Annual Assessment Report

Department: Physics and Engineering
Academic Year: 2021–2022
Date of Submission: August 31, 2022
Department Chair: Bob Haring-Kaye

I. Response to the previous year PRC's recommendations

Quality of Evidence and Measurement Instruments: It is clear that faculty collect quality, reliable and valid evidence to assess the two different PLO's under consideration. The measuring instruments identified include the Major Field Test in Physics and a new laboratory assessment rubric based on AAC&U VALUE Rubrics guidelines. We encourage the department to be faithful in collecting data through these assessment instruments on a yearly basis to ensure a larger sample size at the time of the next review of the relevant PLO's.	**Response:** We have continued to collect data using these direct-measurement instruments this past academic year. Please see Sec. II for more detailed information, including the results and their interpretations.
Methods of Assessment: Only direct methods of assessment are identified and used. We recognize that the department did assess two PLO's and a key question, while also being engaged in significant program development and faculty hiring.	**Response:** We designed and implemented a new indirect method of assessing our learning objectives during the summer of 2022. We administered a survey to our departmental majors who graduated one year ago (Class of 2021) and a similar survey to those who graduated five years ago (Class of 2017) in an effort to gauge the longitudinal effectiveness of our physics program. Questions solicit feedback on the impact of various aspects of our program including courses taken within the major, research experiences, and our departmental faith-learning integration. The new surveys are included in Appendix A. We are considering the development of a similar survey for our current senior majors and administering it shortly before they graduate.

Use of evidence: Report on the progress of the proposed Closing the Loop Activities in future annual reports.	**Response:** Please see Sec. II of this report.
Notes:	

II A. Program Learning Outcome (PLO) assessment

If your department participated in the ILO assessment you may use this section to report on your student learning in relation to the assessed ILO. The assessment data can be requested from the Dean of Curriculum and Educational Effectiveness.

Program Learning Outcome	**Critical Thinking**
Who is in Charge /Involved?	Department Chair
Direct Assessment Methods	Major Field Test (MFT) in Physics
Indirect Assessment Methods	
Major Findings	The MFT in Physics was administered to two (*N* = 2) graduating Physics and Engineering Physics majors in April 2022. The average scores in the subcategories of Introductory Physics and Advanced Physics, as well as the Overall Scaled Score and Percentile Ranking among national scores collected within a recent time period, are compared with those of the same majors in 2021 (*N* = 8), 2019 (*N* = 5), 2018 (*N* = 4), and 2017 (*N* = 5) in a histogram chart included with this report (see Appendix B). (The MFT was unavailable in 2020 due to the pandemic.) The results in each assessment category for the 2022 cohort are generally higher than the others obtained within the past five years, however one must exercise caution when drawing conclusions from such a small sample size. In fact, the statistical uncertainties (standard deviation of the mean) for each average value are also larger than the corresponding ones for the other years indicated in the histogram. That said, we prefer to separate the results gathered each year from one another, rather than combine them to increase the overall statistics, to look for annual trends in the data. Comparing the data this way, each of the indicated average scores in the histogram for the 2017–2022 cohorts generally agree with each other within their respective statistical uncertainties.

Closing the Loop Activities	We plan to revisit the departmental student learning objectives and curricular map now that the department is fully restaffed at the start of the 2022–23 academic year. Since the MFT exam is similar in content to the Physics GRE subject test, which some of our students take as part of their graduate school application, perhaps our students could benefit from a targeted review of the exam material and a related discussion of test-taking strategies during their senior year. This could potentially be integrated into either our existing senior seminar course or a senior research experience for our majors.
Collaboration and Communication The assessment data are shared among department faculty and discussions about closing the loop activities will be ongoing.	
Program Learning Outcome	**Skills: Oral/Written**
Who is in Charge /Involved?	Professor of Senior Seminar course (PHY–195), PHY–022 (General Physics Lab I), PHY–024 (General Physics Lab II), and PHY–026 (Modern Physics Laboratory)
Direct Assessment Methods	Faith-learning paper in PHY–195, individual abstracts and discussion sections (primarily incorporating experimental error analysis, interpretations, and conclusions) in the final lab reports submitted in PHY–022, PHY–024, and PHY–026. (Note that PHY–022 and PHY–024 are typically taken by first-year majors, and PHY–026 by second-year majors.) We continued the use of a laboratory assessment rubric developed the previous academic year that follows the guidelines and structure of the Association of American Colleges and Universities (AAC&U) VALUE rubrics (see Appendix C). The rubric allows for a robust assessment of both writing and experimental skills across our entire laboratory curriculum. This year, abstracts and discussion sections for students in PHY–022, PHY–024, and PHY–026 were evaluated using assessment dimensions (rows) 1 and 4 of the rubric. The faith-learning paper in PHY–195 was assessed using an existing rubric specifically designed for this purpose.
Indirect Assessment Methods	
Major Findings	PHY–195: The faith-learning papers of two graduating senior majors were evaluated according to the corresponding assessment rubric (see Appendix D). The overall average score of 21.0 ± 0.6 indicates a solid degree of proficiency (the maximum score is 24) with a small variance between the students. PHY–022 and 024: The laboratory assessment rubric described above was used to assess the individual abstract and discussion sections of 18 (16) students in PHY–022 (PHY–024) during the Fall 2021 (Spring 2022) semester. The overall average scores in the “Understanding the Purpose of the Experiment” and “Interpretation of the Results” assessment

	dimensions for PHY–022 were 2.3 $\pm$ 0.2 and 2.6 $\pm$ 0.1, respectively. The corresponding scores in PHY–024 were 2.3 $\pm$ 0.2 and 2.4 $\pm$ 0.2, respectively. Referring to the rubric, these scores indicate a beginning "milestone" development in understanding and expressing the "big picture" of the experiment under study, perhaps not surprising given the introductory nature of the lab experience. The scores across both semesters agree with each other (within their respective statistical uncertainties) and with the same assessment dimension scores from the previous academic year for these two courses. PHY–026: Applying the same rubric to the four students who submitted final reports in this course with individually-written abstracts and discussion sections, we obtained an average overall score of 3.0 $\pm$ 0.0 (2.0 $\pm$ 0.0) for the "Understanding the Purpose of the Experiment" ("Interpretation of the Results") dimension. Perhaps not surprisingly, these scores suggest that the students' overall understanding of a given experiment is generally stronger than that in the introductory physics environment. However, their average interpretive skills show no evidence of improvement compared to those in the introductory lab courses. Of course, our conclusions are necessarily limited by the fact that different experiments and groups of students are included in these comparisons. Interestingly, however, we could track one student longitudinally through the three-course lab sequence based on the assessments performed over the past two years. In the course progression of PHY–022, PHY–024, and PHY–026, this student received scores of 3, 2, and 3 (respectively) in the "Understanding the Purpose of the Experiment" category and scores of 3, 3, and 2 (respectively) in the "Interpretation of the Results" category. Although very little can be learned about the curriculum from one student, we are nevertheless hopeful that with additional assessment data we can draw more meaningful conclusions.
Closing the Loop Activities	We plan to use the same laboratory assessment rubric in PHY–170 (Advanced Physics Laboratory) during the Fall 2022 semester to track average development in sophistication when writing abstracts and discussion sections for a few of our junior and senior majors. We also anticipate being able to track the longitudinal development of two students who were assessed with this rubric in PHY–022 and PHY–024 during the 2020–2021 academic year (though unfortunately there will be a gap in the availability of assessment data for PHY–026). In addition, this same rubric will be used to assess laboratory skills (mostly data acquisition, analysis, and interpretation) across our lab curriculum this upcoming academic year. We plan to use these data to gauge the relative importance of PHY–170 in reaching the "capstone" level of understanding shown in the rubric. In any case, we will use the results of the writing and laboratory assessments to reevaluate how our laboratory curriculum helps fulfill our student learning objectives.

Collaboration and Communication
The assessment data are shared among department faculty and discussions about closing the loop activities will be ongoing.

Program Learning Outcome	**Skills: Christian Orientation**
Who is in Charge /Involved?	Professor of Senior Seminar course (PHY–195), Department Chair
[Direct Assessment Methods]	Faith-learning paper in PHY–195, assessed using an existing rubric specifically designed for this purpose.
[Indirect Assessment Methods]	Survey of one- and five-year graduates in the major
Major Findings	PHY–195: As mentioned earlier, the faith-learning papers of two graduating senior majors were evaluated according to the corresponding assessment rubric (see Appendix D). The overall average score of 21.0 ± 0.6, which includes evaluations of both the students' writing ability ("Organization" and "Style and Mechanics" assessment dimensions) and their development of a faith-integration thesis ("Ideas," "Support for Thesis," and "Depth of World View" assessment dimensions), indicates a solid degree of proficiency (the maximum score is 24) with a small variance between the students. However, we note that the "Depth of World View" category revealed the weakest degree of sophistication for both students. In general, their descriptions of individual experiences and opinions were strong, but their integration of ideas and concepts from multiple sources in the literature was rather underdeveloped. Surveys: The one- and five-year alumni surveys (see Appendix A) were just developed and administered this past summer so our available feedback is still rather limited (the response rate to date is 18% on the one-year survey and 0% on the five-year survey). However, based on the responses we have received so far, it appears that our Senior Seminar course and the personal one-on-one mentoring that we provide our students have been impactful aspects of our departmental faith-learning integration.
Closing the Loop Activities	Instead of reading two books to completion in our Senior Seminar course, we may consider assigning shorter readings from multiple sources to expose our students to more viewpoints on integrating the Christian faith and science. Since we will have our first graduating class of engineering majors this upcoming academic year, we are also planning to combine some of their activities with those of the graduating physics majors to enrich the classroom discussions with more students involved in them. We also plan to discuss the feedback from the surveys as a department once we have more input available.
Collaboration and Communication	

The assessment data are shared among department faculty and discussions about closing the loop activities will be ongoing.

or/and

II B. Key Questions

Key Question	There was no key question for the 2021–2022 academic year stated in our 2018–2024 departmental assessment plan. However, given the recent and upcoming retirements of physics faculty in our department, a relevant question might be “Can we hire physics profs to replace Ken and Michael?”
Who is in Charge/Involved?	All departmental faculty as well as additional members of the 2021–2022 Physics Search Committee consisting of Rick Ifland (Acting Provost), Michael Everest (Chemistry), and Lesa Stern (Communications).
Direct Assessment Methods	Results of the hiring process
Indirect Assessment Methods	
Major Findings	Jennifer Ito was hired to join our department faculty as an Assistant Professor of Physics and Astronomy beginning this August, effectively replacing Michael Sommermann. This brings the number of full-time, tenure-track faculty in physics and engineering to six (three in physics and three in engineering). We were also able to hire a full-time Lab Manager (Will Allison) to assist with both the physics and engineering programs prior to the start of the previous academic year.
Recommendations	Faculty mentoring will be an important part of our work together given all of the new members who have joined the department recently. Also, fundraising for the engineering program remains a critical component so we don’t burden the college operating budget (see Sec. III).
Collaboration and Communication: All members of the department are involved in ongoing discussions.	

III. Follow-ups

Program Learning Outcome or Key Question	1. Building the engineering program, including the addition of faculty members, and hiring physics faculty to replace those who are retiring. 2. Fundraising for the engineering program.
Who was involved in implementation?	All department members as well as members of the associated search committees.
What was decided or addressed?	1. In the past two years, we hired two new engineering faculty (Johan Estrada-Lopez and Doug Fontes), a department Lab Manager (Will Allison), and replacements for Ken Kihlstrom (Ben Carlson) and Michael Sommermann (Jen Ito). 2. The ongoing fundraising efforts specifically target capital equipment, facility needs, endowment for staffing, and ongoing operating expenses. We are also looking into the possibility of fundraising to support the (increasingly expensive) housing needs of the new faculty.
How were the recommendations implemented?	1. See previous statement. 2. Dan Jensen has been collaborating with Reed Sheard and his staff on this front, securing grants from the Fletcher Jones ($475,000) and MERICOS ($300,000) Foundations. Dan was also able to secure smaller grants to support the Junior Design and Senior Capstone courses.
Collaboration and Communication: All departmental faculty we involved and there were ongoing discussions with Eileen, Reed, Rick, and the search committee members.	

IV. Other assessment or Key Questions related projects

Project	ABET accreditation
Who is in Charge /Involved?	Dan Jensen is leading the effort and the departmental faculty (especially the engineering faculty, Lab Manager, and Department Chair) are playing a supporting role.
Major Findings	Achieving ABET accreditation is an exhaustive process involving several components, many of which need to be completed this upcoming academic year (including an extensive Self Study). We will officially apply for accreditation once we have graduated our first class of engineering students next spring.
Action	We are currently in the process of finalizing the Westmont Engineering Program Educational Objectives (PEOs), developed in coordination with our Engineering Advisory Board. The PEOs are broad, general statements describing what our program is preparing our graduates to achieve a few years after graduation.

Collaboration and Communication: Ongoing discussions among the department faculty and staff.

Project	Assessment of Student Learning in Engineering Program
Who is in Charge /Involved?	Dan Jensen is leading the effort and the engineering faculty are playing a supporting role.
Major Findings	ABET, the Engineering Accreditation Organization, mandates that we assess 7 student learning outcomes. This assessment process is quite detailed and also incorporates a continuous improvement aspect. The ABET assessment accreditation process involves assessment in 7 other areas as well including items such as curriculum, facilities, faculty, etc. The full ABET assessment plan for Westmont Engineering is available upon request.
Action	The assessment process is ongoing following the ABET guidelines and procedures.
Collaboration and Communication: Ongoing discussions among the department faculty and staff.	

V. Adjustments to the Multi-year Assessment Plan (optional)

Proposed adjustment	Rationale	Timing

VI. Appendices

A. Prompts or instruments used to collect the data
B. Rubrics used to evaluate the data
C. Relevant assessment-related documents (optional)

Appendix A

One-Year Alumni Survey
Department of Physics and Engineering, Westmont College

One of the procedures that the Department of Physics and Engineering uses to assess our student learning outcomes is to poll our alumni one and five years after graduation to find out their views of the nature and quality of their experiences in our department. In addition to providing summaries of this information in our annual assessment reports, we hope to use it to improve our program for our current and future majors.

Graduation year:

1. What are you doing currently? (Are you employed, in graduate school, etc. and where?)

2. On a scale of 1 to 5 (1 = lowest, 5 = highest), how confident of your abilities are you in your current situation?

3. How does your college preparation compare with your peers at work or school? In what area(s) do you feel better prepared than your peers? In what area(s) do you feel lacking in preparation?

4. What specific skills that you learned and specific courses that you took are most useful to you now?

5. Using the same 1 to 5 scale defined above, how impactful are your experiences as a physics/engineering/engineering physics major in your current employment/schooling?

6. What aspect(s) of our departmental faith-learning integration have been most helpful to you at this stage of your personal, professional, and spiritual journey? Are there ways that we could incorporate this integration better?

7. Did you participate in a research experience while at Westmont?

8. If yes, in what context? (Department semester, department summer, REU program, industry internship, other)

9. Briefly describe your research experiences and contributions to the larger project.

10. In what ways did you find your research experiences beneficial?

11. What course(s) would you have liked to have taken at Westmont but didn't/couldn't? (The course(s) may have been offered and you didn't take it, or it may not have been offered.) Why do you wish you had taken this/these course(s)?

12. In what area(s) is our program strong?

13. In what area(s) does our program need work? How specifically can we improve?

14. Other comments or suggestions:

Five-Year Alumni Survey
Department of Physics and Engineering, Westmont College

One of the procedures that the Department of Physics and Engineering uses to assess our student learning outcomes is to poll our alumni one and five years after graduation to find out their views of the nature and quality of their experiences in our department. In addition to providing summaries of this information in our annual assessment reports, we hope to use it to improve our program for our current and future majors.

Graduation year:

1. What have you done since leaving Westmont? (Employment, graduate school, etc.)

2. What are you doing currently? (Are you employed, in graduate school, etc. and where?)

3. Using a 1 to 5 scale (1 = lowest, 5 = highest), how impactful are your experiences as a physics/engineering/engineering physics major in your current employment/schooling?

4. What specific skills that you learned and specific courses that you took are most useful to you now?

5. Did you participate in a research experience while at Westmont?

6. If yes, in what context? (Department semester, department summer, REU program, industry internship, other)

7. Briefly describe your research experiences and contributions to the larger project.

8. In what ways did you find your research experiences beneficial?

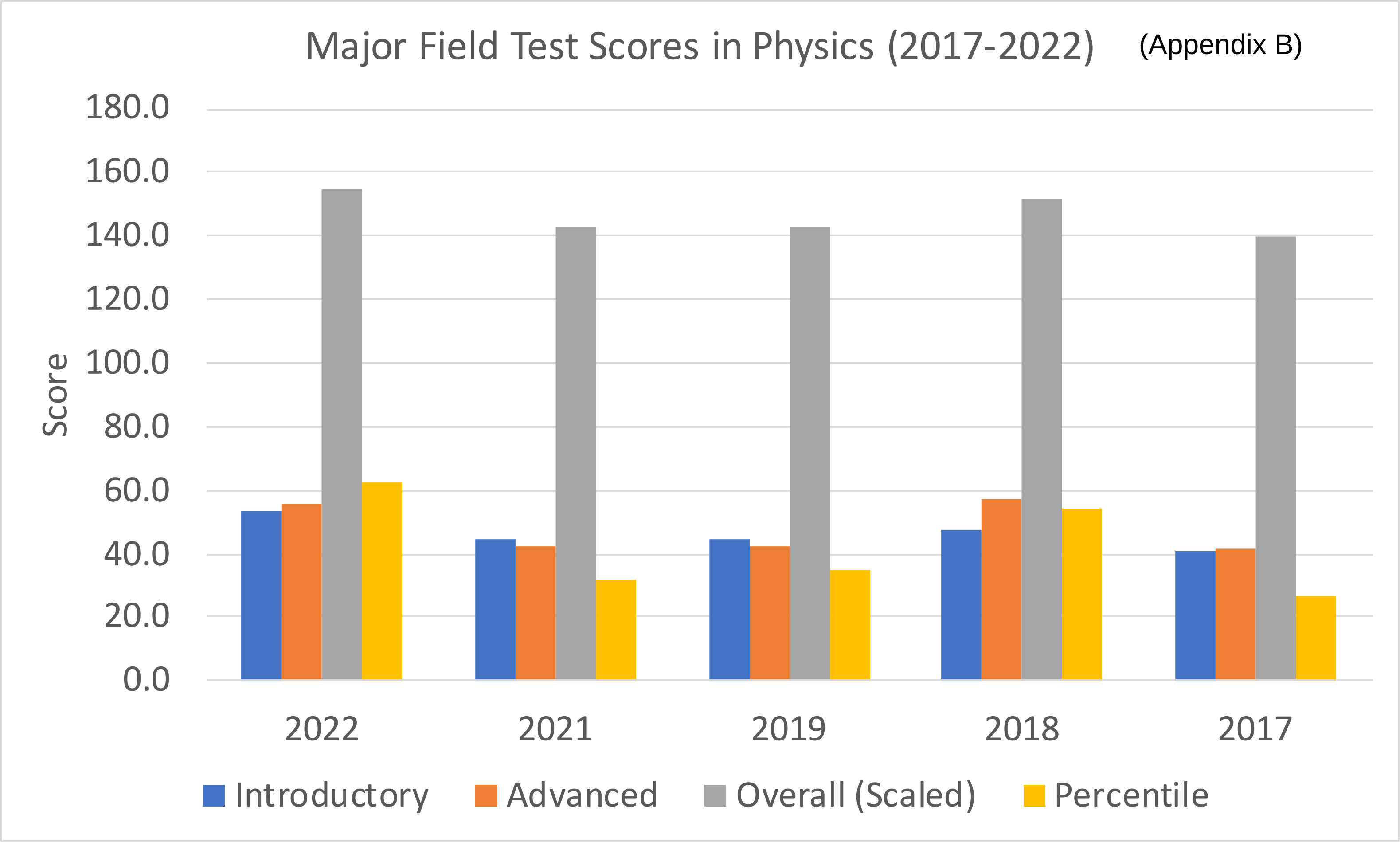
9. What aspect(s) of our departmental faith-learning integration have been most helpful to you at this stage of your personal, professional, and spiritual journey? Are there ways that we could incorporate this integration better?

10. What course(s) would you have liked to have taken at Westmont but didn't/couldn't? (The course(s) may have been offered and you didn't take it, or it may not have been offered.) Why do you wish you had taken this/these course(s)?

11. What (other) aspect(s) of your Westmont education were lacking?

12. In what ways do you think our program could be improved? Please be as specific as you can.

13. Other comments and suggestions:



Major Field Test Scores in Physics (2017-2022)
(Appendix B)
Score
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
2022
2021
2019
2018
2017
Introductory
Advanced
Overall (Scaled)
Percentile

Appendix C

WESTMONT PHYSICS LABORATORY EXPERIENCE VALUE RUBRIC

Definition

All physics majors in the Department of Physics and Engineering are required to complete a three-course laboratory sequence (PHY–022, 024, and 026) at the beginning of their major coursework. This rubric assesses the students' work and understanding as demonstrated longitudinally throughout this laboratory sequence. *Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet the benchmark (cell one) level performance, or use N/A.*

	Capstone 4	**Milestones** 3	 2	**Benchmark** 1
Understanding the Purpose of the Experiment *Ability to appreciate why the experiment is performed and what will be learned from it*	Correctly **identifies** and **articulates** the relevant physical concepts and **adapts** and **applies** these concepts to generate new ideas related to the questions at hand. Sees the big picture and not just the details/calculations, yet is cognizant of nuances and assumptions. Able to identify and discuss how results add to or reinforce previous works about the topic under study.	Correctly **identifies** and **articulates** the relevant physical concepts and **applies** these concepts to the questions at hand. Sees the big picture and not just the details/calculations.	**Identifies** many of the relevant physical concepts and **correlates** these concepts to the measurements being performed.	Demonstrates a basic understanding of the physics ideas related to the experiment, but perhaps incompletely and/or with some errors.
Quality of the Data *Ability to perform careful measurements and obtain meaningful results*	Designs and effectively implements appropriate measurement methods or numerical calculations to collect or generate high-quality data that can be processed for further analysis and interpretation.	Measurement methods or numerical calculations allow students to collect or generate **high-quality** data that can be processed for further analysis and interpretation.	Measurement methods or numerical calculations allow students to collect or generate reasonable data that can be processed for further analysis and interpretation.	Measurements contain errors that are not recognized or accounted for.
Quality and Sophistication of Data Analysis *Ability to analyze data correctly using appropriate methods and strategies*	Analyzes data appropriately and thoroughly. Carefully considers and analyzes potential sources of systematic and random error and mediates the sources to the extent possible. Sophisticated methods (such as computer coding) are used to provide appropriate quantitative estimates of the degree of random error.	Analyzes data appropriately. Considers and analyzes potential sources of systematic and random error. Properly infers indirect measurements (with their uncertainties) from graphs. Data tables are properly organized and labeled, and data values have appropriate significant figures based on the estimated measurement precision.	Data analysis includes some quantitative error analysis (such as the determination of the degree of random error) and graphs with appropriate titles, axes labels, units, and curve fits. Data tables are properly organized with appropriate column labels.	Data analysis is simplistic, incomplete, and/or contains several mistakes.
Interpretation of the Results *Ability to correctly discuss the meaning and significance of the results.*	Discussion of the significance of the results is clear, compelling, correct, complete and sophisticated. Interpretations and conclusions convey a deep understanding of the topic under study, and may point toward insightful improvements if the experiment was repeated.	Discussion of the significance of the results is clear, correct and complete. Interpretations and conclusions convey a solid understanding of the topic under study.	Discussion of the significance of the results is largely correct, but may be incomplete. Interpretations and conclusions suggest the student understands most of the topic under study.	Interpretations and conclusions are basic, and may be incomplete and/or may contain misunderstandings or errors.

Appendix D

Faith-Learning Writing Rubric

	Below Basic	Basic	Proficient	Advanced
Ideas	Shows minimal engagement with the topic, fails to recognize multiple dimensions & perspectives; lacks even basic observations	Shows some engagement with the topic but without elaboration; offers basic observations but without original insight	Demonstrates engagement with the topic, recognizing multiple dimensions and/or perspectives; offers some insight	Demonstrates engagement with the topic, recognizing multiple dimensions and/or perspectives with elaboration and depth; considerable insight
Support for Thesis	Little or no evidence provided	Some evidence but not enough to develop argument in a unified way. Evidence may be inaccurate, irrelevant or inappropriate for the purpose of the essay	Evidence accurate, well documented, and relevant but not complete, well integrated, and/or appropriate for the purpose of the essay	Evidence accurate, well documented, relevant, complete, well integrated, and appropriate for the purpose of the essay
Organiza-tion	Organization is missing both overall and within paragraphs, Introduction and conclusion may be lacking or illogical.	Organization, overall and/or within paragraphs, is formulaic or occasionally lacking in coherence; few evident transitions. Introduction and conclusion may lack logic	Few organizational problems on any of the three levels (overall, paragraphs, transitions). Introduction and conclusion are effectively related to the whole.	Organization is logical and appropriate to assignment; paragraphs are well-developed and appropriately divided; ideas linked with smooth and effective transitions. Intro. and conclusion are effectively related to the whole.
Style and Mechanics	Multiple and serious errors of sentence structure; frequent errors in spelling, capitalization, punctuation hindering communication. No sign of proofreading	Sentences show errors of structure and little variety; errors of spelling, capitalization, punctuation cloud meaning. Insufficient proofreading	Effective and varied sentences; some errors in sentence construction; minor and rare errors in spelling, capitalization and punctuation	Each sentence structured effectively; rich and well-chosen variety of sentence styles and lengths; virtually free of mechanical errors
Depth of World View	Addresses neither faith nor science with personal or intellectual insight beyond platitudes or the trivial	Shows some insight in either faith or science but not both. Overly relies on the personal or intellectual to the expense of the other	Competently address both science and faith with insight and maturity. Displays knowledge of faith/science literature but brings own perspective	Provides a truly integrated view of science and faith, honoring both realms. Is able to support personal insights with wisdom from published literature.
Overall	In both content and writing quality the work is substandard	There is potential quality demonstrated but not sustained.	The writing and ideas combine to make an informative paper.	The insights demonstrated are remarkable and the writing is a pleasure to read.

2022 results:

Student	Rubric score
A	20
B	22
AVERAGE	21.0
ST DEV	1.4
ST DEV MEAN	0.6