Environmental Science B.S. (ENVS)
Program Learning Outcomes, F2020-S2021

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:

	2021, n=5	**2018, n=2**	**2017, n=4**	**2016, n=6**	**2015, n=3**
Overall group mean	64th %ile	31st, 35th %ile	64h %ile	39th %ile	76th %ile
% above 60th %ile	40%	0%	25%	33%	33%
Cell Biology mean	41st %ile	3rd, 33rd %ile	57th %ile	22nd %ile	14th %ile
% above 60th %ile	20%	0%	25%	0%	0%
Genetics/Molecular mean	12th %ile	9th, 43rd %ile	29th %ile	3rd %ile	39th %ile
% above 60th %ile	0%	0%	25%	17%	33%
Organismal mean	54th %ile	31st, 37th %ile	37th %ile	50th %ile	93rd %ile
% above 60th %ile	40%	0%	25%	50%	67%
Pop/Eco/Evol. Biol. mean	94th %ile	39th, 73rd %ile	98th %ile	88th %ile	92nd %ile
% above 60th %ile	100%	50%	75%	50%	100%

Conclusions Drawn from Data:
In general, we have not had a large enough population of ENVS majors to get statistically meaningful data about their Biology content knowledge. (Gray numbers indicate criteria not met.) However, we have noticed that some of the weaker students overall tend to self-select into this major. Due to this fact, we worked with several other departments to create an Environmental Studies major that has less science courses and more writing and policy

courses. This major is housed in the Department of Literature, Journalism, and World Languages.

Clearly, however, these students are doing exceedingly well in the area of population biology, ecology and evolution, which best fits with the focus of this major.

Note that in 2019, this exam was not given due to a mishap with the new computer lab, and in 2020, it was not administered due to the complications of COVID-19.

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

Rubric Used: ETS 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*	2021	2020	2019	2018	2017	2016	2015
Analytical mean	COVID-19	COVID-19	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 not administered in spring 2020 due to COVID-19.

No ENVS majors took Chemistry Senior Seminar in 2015 – 2021, 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. In the Spring 2020 and 2021, this certified exam could not be offered because of the remote environment.

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 3070, Instrumental Analysis (see below) and Senior Exit Survey.

HPLC, ICP, IR, UV-vis: Chemistry 3070 (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 2020	Fall 2019	Fall 2018	Fall 2017	Fall 2016	Fall 2015
HPLC CHE3070	COVID-19	HPLC not working	100% (n=4)	100% (n=2)	N/A	100% (n=5)
ICP CHE3070	COVID-19	100% (n=4)	25% (n=4)	100% (n=2)	N/A	N/A
IR CHE3070	COVID-19	100% (n=4)	100% (n=4)	100% (n=2)	N/A	100% (n=5)
UV-vis CHE3070	COVID-19	100% (n=4)	100% (n=4)	100% (n=2)	N/A	100% (n=5)

No ENVS majors took Chemistry Senior Seminar in 2015 – 2021, 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, all four instruments that were assessed (HPLC, ICP, IR, UV-vis) in fall 2017, and all three instruments that were assessed (ICP, IR, UV-vis) in fall 2019. 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. In the Fall 2020, we could not assess students' ability to use these 4 instruments because this course was offered remotely and students were on zoom and not in the lab.

Changes to be Made Based on Data: We do not need to make changes to the program as students are typically successful in using these instruments.

Rubric Used: The following scale will be used.

Instrument	**4**	**3**	**2**	**1**
HPLC (CHE3070)	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 (CHE3070)	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 (CHE3070)	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 (CHE3070)	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:

	Number of students responding of total	% participated in life of dept	Criteria met?	Notes
Sp 2021	5 of 5	60%	No	
Sp 2020	--	--	--	Survey not given (COVID)
Sp 2019	1 of 3	33%	No	
Sp 2018	--	--	--	Survey not given
Sp 2017	3 of 4	75%	Almost	
Sp 2016*	5 of 6	83%	Yes	
Sp 2015	3 of 3	100%	Yes	

Conclusions Drawn from Data: In general, the ENVS majors are participating in the life of the department. However, with such small numbers of students, there is a lot of fluctuation from year to year.

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:

	Number of students	% scoring 3 or above	Criteria met?	Notes
Sp 2021	2	100%	Yes	
Sp 2020	3	67%	No	Small sample size
Sp 2019	4	100%	Yes	
Sp 2018	2	100%	Yes	
Sp 2017	4	100%	Yes	
Sp 2016*	7	100%	Yes	

*A random sample of students was selected in 2016 and 7 ENVS majors were in this sample.

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 4097 Grading Rubric for *Integration of Science & Faith* annotated bibliography (Info Literacy Assign #2) (25 points)

Grading aspect	Capstone 4	Milestones 3	Milestones 2	Benchmark 1
Number of references 0 – 10 points	☐ At least 5 references ☐ At least 3 references are journal articles or books.	☐ 3-4 references ☐ 2 or fewer references are journal articles or books.	☐ 2 or fewer references, ☐ No references are journal articles or books	☐ No references
Choice of references 0 – 15 points	☐ Annotated bibliography includes 1 – 2 sentences describing choice, use, and purpose of each reference (including bias) ☐ Particular aspects (chapter, pages, figures) of each source are indicated for which the student anticipates using. ☐ Sources are of more than one type such as websites, books, and journal articles. ☐ Credibility of the author is verified ☐ References are properly formatted ☐ Includes at least one source from an alternate viewpoint, written by an author that holds that viewpoint.	☐ Missing 2 of the details	☐ Missing 3 of the details	☐ Little evidence of thought and consideration towards the use, purpose, and ideas derived from each source.

BIO 4097 Grading Rubric for *Integration of Science & Faith* outline (25 points)

Grading aspect	Capstone 4	Milestones 3	Milestones 2	Benchmark 1
Thesis and direction of the paper 0 – 15 points	☐ Thesis is clear ☐ The outline reflects a clear organization of the paragraphs with supporting ideas, as well as reference to how each source will be used.	☐ Thesis is somewhat clear ☐ Overall organization of outline is somewhat clear	☐ Thesis is unclear ☐ No real indication of any thought towards organization of the ideas and supporting evidence within the paper.	☐ No outline
Ideas and organization of the individual supporting paragraphs 0 – 10 points	☐ Thoughtful and organized flow of ideas ☐ Sub-bullets for each main paragraph / supporting idea show evidence of deep thought about the paper ☐ Mention of multiple concepts from PLNU courses that have influenced position	☐ Evidence of overall structure, but student has not yet thought deeply about how to put the main ideas together ☐ Outline has main ideas, but has few sub-bullets ☐ Mention of 1-2 concepts from PLNU courses that have influenced position.	☐ Very little evidence of thought towards organization, main ideas, and structure for the paper. ☐ Outline is highly incomplete. ☐ No mention of how PLNU courses have influenced position.	☐ No outline

BIO 4097 Grading Rubric for *Integration of Science & Faith* Essay (100 points)

Grading aspect	Capstone 4	Milestone 3	Milestone 2	Benchmark 1
Integration of science and faith (evolution or creation care) **0 -20 points**	☐ Deep personal reflection is evident ☐ Question for this assignment was clearly answered ☐ Clear statement of position. ☐ 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)	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Critical Thinking **0 – 20 points**	☐ Issue is stated clearly & position is well-supported with evidence & sources. ☐ Alternate position(s) is/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 position(s) demonstrate(s) grace and understanding	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Incorporation of concepts discussed in PLNU classes **0 – 20 points**	☐ Specific concepts from specific PLNU classes, including science and/or religion classes, are included as part of reflection and defense of 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.	Meets 1 of the criteria for a Capstone 4. Comments:		Meets none of the criteria for a Capstone 4. Comments:
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 coll. sci. audience. ☐ Sufficient length to make a good, complete defense (1200 – 1600 words)	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Information Literacy **0 – 20 points**	☐ Sources are current, authoritative, and relevant to the topic ☐ Communicates, organizes and synthesizes information from sources to achieve a specific purpose, with clarity and depth ☐ Use of in-text citations as well as the annotated bibliography ☐ Excellent choice of paraphrasing, summarizing, or quoting to enhance the essay and support the author's argument ☐ Distinguishes between common knowledge and ideas requiring attribution ☐ Source for the alternate view actually holds that viewpoint	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:

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. Due to the complications of COVID, we will collect these data again in 2022.) 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.

1) 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.
2) 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 – 2021, 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.