, the ENVS majors are participating in the life of the department.

Changes to be Made Based on Data: No changes to the program.

Rubric Used: Not applicable to self-reported data.

Learning Outcome: PLO5: Develop a rationally defensible integration of science and faith, particularly with regard to environmental stewardship.

Outcome Measure: During their senior year, students will defend the integration of their faith with various scientific topics via a written essay.

Criteria for Success: At least 80% of our students will achieve a level of 3 or higher on each area of the science/faith integration essay rubric, which considers both science/faith integration and critical thinking.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:
Of the 4 ENVS majors who graduated in 2019, 100% scored 3 or above on the science faith integration essay (**criteria met**).

Of the 2 ENVS majors who graduated in 2018, both scored 3 or above on the science faith integration essay (**criteria met**).

Of the 4 ENVS majors who graduated in 2017, 75% scored 3 or above on the science faith integration essay (**criteria met within statistical bounds**).

A random sample of students was selected in 2016 and 7 ENVS majors were in this sample. 100% of the students scored 3 or above on the science faith integration essay (**criteria met**).

Conclusions Drawn from Data: The ENVS majors are able to develop a rationally defensible integration of science and faith.

Changes to be Made Based on Data: No changes to the program.

Rubric Used: See attached.

BIO 497 Grading rubric for *Integration of Science & Faith* Essay (2017)

Grading aspect	Capstone 4	Milestones 3	Milestones 2	Benchmark 1
Integration of science and faith (evolution or creation care) 0 -20 points	• Deep personal reflection is evident • Clear and well-defended position that merges faith and scientific reasoning (note: the exact position is not important, but rather the evidence of reflection, understanding, and ability to defend that position)	Obvious evidence of reflection on the integration of science and faith, but the author is only marginally effective at defending his/her position.	Evidence of clear and deep reflection is not very apparent, and the position taken is not well-defended.	There is no indication of personal reflection and thought into the integration of faith and science.
Critical Thinking **0 – 20 points**	• Issue is stated clearly • Position is well-supported with evidence and sources. • Alternate positions are clearly addressed in a manner that flows well with the author's argument • Clear arguments against these alternate positions using personal reflection and scientific information • Evaluation of altering positions demonstrate grace and understanding	Fairly strong support of the argument. Alternate positions are addressed and the author's own position is supported against these positions, but didn't demonstrate adequate understanding of other positions, nor did a strong argument against them emerge.	Position is weakly defended Other, perhaps conflicting, positions on this issue are mentioned, but are poorly addressed	Position is not defended There is no reference to any other position on this issue.
Incorporation of concepts discussed in various classes while at PLNU Critical Thinking **0 – 20 points**	• Concepts from PLNU classes, including science and / or religion classes, are included as part of the author's reflection and defense of his/her position. • Includes a clear reflection of how the position has changed while at PLNU. If his/her position has not changed, essay still includes a clear explanation of why it did not change, that demonstrates personal reflection.	Concepts and discussion from PLNU classes are included and discussed appropriately, but are not clearly interwoven into the author's defense and explanation of his/her own position or how this position has changed while at PLNU	Concepts and discussions from PLNU classes are part of his/her defendable position, but there is no reflection on how/if these have affected the author's position.	No concepts or discussions from PLNU classes are clearly included in the argument
Written Communication **0 – 20 points**	• No, or very few, grammatical and spelling errors. • Essay flow is excellent with a clear introduction, argumentative reasoning, and a strong conclusion. • Writing effectively communicates with a college science audience. • Sufficient length to make a good, complete defense (estimated ~1200 – 1600 words; can be less if essay is sufficiently and concisely supported)	Few grammatical and spelling errors are apparent in the writing. Writing shows evidence of revision, but the argument does not flow very well. Essay is of sufficient length to support the argument	Writing is OK, but grammatical and spelling errors are somewhat frequent. Further revisions are required. Essay length is not sufficient to support the argument.	Writing is very poor with several grammatical and spelling errors. No evidence of revision. (Essay is <800 words)
Information Literacy **0 – 20 points**	• Includes 5 or more appropriate sources. Includes sources from more than one type (websites, books, articles, etc.). Multiple journal and/or book sources. • Includes substantial references in the text that enhance the essay and support the author's argument. • Paraphrasing is done well, and quotes are used correctly, but not overly frequently. • Annotated bibliography includes 1 – 2 sentences appropriately describing why each reference was chosen and how it was used.	Includes 3-4 appropriate sources. Includes some references in the text that are incorporated into the essay well. Some of the references may not be appropriate for the topic or may not be used appropriately.	Includes 1 – 2 appropriate sources. In-text references show little connection to the essay. Quotes are overly used or long. No indication as to how / why the references were used.	Includes no appropriate sources. No in-text references. Or most sources were inappropriate or used for incorrect purposes.

Learning Outcome: PLO6: Be prepared for post graduate studies or a science-related career.

Outcome Measure: Tracking of alumni data regarding their postgraduate education and profession along with Senior Exit Survey.

Criteria for Success (if applicable): Success rates for alumni who apply for graduate or professional schools will be >75% and the percentage of graduates who obtain jobs in science-related occupations will be >70%. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data: (These data are collected every 5 years, and were not collected in 2019.)

1) The success rate for alumni who apply to graduate or professional schools has been well over 90% for at least 20 years. For dental, medical, optometry, pharmacy, and veterinary schools, there have been 166 acceptances out of 181 applicants (91.7%) between 2004 – 2014.
2) An alumni survey was conducted by the Biology and Chemistry Depts. in January, 2015, that included graduates from 2004 – 2014. 408 alumni were emailed and 115 responded (28% response rate). The lowest response rate was from the class of 2007 (7%); all other classes had a response rate of 21-42%, which is fairly typical of alumni surveys.
3) 8 ENVS majors responded (33% response). Of these alumni, 88% are employed or attending school in a Biology or STEM-related field (**criteria met**). 1 is employed outside science.

No ENVS majors took Chemistry Senior Seminar in 2015 – 2019, so there is no survey data.

Conclusions Drawn from Data: The ENVS majors are successful at obtaining jobs and entering graduate/professional schools.

Changes to be Made Based on Data: No changes to program.

Rubric Used: Not applicable to self-reported data. Survey instrument is attached.

Chemistry Seminar Exit Survey 2019 (Environmental Science Major)

1) What is your current career goal?
   a) Professor
   b) Teacher
   c) Health professional – please specify
   d) Biotechnology or pharmaceutical industry
   e) Academic or government lab
   f) Graduate student – please specify field or specialty
   g) Other – please specify

2) Rank how well prepared you were to meet the following program learning outcomes (goals) that were set for your major.

I. Students will demonstrate an understanding of the process of science, and of the concepts and theories of biology across a broad range of organizational levels: molecular, cellular, organismal, and ecological (population, community, ecosystem).
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

II. Students will apply key concepts and principles in analytical chemistry including quantitative and instrumental analysis.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

III. Students will use standard instrumentation and laboratory equipment to conduct scientific experiments and perform chemical characterization and analyses.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

IV. Students will participate in the life of the Biology and/or Chemistry Department by involvement in one or more of the following areas: research, biology and/or chemistry clubs, and/or various positions of responsibility serving as graders, tutors, stockroom workers and/or teaching assistants.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

V. Students will develop a rationally defensible integration of science and faith, particularly with regard to environmental stewardship.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

VI. Students will be prepared for post graduate studies or a science-related career.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

3) Were you involved in the PLNU chemistry summer research program?
   a) Yes – describe what role this experience played in your learning of chemistry
   b) No – describe why not

4) Do you have any suggestions related to the summer research program?

5) What were one or two aspects of the chemistry curriculum that might have been improved?

6) Do you feel prepared to take the next step academically?
   a) Yes – describe what experiences (classes) helped you to get there
   b) No – describe what additional or different experiences would have helped

7) If you were starting over as a freshman next fall, would you make any different decisions about your major, or about elective course choices, etc.?

8) Are there chemistry courses that PLNU does not offer that you would have liked to take?

9) Do you feel like you are a part of the chemistry department community? Why or why not?

Alumni Survey 2015

The Biology and Chemistry Departments are doing an extensive Program Review. We would greatly appreciate your feedback as a PLNU alum on your experience as a Biology or Chemistry major. This 15-question survey should take about 15 minutes to complete. If you provide your email address, we will also enter you into a drawing for one of three $100 Amazon cards as a thank you for your time!

1) What year did you graduate from PLNU?

2) What was your major?
   a) Biology-BA
   b) Biology-BS
   c) Chemistry
   d) Biology-Chemistry
   e) Environmental Science

3) What is your highest degree earned?
   a) BA/BS
   b) MA/MS
   c) PhD
   d) MD/DO
   e) PA
   f) DDS
   g) DVM
   h) OD
   i) PharmD
   j) Other – please specify

4) What is your current professional situation?
   a) Professor
   b) Teacher
   c) Health professional
   d) Biotechnology or pharmaceutical industry
   e) Academic or government lab
   f) Graduate student – please specify field or specialty
   g) Other – please specify

5) Rank how well we prepared you to meet the following goals that were set for your major. (Only PLOs for specified major selected in #2 will appear.)
   a) Unprepared
   b) Somewhat unprepared
   c) Prepared
   d) Well prepared
   e) Extremely well prepared

6) Were you involved in the PLNU biology or chemistry summer research programs?
   a) Yes – describe how this experience is impacting your career.
   b) No

7) Which classes or experiences do you appreciate more now as opposed to when you had just graduated?

8) Is there any course, topic, or skill you've repeatedly encountered that you wish you had been taught at PLNU? Please explain.

9) If you are pursuing a career in environmental science, do you wish you had substituted an internship experience for a science elective while you were at PLNU?
   a) I am not pursuing a career in environmental science.
   b) I did an internship.
   c) Yes, I wish I had done an internship while at PLNU.
   d) No, I did not need to do an internship while at PLNU.

   Comments?

10) Do you wish you had taken any of the following options at PLNU?
   a) BIO130/140 (Human Anatomy & Physiology)
   b) Upper-division anatomy class
   c) No, I didn't need an Anatomy class

   Comments?

11) What were one or two aspects of the biology curriculum that might have been improved to better prepare you for your profession or for further studies?

12) What were one or two aspects of the chemistry curriculum that might have been improved to better prepare you for your profession or for further studies?

13) Have you done any of the following? Check all that apply.
   a) Recommended PLNU to a prospective student
   b) Promoted PLNU to another person
   c) Been involved with the alumni association
   d) Donated to Research Associates
   e) Other – please specify.

14) Since you left PLNU, have you ever had a conversation in which you had to integrate Christian faith with scientific knowledge? Did you feel prepared scientifically? Did you feel prepared theologically? Check all that apply. Please describe the situation and your feelings about your preparation.
   a) I've never had such a conversation.
   b) I felt prepared scientifically.
   c) I didn't feel prepared scientifically.

d) I felt prepared theologically.
e) I didn't feel prepared theologically.

15) Since you left PLNU, have you made any decisions that were influenced by your knowledge of creation care and sustainability? If so, did you feel prepared to make those decisions from a scientific understanding of sustainability?
a) I do not tend to make decisions based on sustainability considerations.
b) I often feel unprepared to make those decisions as it is rarely clear to me which options would best benefit the planet.
c) I usually feel prepared to make those decisions as I am generally confident in my understanding of how my choices affect, and which options are best for, the planet.
d) I feel very comfortable in my scientific knowledge of how various decisions will affect the earth, either negatively or positively.

16) Please provide your email address to be entered into the drawing for an Amazon gift card. Your email address will not be associated with your responses on this survey.