Biology Department Assessment of Program Learning Outcomes
MS in General Biology
2021-2022

Learning Outcome:
PLO #1: Discuss major concepts and theories in biology.

Outcome Measures:
MS exam questions on description of major course topics (direct measure)
MS written version of thesis (direct measure)

Criteria for Success (if applicable):
100% of students will score at "developed" or higher on rubric

Longitudinal Data:

Measure	% of students achieving "developed" or "highly developed"							
	2015-2016	2016-2017	2017-2018	2018-2019		2019-2020	2020-2021	2021-2022
MS exam	N=2	N=5	N=10	N=6		N=10	N=8	N=13
	100%	100%	100%	100%	No revisions	70%	100%	62%
					Revisions to 1-2 answers	30%	-	38%
					Revisions to 3-4 answers	-	-	-
					Revisions to 5+ answers	-	-	-
MS thesis-Written portion (Thesis students)	N=2	N=2	N=0	N=1		N=1	N=0	N=2
	100%	100 %	-	100%		100%	-	100%

Conclusions Drawn from Data:
All graduating students are performing very well and meeting the criteria.

Changes to be Made Based on Data:
None

Rubric used:
Appendix A: Rubric for MS exam, Part II: Description of summer course major concepts – shaded rows
Appendix B: Rubric for MS thesis (written) – shaded row

APPENDIX A: Rubric for MS exam, Part II: Description of summer course major concepts (shaded rows)

Summer course	Aspect of answer	Initial (fail)	Emerging (fail)	Developed (pass)	Highly Developed (pass)
#1	**Choice of topic**	Topic not addressed in course	Topic of minor importance in course	One of several main topics from course	Clearly a central topic from course
#1	**Topic description**	Inaccurately described	Accurately described, with minimal/no use of vocabulary from the course	Accurately described, with some use of vocabulary from the course	Accurately described using appropriate vocabulary from the course
#2	**Choice of topic**	Topic not addressed in course	Topic of minor importance in course	One of several main topics from course	Clearly a central topic from course
#2	**Topic description**	Inaccurately described	Accurately described, with minimal/no use of vocabulary from the course	Accurately described, with some use of vocabulary from the course	Accurately described using appropriate vocabulary from the course
#3	**Choice of topic**	Topic not addressed in course	Topic of minor importance in course	One of several main topics from course	Clearly a central topic from course
#3	**Topic description**	Inaccurately described	Accurately described, with minimal/no use of vocabulary from the course	Accurately described, with some use of vocabulary from the course	Accurately described using appropriate vocabulary from the course
#4	**Choice of topic**	Topic not addressed in course	Topic of minor importance in course	One of several main topics from course	Clearly a central topic from course
#4	**Topic description**	Inaccurately described	Accurately described, with minimal/no use of vocabulary from the course	Accurately described, with some use of vocabulary from the course	Accurately described using appropriate vocabulary from the course

Appendix B: Rubric for MS thesis (written) – selected row pertaining to PLO #1

Component	Initial (70%)	Emerging (80%)	Developed (90%)	Highly Developed (100%)
Problem, question and/or hypothesis	• Fails to identify or summarize problem accurately • No indication of purpose of the research	• Summarizes the problem, though some aspects are incorrect or confusing • Some indication of purpose of the research	• Clearly identifies the problem • Clearly articulates the purpose of the research	• Clearly identifies the problem as well as nuanced aspects or key details • Clearly articulates the purpose of the research, beyond the narrow field
Choice of and use of relevant literature	• References not appropriately integrated into the paper	• Fewer than 35 references appropriately integrated into the paper	• 35-50 references appropriately integrated into the paper	• 50+ ref. appropriately integrated into paper
Knowledge of major biology theories	• Inadequate evidence of understanding of relevant biology concepts	• Basic evidence of understanding of relevant biology concepts	• Clear and adequate evidence of understanding of relevant biology concepts	• Clear and comprehensive evidence of understanding of relevant biology concepts
Methods (data collection/anal)	• No explanation or justification of research design • Methodology is unclear and incomplete	• Some explanation of research design, but no justification • Methodology is basic, but incomplete	• Clearly explains research design, but no justification • Explains methodology	• Clearly justifies and explains research design • Clearly explains methodology
Results	• Graphs and tables are poorly/inaccurately done • One or more pieces of data inaccurately interpreted in text with many opinion statements.	• Graphs and tables are inaccurate/missing labels with some errors • Usually accurately summarizes tables and graphs in text with obvious opinions	• Graphs and tables are adequate • Accurately summarizes the tables and graphs in text with some opinion	• Graphs and tables are professional • Accurately summarizes the tables and graphs in text w/o opinion
Conclusion(s)	• Fails to identify conclusions, or conclusion is a simplistic summary • Conclusion presented as “proof"	• Identifies conclusions and refers to some specific pieces of evidence • Does not relate conclusion to the broader field	• Clearly links evidence with the conclusion • Minimal consideration of limitations	• Clearly links evidence with the conclusion • Considers limitations of the study

Learning Outcome:
PLO #2: Carry out and communicate various experimental methods and types of data analysis.

Outcome Measures:
MS exam questions on analysis of three research papers (direct measure)
MS written version of thesis (direct measure)

Criteria for Success:
100% of students will score at "developed" or higher on rubric

Longitudinal Data:

Measure	**% of students achieving "developed" or "highly developed"**							
	2015-2016	2016-2017	2017-2018	2018-2019		2019-2020	2020-2021	2021-2022
MS exam questions (Non-thesis option)	N=2	N=5	N=10	N=6		N=10	N=8	N=13
	100%	100%	100%	100%	No revisions	40%	62.5%	69%
					Revisions to 1-2 answers	30%	25%	31%
					Revisions to 3-4 answers	30%	12.5%	-
					Revisions to 5+ answers	-	-	-
MS thesis-Written portion (Thesis option)	N=2	N=2	N=0	N=1		N=1	N=0	N=2
	100%	100%	-	100%		100%	-	100%

Conclusions Drawn from Data
Most graduating students are performing well and meeting the criterion, although some need to rewrite some answers. Many students are taking at least 1-2 Reading in Biology courses or Perspectives of Science courses during the program which provide extra practice in analyzing articles; continued improvement in seen as a result.

Changes to be Made Based on Data:
All students will be strongly encouraged to at least one of our 1-unit elective readings courses to prepare for this portion of the exam.

Rubric used:

Appendix A: Rubric for MS exam, Part I: Research article analysis – shaded row
Appendix B: Rubric for MS thesis (written) – shaded rows

Appendix A: Rubric for MS exam, Part I: Research article analysis (shaded row pertains to PLO #2)

Aspect of answer	Initial (fail)	Emerging (fail)	Developed (pass)	Highly Developed (pass)
General relevance to field	Missing	Unclear	Clear, but not accurate or unclear, incomplete or lacks depth of analysis	Clear and accurate
General problem/ question	Missing	Unclear	Clear, but not accurate or incomplete	Clear and accurate
1st major claim	Identified claim is inaccurate or not important	Identified claim is inaccurate or incomplete or lacks depth	Accurately identified claim, but not a main claim	Accurately identified the one of most important claims
Evidence	Specific data is not identified or does not match the claim	Relevant tables, figures, etc. are mentioned but no specific areas	Specific areas of relevant figures, tables, etc. are correctly identified	Specific areas of relevant figures, tables, etc. are correctly identified
Justification	Justification missing for claim	Weak attempt made to justify claim, but inaccurate, incomplete, or unclear	Justification given for why data supports the claim, but not clear or incomplete	Clear justification as to why the data supports the claim
Methods	Methods missing AND not in own words	Missing some major methods OR not in own words	Major methods identified in own words, but unclear	Major methods clearly identified in own words

Appendix B: Rubric for MS thesis (written) – shaded row pertains to PLO #2

Component	Initial (70%)	Emerging (80%)	Developed (90%)	Highly Developed (100%)
Problem, question and/or hypothesis	• Fails to identify or summarize problem accurately • No indication of purpose of the research	• Summarizes the problem, though some aspects are incorrect or confusing • Some indication of purpose of the research	• Clearly identifies the problem • Clearly articulates the purpose of the research	• Clearly identifies the problem as well as nuanced aspects or key details • Clearly articulates the purpose of the research, beyond the narrow field
Choice of and use of relevant literature	• References not appropriately integrated into the paper	• Fewer than 35 references appropriately integrated into the paper	• 35-50 references appropriately integrated into the paper	• 50+ ref. appropriately integrated into paper
Knowledge of major biology theories	• Inadequate evidence of understanding of relevant biology concepts	• Basic evidence of understanding of relevant biology concepts	• Clear and adequate evidence of understanding of relevant biology concepts	• Clear and comprehensive evidence of understanding of relevant biology concepts
Methods (data collection/anal)	• No explanation or justification of research design • Methodology is unclear and incomplete	• Some explanation of research design, but no justification • Methodology is basic, but incomplete	• Clearly explains research design, but no justification • Explains methodology	• Clearly justifies and explains research design • Clearly explains methodology
Results	• Graphs and tables are poorly/inaccurately done • One or more pieces of data inaccurately interpreted in text with many opinion statements.	• Graphs and tables are inaccurate/missing labels with some errors • Usually accurately summarizes tables and graphs in text with obvious opinions	• Graphs and tables are adequate • Accurately summarizes the tables and graphs in text with some opinion	• Graphs and tables are professional • Accurately summarizes the tables and graphs in text w/o opinion
Conclusion(s)	• Fails to identify conclusions, or conclusion is a simplistic summary • Conclusion presented as “proof"	• Identifies conclusions and refers to some specific pieces of evidence • Does not relate conclusion to the broader field	• Clearly links evidence with the conclusion • Minimal consideration of limitations	• Clearly links evidence with the conclusion • Considers limitations of the study

Learning Outcome:

PLO #3: Demonstrate knowledge and skills in critical thinking, such as analysis and synthesis, as applied to primary literature in the field of biology.

Outcome Measures:

MS exam questions on analysis of three research papers (direct measure)

MS written version of thesis (direct measure)

Criteria for Success:

100% of students will score at "developed" or higher on rubric

Longitudinal Data:

Measure		**% of students achieving "developed" or "highly developed"**						
	2015-2016	2016-2017	2017-2018	2018-2019		2019-2020	2020-2021	2021-2022
MS exam – non-thesis option	N=2	N=5	N=10	N=6		N=10	N=8	N=13
	100%	100%	100%	100%	No revisions	40%	62.5%	69%
					Revisions to 1-2 answers	30%	25%	15%
					Revisions to 3-4 answers	10%	-	15%
					Revisions to 5+ answers	20%	12.5%	-
MS thesis-written portion (Thesis option)	N=2	N=2	N=0	N=1	N=0	N=1	N=0	N=2
	100%	100%	-	100%	-	100%	-	100%

Conclusions Drawn from Data:

Most graduating students are performing well and meeting the criterion, although some need to revise answers. Many students are taking at least 1-2 Reading in Biology courses or Perspectives of Science courses during the program which provide extra practice in analyzing articles; continued improvement in seen as a result.

Changes to be Made Based on Data:

All students will be strongly encouraged to at least one of our 1-unit elective readings courses to prepare for this portion of the exam.

Rubric used:

Appendix A: Rubric for MS exam, Part I: Research article analysis – shaded rows

Appendix B: Rubric for MS thesis (written) – shaded row

Appendix A: Rubric for MS exam, Part I: Research article analysis (shaded row pertains to PLO #2)

Aspect of answer	Initial (fail)	Emerging (fail)	Developed (pass)	Highly Developed (pass)
General relevance to field	Missing	Unclear	Clear, but not accurate or unclear, incomplete or lacks depth of analysis	Clear and accurate
General problem/ question	Missing	Unclear	Clear, but not accurate or incomplete	Clear and accurate
1st major claim	Identified claim is inaccurate or not important	Identified claim is inaccurate or incomplete or lacks depth	Accurately identified claim, but not a main claim	Accurately identified the one of most important claims
Evidence	Specific data is not identified or does not match the claim	Relevant tables, figures, etc. are mentioned but no specific areas	Specific areas of relevant figures, tables, etc. are correctly identified	Specific areas of relevant figures, tables, etc. are correctly identified
Justification	Justification missing for claim	Weak attempt made to justify claim, but inaccurate, incomplete, or unclear	Justification given for why data supports the claim, but not clear or incomplete	Clear justification as to why the data supports the claim
Methods	Methods missing AND not in own words	Missing some major methods OR not in own words	Major methods identified in own words, but unclear	Major methods clearly identified in own words

Appendix B: Rubric for MS thesis (written) – shaded row pertains to PLO #2

Component	Initial (70%)	Emerging (80%)	Developed (90%)	Highly Developed (100%)
Problem, question and/or hypothesis	• Fails to identify or summarize problem accurately • No indication of purpose of the research	• Summarizes the problem, though some aspects are incorrect or confusing • Some indication of purpose of the research	• Clearly identifies the problem • Clearly articulates the purpose of the research	• Clearly identifies the problem as well as nuanced aspects or key details • Clearly articulates the purpose of the research, beyond the narrow field
Choice of and use of relevant literature	• References not appropriately integrated into the paper	• Fewer than 35 references appropriately integrated into the paper	• 35-50 references appropriately integrated into the paper	• 50+ ref. appropriately integrated into paper
Knowledge of major biology theories	• Inadequate evidence of understanding of relevant biology concepts	• Basic evidence of understanding of relevant biology concepts	• Clear and adequate evidence of understanding of relevant biology concepts	• Clear and comprehensive evidence of understanding of relevant biology concepts
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Results	• Graphs and tables are poorly/inaccurately done • One or more pieces of data inaccurately interpreted in text with many opinion statements.	• Graphs and tables are inaccurate/missing labels with some errors • Usually accurately summarizes tables and graphs in text with obvious opinions	• Graphs and tables are adequate • Accurately summarizes the tables and graphs in text with some opinion	• Graphs and tables are professional • Accurately summarizes the tables and graphs in text w/o opinion
Conclusion(s)	• Fails to identify conclusions, or conclusion is a simplistic summary • Conclusion presented as “proof"	• Identifies conclusions and refers to some specific pieces of evidence • Does not relate conclusion to the broader field	• Clearly links evidence with the conclusion • Minimal consideration of limitations	• Clearly links evidence with the conclusion • Considers limitations of the study

Learning Outcome:
PLO #4: Distinguish between science and faith, and discuss the potential compatibility of the two domains.

Outcome Measure:
Indirect assessment: Alumni survey question
Direct assessment: Signature assignment added in 2015 to BIO 6033 (History & Philosophy of Science)

Criteria for Success:
Indirect assessment: At least 80% of students will "agree" or "strongly agree" that they are able to "Distinguish between science and faith, and discuss the potential compatibility of the two domains" as a result of the program.
Direct assessment: At least 80% of students will score at "developed" or higher for both rows on the rubric

Longitudinal Data:

Assessment	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
Alumni survey (Indirect)	50% strongly agreed with the statement, 16.7% agreed with the statement	Data not collected this year*	Data not collected this year*	Switched to two distinct questions (below)	Data not collected this year*
Alumni survey (Indirect): *Did the program coursework help you to distinguish between the types of questions science faith can answer?*				40% strongly agreed with the statement, 27% agreed with the statement	
Alumni survey (Indirect): *Did the program coursework (assignments, discussions) include the potential compatibility of science and faith?*				53% strongly agreed with the statement, 13% agreed with the statement	
BIO 6033 Signature assignment (Direct): *Explanation of the distinction between religious faith and science*	N=15		N=16	N=14	N=12
	60%	Data not collected this year**	62%	54%	60%
BIO 6033 Signature assignment (Direct): *Articulation of the possibility of a relationship and compatibility of the two domains*	100%	Data not collected this year**	94%	93%	100%

*Alumni survey is only conducted every 3 years.
**BIO 6033 has been offered once every other year, but starting in 2019, it is offered every year.

Conclusions Drawn from Data:

In BIO 6033, almost all students see the possibility of compatibility of science and faith, but a significant percentage are still not clearly distinguishing between science and faith. In the alumni survey, we are now collected more data to get more specific student responses, but the percentages are still lower than desired.

Changes to be Made Based on Data:

Instruction in BIO 6033 will continue to be adjusted to address more clearly that science focuses on what, where, how, and when questions regarding the physical world, while faith addresses supernatural issues and questions related to "why?" in attempt to have a greater percentage of students at the "developed" level or higher.

Questions used on Alumni Survey (indirect assessment)

a. Did the program coursework (assignments, discussions) help you to distinguish between the types of questions science can answer and the types of questions faith can answer?
b. Did the program coursework (assignments, discussions) include the potential compatibility of the two domains (science and faith)?

Rubric used:

BIO 633 Signature Assignment and Rubric for PLNU Graduate Biology program PLO#4

Signature assignment:

a. In a 200-300 word essay, distinguish between science and faith.
b. In a 200-300 word essay, discuss the potential compatibility of the two domains within the context of explanations for the diversity of life on earth.

Component	Initial (70%)	Emerging (80%)	Developed (90%)	Highly Developed (100%)
Explanation of the distinction between religious faith and science	Minimal or inaccurate description of both science and religious faith	Basic description of both science and religious faith	Good description of both science and religious faith	Excellent and thorough description of both science and religious faith
Articulation of the possibility of a relationship and compatibility of the two domains	Denies the possibility of a relationship/ intersection between religious faith and science	States ambivalence about the possibility of a relationship/ intersection between religious faith and science	Acknowledges the possibility of a relationship/ intersection between religious faith and science.	Fully embraces possibility of a relationship/ intersection between religious faith and science, and provides personal evidence of such a relationship