

Weber State University
Biennial Report on Assessment of Student Learning

Cover Page

Department/Program: **Microbiology**
Academic Year of Report: 2021-2022 and 2022-2023
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Program page link: <https://www.weber.edu/ie/Results/Microbiology.html>

A. Mission Statement

Information is current; no changes required: YES

Update if not current:

B. Student Learning Outcomes

(Please include certificate and associate credential learning outcomes)

Information is current; no changes required: NO

In Fall 2023, the Department developed new program-level outcomes. These outcomes were developed after examining program outcomes from similar microbiology majors at other institutions, including, UC Davis, Oregon State University, Montana State University, Brigham Young University, Utah Valley University, Northern Arizona University, and The University of Arizona. We also consulted the American Society for Microbiology's list of curriculum guidelines for concepts, competencies, and skills in microbiology (<https://asm.org/guideline/asm-curriculum-guidelines-for-undergraduate-microb>).

Program outcomes:

Graduates of our program will be able to:

1. **Core concepts:** Demonstrate a working knowledge of the core concepts of microbiology: microbial structures and functions, microbial genetics, microbial ecology, evolution, and microbial physiology.
2. **Impact of microbes:** Evaluate the impact and importance of microbes on human health and the environment.
3. **Scientific thinking:** Design experiments, and collect and evaluate data from a variety of scientific experiments, using problem solving, quantitative reasoning, graphical representation, and statistical analysis.
4. **Laboratory skills:** Demonstrate proficiency in laboratory skills needed for the identification, quantification, and analysis of microorganisms and microbial communities, and will be knowledgeable of laboratory safety practices.
5. **Career-building skills:** Develop important career skills such as oral and written communication, multimedia, collaboration, and application of ethics.

All outcomes are introduced and practiced in the five core microbiology courses. One or more outcomes are practiced and further developed in each elective course.

C. Curriculum Grid

Information is current; NO

	Core concepts	Impact of Microbes	Scientific Thinking	Laboratory Skills	Career-building skills	HIEE Designation
Required Core Courses						
2054, Principles of Micro (LS)	I (A – LS outcomes)	I, A	I	I, A		
3053, Micro Procedures			P	M, A	M,A	
3154, Micro Ecology (CRE)	M (ecology & evolution),A	P	M,A			A
4054, Micro Physiology	M (physiology),A					
4154, Micro Genetics	M (genetics),A		P, A			
Elective Courses						
3012, Global Public Health (GBL)		M,A				A
3254, Immunology	P			P		
3305, Medical Microbiology				P	P,A	
3403, Tropical Diseases (GBL)	P	P				A
3484, Environmental Micro	P, A			M, A		
3502, Environmental Health (SUS)		M, A				A
3753, Geomicrobiology (CRE)		P, A				A
3813, Bioinformatics (CRE)			P,A			A
3853, Food Microbiology		M, A		M,A	M	
4252, Cell Culture				M	P	
4354, Industrial Microbiology				M	M, A	
4554, Virology	P,A		P	P,A		
High Impact Courses						
4800, Directed Research				M		A
4830, Directed Readings			M		A	A
4991, Micro Seminar					M	

I = Introduced

P= Practiced within the course: most courses address each of the program outcomes, courses where an outcome is practiced indicates it is an important component of the course

M = Mastered

A = Assessed

High Impact Educational Experiences happen in most of our courses through labs, field trips, and active learning. However, courses with a HIEE designation (CRE; SUS; or GBL) will be assessed as shown above for the outcomes associated with each designation.

D. Program and Contact Information

Information is current; no changes required: YES

Update if not current:

E. Assessment Plan

Information is current; no changes required: NO

Going forward (beginning Fall 2023) we will use an outcome-based assessment based on the new program learning outcomes. Each outcome will be assessed in the courses indicated in the grid using one or more assignments and reported by the faculty to the department chair. Assessment outcomes will be reported to the department in an annual spring department meeting. Outcomes from assessments will be compiled for the biennial assessment report.

Timeline:

General Education: Assessed each year

Program outcomes:

2023-2024: All outcomes will be assessed in *required* microbiology courses for preparation of the 2024 program review.

2024-2025: Outcomes assessed: Core concepts & Impact of Microbes

2025-2026: Outcomes assessed: Scientific Thinking & Laboratory Skills

2026-2027: Outcomes assessed: Career-building skills & HIEE

Assessment Strategy:

General Education Courses:

- All faculty are now including assessment questions tagged to natural science and life science learning outcomes in general education courses.
- General education courses will be assessed annually in at least 2 sections. Data will be compiled by the department chair for inclusion in assessment reports.
- For this report, individual instructors have been assigned to compile assessment data from one of their general education courses.

Program Outcomes:

- In Fall 2023, the department finalized our new learning outcomes and established the curriculum grid (above). By the end of Spring 2024 faculty will propose how outcomes will be assessed in each class, and will present one semester of data.

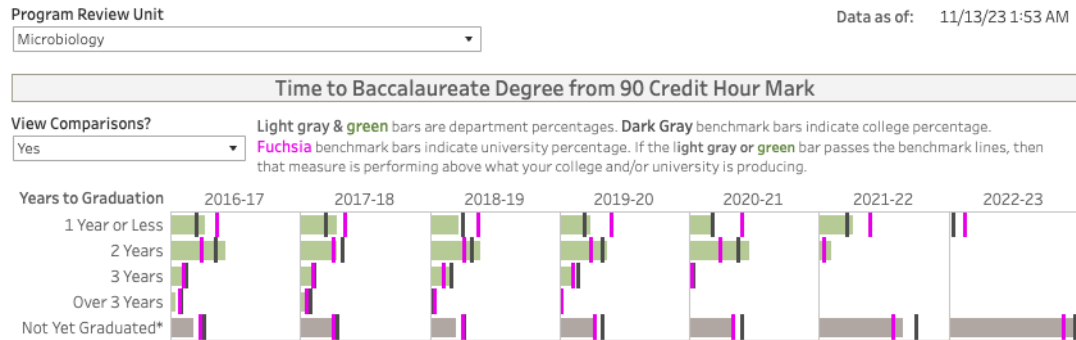
Gathering data & reporting:

- Faculty will collect data in the spring of 2024 and report that data at a department meeting focused on 2023-2024 assessment

- Data will be compiled and reported in a narrative format.

F. Student Achievement

Time to Graduation:



Although the Microbiology major can be completed in 120 credits, Microbiology majors graduate, on average, with about 150 credits (5-year average). This explains why our majors time to graduation from 90 credits, within one year, is similar to other majors within the College of Science, but is well below the University benchmark. However, the department surpasses the benchmarks for both the College and University for graduation within two years. This is consistent with taking an extra 30 credits. Many microbiology students, as well as other majors in the College of Science, take extra coursework in preparation for professional school, which accounts for most of the credits above 120 credits. It is also common for microbiology majors to have switched majors, sometimes several times, or to accumulate credits in minors or extracurricular activities (sports, music), which can also account for the higher number of credits and increased time to graduation. 2021-2022 data seems to be different than the other years and we cannot account for the difference at this time. We will continue to observe this and see if it is repeated in future years.

Advisors help students plan for graduation and account for coursework that will be most valuable for each student’s career goals. The department has detailed graduation maps for majors, and pre-professional majors. The graduation maps outline the sequence of courses needed for graduation within four years and between 120 and 133 credits (not including developmental courses).

At this time, we don’t see a need to make adjustments. However, the number of credits students earn by graduation has been gradually increasing. It is worth monitoring this metric and making changes advising as needed.

G. Evidence of Learning

1) Courses within the Major:

This year, our department decided to update our program learning outcomes and make a new assessment plan. Since our last biennial report, we have had three faculty retire and one faculty member leave within a year of his hire. This loss made assessment of the upper division courses more difficult or unavailable. In addition, the switch from Chi-tester to Canvas exams and the pandemic-related changes to exams dramatically changed assessment methods in some classes. All of the new program-level learning outcomes will be assessed in the 2023-2024 academic year in all of the *required* microbiology core courses. After that, two outcomes per year will be assessed each year in required and

elective courses and reported in a narrative-based format. Assessments will be presented in a narrative format focusing on the outcomes, not the individual courses.

2) **General Education course assessment:**

Because instructors use different modalities and strategies for teaching and assessing our general education courses, only one instructor has submitted assessment for each course. This is considered a sampling of our general education offerings. As faculty become more comfortable using Canvas to assess learning outcomes, additional data from multiple sections will be included. Assessment grids are included at the end of the report.

Overall Interpretation of General Education Outcomes and Action Plans:

- MICR 2054 Principles of Microbiology (Table D2):
 - The learning outcomes for the microbiology course closely mirror the LS Learning Outcomes and the Microbiology Program Outcome #1.
 - Finding: The four LS outcomes are met through the current course content and are demonstrated through assessment by exams.
 - Action: More formative assessment methods could help students improve scores on exams, however no course content changes are needed at this time.
 - Finding: The four NS outcomes are more difficult to assess within the current course outline. However, we have evidence that these outcomes are met.
 - Action: NS 4 Problem solving: The class almost met the criteria for this outcome. Students need more examples and opportunities to work with data, and more formative assessments will be used.
 - Action: NS 1 Nature of Science: This is a difficult outcome to assess. Based on these metrics, the criteria were almost met. Instructors of this course will collaborate to identify better ways to include this outcome in the course.
 - Closing the loop: A new text has been adopted for Fall 2023-2024. It was chosen because it presents materials more concisely and clearly. New formative assessments (e.g. Smart Book readings and quizzes) for each topic will be used and the course will be reassessed.
- MICR 1153 Public Health; Sex, Travel, and Food (Table D1):
 - This course has recently been rebranded to increase enrollments and to include more topics that are of interest to college students.
 - Finding: Assessed in Summer 2023 with pre- and post-tests and with class-based projects. Assessment indicates that all outcomes were met or were close to being met.
 - Action: Some outcomes did not meet the pre/post-test improvement target, because pre-test knowledge was high. This could provide an opportunity to include different, or more in-depth, topics.
 - Action: A few outcomes (NS1; LS1; LS 4) would benefit from “revised lecture materials to make sure that content is clear and assess in future semesters to see if understanding is improved to meet target performance.”

- “Closing the Loop:” Different instructors use different approaches to this course. A different section will be assessed each semester and results discussed between faculty to identify best practices for each outcome.
- MICR 1113 Introduction to Microbiology (Table D3)
 - Assessed two semesters, one instructor: Fall 2022; Spring 2023, online sections
 - Finding: All outcomes were met with at least one measure
 - Finding: When outcomes were not met it was often due to students not submitting assignments.
 - Action: Greater emphasis will be placed on reminding students of due dates and completing assignments.
 - Finding: Outcomes with more difficult content (Levels of Organization, Metabolism, and Genetics) were not met on multiple choice assessments.
 - Action: Add interventions and modify methods for teaching concepts students find difficult. For example, add readings, practice quizzes, or different homework assignments.
 - “Closing the Loop:” All instructors, especially of online sections, will be encouraged to intervene sooner when students appear to not be participating.

Appendix A

Most departments or programs receive a number of recommendations from their Five/Seven-Year Program Review processes. This page provides a means of updating progress towards the recommendations the department/program is enacting.

Date of Program Review: 2019	Recommendation	Progress Description
Recommendation 1: Improve assessment practices	More discussion of what works and does not work.	<ul style="list-style-type: none"> ▪ More discussion during department meetings beginning in 2021 ▪ Involve all faculty, including adjuncts in assessment ▪ New assessment plan proposed in this document
Recommendation 2: Professional development for faculty	Provide more opportunities for professional development	<ul style="list-style-type: none"> ▪ All faculty, especially new faculty, are encouraged to participate in professional development or attend conferences. Faculty list their professional development on their annual reports.
Recommendation 3: Better coordination of content for general education courses	3a: Despite use of the same text, it is unclear how much coordination occurs among faculty teaching Elementary Public (Micro 1153) and also the Introductory Microbiology (Micro 1113).	<ul style="list-style-type: none"> ▪ Faculty have been instructed on how to use Canvas to align outcomes to quiz banks and assessments. Faculty discuss course and content.
	3b: Updating the Public Health Microbiology course to make it stand out in the Microbiology and General Education programs may help to attract more students to Microbiology and the College of Science	<ul style="list-style-type: none"> ▪ MICR 1153 has been rebranded as <i>Sex, Food, and Travel</i>. Instructors, including adjuncts share a Canvas sandbox to share course content and assessments ▪ More coordination of MICR 2054, Principles of Microbiology is ongoing ▪ New General Education course MICR 1353: Microbes Rule, the Power of Disease added as an online and face-to-face course. First offerings in Summer 2023. Development of this course was a collaborative effort.
Recommendation 4: Update curriculum	We think the new emphases/concentrations strengthen the curriculum	<ul style="list-style-type: none"> ▪ New program learning outcomes ▪ The emphases have been helpful in recruiting students to the major and help with advising ▪ In 2024, we will reassess the courses that are included in each emphasis and add/remove as needed.
		<ul style="list-style-type: none"> ▪ Curriculum changes which include: teaching all required courses fall and spring semesters, offering more course formats (online, hybrid, virtual) ▪ New Courses: Tropical Diseases – online. Bioinformatics ▪ New General Education Course: MICR 1353 Microbes Rule - The power of disease.
Recommendation 5: Faculty workload.	We recommend that at least one new faculty line be directed to the Microbiology Department. These new hires should be strategic to areas of expertise that will provide more teaching flexibility for all faculty.	<ul style="list-style-type: none"> ▪ A new hire made in 2022, left for personal reasons in 2023. ▪ We have had three retirements of tenured faculty since the last review ▪ We hired one instructor in 2023 ▪ We are currently hiring for two faculty positions. We desperately need to fill these positions to support the medical microbiology emphasis and to maintain current course offerings.

Recommendation 6: Program support	Review Team strongly recommends that additional space be dedicated to faculty research laboratories.	<ul style="list-style-type: none"> ▪ Renovations made to room TY 466 and the Equipment room to make more functional spaces. (completed for 2021 report) ▪ If the department is to grow, more research space will be needed.
Recommendation 7: Relationships with External Communities	We encourage the entire faculty to interact with the Advisory Board, which is interested in providing more support and information to the faculty about the skills that students need in the workforce and job opportunities in the region.	<ul style="list-style-type: none"> ▪ The advisory board did not meet in 2020-2021 due to COVID and has not been reformed. This has not been a priority for the department or college. Faculty do not have the capacity to revive the advisory board at this time.

Additional narrative:

As part of our preparation for our program review in 2024-2025, the department is updating and revising our 5-year strategic plan.

Appendix B

Please provide the following information about the full-time *and adjunct faculty* contracted by your department during the last academic year (summer through spring). Gathering this information each year will help with the headcount reporting that must be done for the final Five-Year Program Review document that is shared with the State Board of Regents.

Faculty Headcount	2019-20	2020-21	2021-22	2022-23
With Doctoral Degrees (Including MFA and other terminal degrees, as specified by the institution)				
Full-time Tenured	6	5	4	2
Full-time Non-Tenured (includes tenure-track)	2	4	4	5
Part-time and adjunct	1	1	1	1
With Master's Degrees				
Full-time Tenured	-	-	-	-
Full-time Non-Tenured	-	-	-	-
Part-time and adjunct	2	4	2	3
With Bachelor's Degrees				
Full-time Tenured	-	-	-	-
Full-time Non-tenured	-	-	-	-
Part-time and adjunct	-	-	-	-
Other				
Full-time Tenured				
Full-time Non-tenured				
Part-time				
Total Headcount Faculty				
Full-time Tenured	6	5	4	2
Full-time Non-tenured	2	4	4	5
Part-time	3	5	3	3

Appendix C

Please respond to the following questions.

- 1) Looking back at your previous biennial report where you identified strategies for improvement, what progress has been made in implementing improvements?
 - **Student completion:** In Fall 2022, we began offering all of our required core courses both Fall and Spring semesters. This has decreased course size and increased faculty-student interaction. It has increased course availability, and appears to be decreasing time to graduation (4.7 years in 20-21 to 4.3 years in 22-23). It is a challenge to assign faculty to these courses and to schedule labs.
 - **Revise Department Program-level Outcomes, Outline assessment plan:**
 - New department program-level outcomes have been presented and a new curriculum map is presented above.
 - An outline for an assessment plan is presented above.
 - Discuss assessment in department meetings
 - **Hire a new faculty member:**
 - A faculty member was hired in for Fall 2022, but he left for personal reasons in Summer 2023.
 - Department is currently hiring two faculty positions for Fall 2024.
 - **Recommendations from Biennial Report Evaluation:**

Recommendation	Action
Learning outcomes consolidated and written as statements	Completed as of this report, see above
Curriculum grid be revised	Completed as of this report, see above
Address measured deficiencies in curriculum	Development of degree emphases Offer required courses every semester
Evidence of assessment measures need more explanation	As outcomes are assessed we will include if the assessments are direct/indirect and summative/formative
Provide narrative to explain thresholds	We will try to include this in all assessments. We are interested in participating in discussions about how thresholds are set.
Interpretation or action plan should be included	We will try to include more detail in the interpretation and action plan, but would like to see some examples of how other departments address this.
Action/closing the loop	We will work as a department to identify ways of “closing the loop” on outcomes. We would like to see some examples of how other departments address this.

- 2) Please take a few minutes to review the new DFWI dashboard in the Report Gallery. This dashboard allows you to see the percentage

of students in each course who earn a D+, D, D-, E, W, UW, or NC grade. The data can be filtered by several parameters. Reflect on the DFWI rates overall and of your underserved minority students versus your Caucasian students:

- a. **What are you seeing?** Overall, the department has high rates of passing grades and low rates of DFWI. The highest rates of DFW grades are in general education courses, especially those taught online. However, the rates of DFWI over time appear to be slowly declining. Several courses with high DFWI rates are low enrollment courses, where the withdraw or fail of one or two students would be a high percent.
 - b. **What concerns you?** None of our rates are especially concerning. There are no current faculty who have consistently high percentages of DFWI grades. We do see higher rates of withdraw or fail among students who are “not college ready” or those placed in developmental math or English. We would recommend that students in these categories be encouraged to take face-to-face courses. We can also look at how online courses can be improved to increase student interaction and participation. Often, a failing grade or withdraw in an online general education course is due to lack of participation, and faculty could improve communication with students who are not participating.
 - c. **What additional data could be beneficial?** Although uncommon, it would be beneficial if incomplete (I) grades were not included in this metric. An I grade is meant to promote student success when life events prevent a student from completing a semester. An I grade should only be counted as “not passing” if it reverts to a failed grade.
- 3) We have invited you to re-think your program assessment. What strategies are you considering? What support or help would you like?

Our strategies for program assessment going forward are presented above. Our department has seen a great deal of overturn in the past few years and this has upended our planning process. It has, however, given us an opportunity for some significant changes to the curriculum and to develop a new strategic plan. In terms of assessment, we could use some help determining how to set thresholds, ideas good assessment tools and strategies, and examples of “closing the loop.”

Glossary

Student Learning Outcomes/Measurable Learning Outcomes

The terms ‘learning outcome’, ‘learning objective’, ‘learning competency’, and ‘learning goal’ are often used interchangeably. Broadly, these terms reference what we want students to be able to do AFTER they pass a course or graduate from a program. For this document, we will use the word ‘outcomes’. Good learning outcomes are specific (but not too specific), are observable, and are clear. Good learning outcomes focus on skills: knowledge and understanding; transferrable skills; habits of mind; career skills; attitudes and values.

- Should be developed using action words (if you can see it, you can assess it).
- Use compound statements judiciously.
- Use complex statements judiciously.

Curriculum Grid

A chart identifying the key learning outcomes addressed in each of the curriculum’s key elements or learning experiences (Suskie, 2019). A good curriculum:

- Gives students ample, diverse opportunities to achieve core learning outcomes.
- Has appropriate, progressive rigor.
- Concludes with an integrative, synthesizing capstone experience.
- Is focused and simple.
- Uses research-informed strategies to help students learn and succeed.
- Is consistent across venues and modalities.
- Is greater than the sum of its parts.

Target Performance (previously referred to as ‘Threshold’)

The level of performance at which students are doing well enough to succeed in later studies (e.g., next course in sequence or next level of course) or career.

Actual Performance

How students performed on the specific assessment. An average score is less meaningful than a distribution of scores (for example, 72% of students met or exceeded the target performance, 5% of students failed the assessment).

Closing the Loop

The process of following up on changes made to curriculum, pedagogy, materials, etc., to determine if the changes had the desired impact.

Continuous Improvement

An idea with roots in manufacturing, that promotes the ongoing effort to improve. Continuous improvement uses data and evidence to improve student learning and drive student success.

Direct evidence

Evidence based upon actual student work; performance on a test, a presentation, or a research paper, for example. Direct evidence is tangible, visible, and measurable.

Indirect evidence

Evidence that serves as a proxy for student learning. May include student opinion/perception of learning, course grades, measures of satisfaction, participation. Works well as a complement to direct evidence.

HIEE – High Impact Educational Experiences

Promote student learning through curricular and co-curricular activities that are intentionally designed to foster active and integrative student engagement by utilizing multiple impact strategies. Please see <https://weber.edu/weberthrives/HIEE.html>

Appendix D: Evidence of Learning: General Education, Life Science Courses

Table D1

Course MICR1153-Public Health: Sex, Food, Travel, and Drugs (Summer 2023; 11343; Twing)

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
NS 1: Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	1153 LO 8: Identify and explain the public health interventions that have improved life expectancy and quality of life through the control of infectious diseases	MC Quiz Question - Immunization works because of immunological memory stored in _____.	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 71%. Improvement between pre-course quiz (35%) and post-lecture quiz (71%) was 36% improvement.	While there was improvement between pre/post quizzes, neither the meet the target performance targets.	Will revise lecture materials to make sure that content is clear and assess in future semesters to see if understanding is improved to meet target performance.
NS 2: Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	1153 LO 6: Discussing current public health issues, including a diverse selection of diseases, with respect to the social, economic, and environmental forces that impact the pattern of diseases worldwide.	MC Quiz Question - What is COVID-19?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 95%. Improvement between pre-course quiz (40%) and post-lecture quiz (95%) was 55% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - Which birth defect does the Zika virus cause?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 100%. Improvement between pre-course quiz (48%) and post-lecture quiz (100%) was 52% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - What is the relationship between HIV and AIDS?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 97%. Improvement between pre-course quiz (38%) and post-lecture quiz (97%) was 59% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
NS3: Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	1153 LO 1: Recognize the impact that the sciences of public health have had on society and the role of science in determining public health practices.	Signature Assignment: Public Health Guide - create a public health guide to communicate scientific public health data to the general public in a medium that is best for communicating with the intended audience	> 80% of the class will earn an > 80% on the project	86% of students scored >80% on the project, which included various deadlines and submissions	Target performance goals were exceeded and student feedback suggests that students find the project interesting and useful to their learning	None required; however I solicit student feedback each semester on how clear, interesting, and useful the project are to improve for future semesters.

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
NS #4 Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	1153 LO 4: Examine data from epidemiological studies to prove or disprove associations between a risk factor and a disease. 1153 LO 5: Discuss ways that health claims can be scientifically evaluated and examine strengths and weaknesses of epidemiological studies.	MC Quiz Question - What is the cause of the reemergence of the measles?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 97%. Improvement between pre-course quiz (58%) and post-lecture quiz (97%) was 39% improvement.	While the post-lecture quiz accuracy exceeded the target performance goals, the percent improvement between pre/post quizzes exceed target did not. This suggests that the majority of students (58%) came into the class already knowing this concept.	No action plan is required since almost 100% of the students knew the content by the end of the course, however, the starting point of almost 60% knowing it before the course suggests that additional content can be covered as well.
		Mid-Term Assignment: Distill-an-Article - distill a scientific article into a social-media-like post and reflect on how we get most of our information and what might be missing	> 80% of the class will earn an > 80% on the project	89% of students scored >80% on the project, which included various deadlines and submissions	Target performance goals were exceeded and student feedback suggests that students find the project interesting and useful to their learning	None required; however, I solicit student feedback each semester on how clear, interesting, and useful the projects are to improve for future semesters. This project appears to be more challenging to understand for ONL students versus WSU or HYBRID students, suggesting that clearer written and recorded instructions could help.
LS 1 Levels of Organization All life shares an organization that is based on molecules and cells and extends to organisms and ecosystems.	1153 LO 2: Explore the diversity of the microbial world. Students will be able to describe the beneficial aspects of microbiology, identify the primary structures of a cell and compare and contrast prokaryotic and eukaryotic cells.	MC Quiz Question - All cells have which of the following?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 95%. Improvement between pre-course quiz (23%) and post-lecture quiz (95%) was 72% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - Prokaryote and eukaryote are phylogenetic classifications of cells.	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 50%. Improvement between pre-course quiz (23%) and post-lecture quiz (50%) was 27% improvement.	While there was improvement between pre/post quizzes, neither the meet the target performance targets.	Will revise lecture materials to make sure that content is clear and assess in future semesters to see if understanding is improved to meet target performance.
		MC Quiz Question - Who discovered the domain archaea?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 92%. Improvement between pre-course quiz (35%) and post-lecture quiz (92%) was 57% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
LS 2 Metabolism and homeostasis: Living things obtain and use energy, and maintain homeostasis via organized chemical reactions known as metabolism.	1153 LO 8: Identify and explain the public health interventions that have improved life expectancy and quality of life through the control of infectious diseases	MC Quiz Question - Which phenolic compound has commonly been added to soap and raises concerns about selection for more antimicrobial-resistant bacteria?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 100%. Improvement between pre-course quiz (17%) and post-lecture quiz (100%) was 83% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - An antibiotic that kills only Gram-Negative bacteria is _____.	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 85%. Improvement between pre-course quiz (35%) and post-lecture quiz (85%) was 50% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
LS 3 Genetics and evolution: Shared genetic processes and evolution by natural selection are universal features of all life	1153 LO 3: Understand the basics of bacterial genetics including DNA replication and protein synthesis. Students will be able to discuss how genetic mutations and recombination leads to vast microbial diversity through the process of natural selection. Students will understand the implications of bacterial genetics on human health.	MC Quiz Question - Which of the following is a change in the sequence that leads to the formation of a stop codon?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 92%. Improvement between pre-course quiz (19%) and post-lecture quiz (92%) was 83% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - What is binary fission?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 100%. Improvement between pre-course quiz (27%) and post-lecture quiz (100%) was 73% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - The biological species concept applies to bacteria.	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 85%. Improvement between pre-course quiz (29%) and post-lecture quiz (85%) was 56% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
LS 4: Ecological interactions: All organisms, including humans, interact with their environment and other living organisms.	1153 LO 7: Describe the human body as an ecosystem for microorganisms and discuss the symbiotic relationship between humans and microorganisms, including both positive and negative outcomes.	MC Quiz Question - Americans have the _____ diverse gut microbiome, when compared to people from rural and pre-industrial areas.	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 98%. Improvement between pre-course quiz (54%) and post-lecture quiz (98%) was 44% improvement.	While the post-lecture quiz accuracy exceeded the target performance goals, the percent improvement between pre/post quizzes exceed target did not. This suggests that the majority of students (58%) came into the class already knowing this concept.	No action plan is required since almost 100% of the students knew the content by the end of the course, however, the starting point of almost 60% knowing it before the course suggests that additional content can be covered as well.
		MC Quiz Question - What vitamin does beneficial E. coli make for us?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 100%. Improvement between pre-course quiz (33%) and post-lecture quiz (100%) was 67% improvement.	Both the post-lecture quiz accuracy and the percent improvement between pre/post quizzes exceed target performance goals.	None required.
		MC Quiz Question - What female body part is most likely to become infected with a urogenital pathogen?	> 80% correct in post-lecture quiz >50% improvement between pre-course quiz and post-lecture quiz accuracy	Post-lecture quiz accuracy for class was 67%. Improvement between pre-course quiz (21%) and post-lecture quiz (67%) was 46% improvement.	While there was improvement between pre/post quizzes, neither the meet the target performance targets.	Will revise lecture materials to make sure that content is clear and assess in future semesters to see if understanding is improved to meet target performance.

Table D2: Evidence of Learning: General Education, Life Science Courses
Course: MICR 2054 Principles of Microbiology; Semester: Spring 2023; Instructor: Culumber; 37 students

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not	Learning Outcome 1. Explain a current research topic in microbiology (e.g. CRISPR technology) and support their conclusions with data.	Measure 1: Rubric graded signature assignment	> 80% of students Meet or Exceed expectation (4 or 5 points)	Measure 1: 37.8% Met or exceed; >97% Met, exceeded or were approaching expectations	Measure 1: Many students did not meet expectations because they didn't include information or data on their topic.	Measure 1: Include more clear instructions and examples of data that can be used to support their conclusions.

Gen Ed Learning Goal	Measurable Learning Outcome	Method of Measurement	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Students will demonstrate understanding of: scientific.	LO2: demonstrating good laboratory skills and to interpret data generated in laboratory experiments	Measure 2: Lab exam #2 (combination of practical and written assessment)	> 80% of class earn >80% on lab exam #3	76.3% met the target	Just missed this semester	Remind students of opportunities to get extra practice, use lab notebooks correctly, and that attendance is vital.
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	LO 1: Identify the structure and functions of the four macromolecules in cells.	Measure 1: Chemistry Quiz (open book/repeatable)	100% of class will earn 90% (set at 100% because should be review material)	95% of students met expectation. One student had <90%, but did not retake the quiz.	Those who earned less than 90% did not use retake attempts	No action needed.
	LO 2: describe ways microbes impact the human host or public health	Measure 2: 45 pooled questions on Final exam (~15 questions per student) (Note: because of the switch to Canvas, outcomes were not linked to quiz banks in Sp 2023 – questions were tallied from Quiz metrics)	> 80% of questions answered correctly	A total of 681 answers were collected. 88% were answered correctly.	This metric was met. Students could identify ways the microbes cause disease.	None needed, except to link question banks to outcomes in Canvas
Science and Society The study of science provides explanations that have significant impact on society, including technological	LO1: Predicting what impacts current research in microbiology will have on the future	Measure 1: Signature assignment, rubric graded	>80% will meet or exceed expectations	80% of students met or exceeded expectations	Students were able to explain the important impacts of microbiology on the future	No changes needed

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	LO2: identifying ways that antibiotics and vaccines have impacted public health	Measure 2: 35 pooled questions on Final exam question bank (~20 questions/student)	>80% of questions will be correct	721 questions from the bank were answered; 91.5% were correct	Students were able to identify the importance of antibiotics and vaccines	No changes needed
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	LO1: demonstrate laboratory skills and understand laboratory processes	Measure 1: Lab Exam # 3	> 80% of class earn >80% on lab exam #3	76% earned >80%	Just missed the target this semester. Did see	Remind students that attendance is crucial for developing and practicing lab skills. Provide additional problem solving for calculating dilutions and other lab math problems.
	LO2: Use data to discuss a topic of microbiological research	Measure 2: Signature assignment: Rubric graded	>80% of students meet or exceed (4+ out of 5)	61% met or exceeded expectations	Many students did not meet expectations because they didn't include information or data on their topic.	Include more clear instructions and examples of data that can be used to support their conclusions.
Levels of Organization All life shares an organization that is based on molecules and cells and extends to organisms and	Identify the structures of bacteria and viruses and know the functions of those structures	Measure 1: Module 1 Quiz (online, open book, multiple attempts, formative assessment)	80% of class will earn 90% or better	89.5% met target	Target was met	No changes needed

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
ecosystems.		Measure 2: Midterm exam 55 pooled questions (~20 questions/student)	>80% of questions will be correct	86.8% correct answers; 1076 total answered questions	Target was met	No changes needed
Metabolism and homeostasis: Living things obtain and use energy, and maintain homeostasis via organized chemical reactions known as metabolism.	LO1: Outline how cells obtain energy from sugar through the central metabolic pathways and fermentation	Measure 1: Module 3 Quiz (online, open book, multiple attempts, formative assessment)	80% of class will earn 90% or better	94.7% met target	Target was met	No changes needed
	LO2: Define the different requirements for oxygen needed by microorganisms	Measure 2: Midterm exam 45 pooled questions (~18 questions/student)	>80% of questions will be correct	83.7% correct answers; 829 total answered questions	Target was met	No changes needed
Genetics and evolution: Shared genetic processes and evolution by natural selection are universal features of all life	LO1: Outline the process of protein synthesis from DNA to proteins	Measure 1: Module 2 Quiz (online, open book, multiple attempts, formative assessment)	80% of class will earn 90% or better	89.5% met target	Target was met	No changes needed
	LO2: Describe how microbial evolution is driven by genetic exchange followed by natural selection and results in phenomenon like antibiotic resistance and antigenic variation	Measure 2: Measure 2: Midterm exam 55 pooled questions (~19 questions/student)	>80% of questions will be correct	83% correct answers; 1045 total answered questions	Target was met	No changes needed

Gen Ed Learning Goal Students will demonstrate understanding of:	Measurable Learning Outcome Students will demonstrate their understanding by:	Method of Measurement Direct and Indirect Measures*	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Ecological interactions: All organisms, including humans, interact with their environment and other living organisms.	Describe the microbial relationships with host organisms or in the environment	Measure 1: Module 4 Quiz (online, open book, multiple attempts, formative assessment)	80% of class will earn 90% or better	95% met target	Target was met	No changes needed
		Measure 2: Final exam 29 pooled questions (~18 questions student)	>80% of questions will be correct	88.6% correct answers; 534 total answered questions	Target was met	No changes needed

Targets for exams were set at >80% correct answers from total questions asked in class. 80% was chosen because it indicates that the majority of the students had a good understanding of the material.

Targets for open book exams or quizzes with multiple attempts were set at “>80% of class would earn >90% or better”, unless where indicated otherwise. Open book assignments are expected to have higher outcomes than proctored exams.

Rubric graded assignments were >80% of class would meet or exceed expectations.

Table D3: Evidence of Learning: General Education, Life Science Courses
Course: MICR 1113—Introductory Microbiology; Instructor: Crook; 84 students

GE Learning Goal	Measurable Learning Outcome	Method of Measurement	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Students will demonstrate understanding of:	Students will demonstrate their understanding by:	Direct and Indirect Measures*				
Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Given a research scenario, students will be able to identify the steps of the scientific method, including formulating new hypotheses.	Direct Measure 1: Multiple choice questions in Canvas	80% of students earn 70% or better on 10 questions.	Measure 1: 82% of students earned 70% or better.	Measure 1: Target was met.	Measure 1: No curricular or pedagogical changes needed at this time.
		Direct Measure 2: Homework assignment	80% of students earn 80% or better on a homework assignment where they formulate hypotheses.	Measure 2: 89% of students earned 80% or better.	Measure 2: Target was met.	Measure 2: No curricular or pedagogical changes needed at this time.

*At least one measure per objective must be a direct measure.

GE Learning Goal	Measurable Learning Outcome	Method of Measure.	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Integration of Science. All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will be able to identify how physics and chemistry contribute to our understanding of microbial life.	Direct Measure 1: Multiple choice questions in Chi-Tester	80% of students earn 70% or better on 10 questions.	Measure 1: 87% of students earned 70% or better.	Measure 1: Target was met.	Measure 1: No curricular or pedagogical changes needed at this time.
		Direct Measure 2: Homework assignment	80% of students earn 80% or better on a homework assignment about the physical and chemical conditions that are necessary for microbial life.	Measure 2: 88% of students earned 80% or better.	Measure 2: Target was met.	Measure 2: No curricular or pedagogical changes needed at this time.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Science and Society. The study of science provides explanations that have significant	Students will be able to identify how advancements in microbiology have	Direct Measure 1: Multiple choice questions in Chi-Tester	80% of students earn 70% or better on 10 questions.	Measure 1: 82% of students earned 70% or better.	Measure 1: Target was met.	Measure 1: No curricular or pedagogical changes needed at this time.

impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	contributed to human well-being and advancement.	Indirect Measure 2: Canvas Discussion Assignment	80% of students participate in a discussion about the positive and negative outcomes of the Golden Age of Microbiology.	Measure 2: 89% of students contributed to the discussion assignment.	Measure 2: Target was met.	Measure 2: No curricular or pedagogical changes needed at this time.
		Direct Measure 3: Rubric-graded Signature Assignment	80% of students earn 80% or better.	Measure 3: 77% of students earned 80% or better.	Measure 3: Target was not met. However, 20 students did not turn in a Signature Assignment, at all.	Measure 3: Greater emphasis will be placed on completing the Signature Assignment.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Problem Solving & Data Analysis. Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will be able to interpret graphs, tables, and figures of scientific data.	Direct Measure 1: Multiple choice questions in Chi-Tester	80% of students earn 70% or better on 10 questions.	Measure 1: 95% of students earned 70% or better.	Measure 1: Target was met.	Measure 1: No curricular or pedagogical changes needed at this time.
		Direct Measure 2: Homework assignment	80% of students earn 80% or better on a homework assignment interpreting simulated data.	Measure 2: 89% of students earned 80% or better.	Measure 2: Target was met.	Measure 2: No curricular or pedagogical changes needed at this time.
		Direct Measure 3: Rubric-graded Signature Assignment	80% of students earn 80% or better.	Measure 3: 77% of students earned 80% or better.	Measure 3: Target was not met. However, 20 students did not turn in a Signature Assignment, at all.	Measure 3: Greater emphasis will be placed on completing the Signature Assignment.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Levels of Organization. All life shares an organization that is based on molecules and cells and extends to organisms and ecosystems.	Students will be able to identify the structures that make up cellular life and what they are composed of. Students will be able to compare and	Direct Measure 1: Multiple choice questions in Chi-Tester	70% of students earn 70% or better on 20 questions.	Measure 1: 71% of students earned 70% or better.	Measure 1: Target was not met.	Measure 1: A lower target performance was set for this learning goal because it is a more challenging topic. Effort will be made to achieve a higher threshold.

	contrast prokaryotic and eukaryotic cells. Students will be able to identify the primary structures of viruses.	Indirect Measure 2: Canvas Discussion Assignment	80% of students participate in a debate about the importance of different macromolecules in cellular life.	Measure 2: 89% of students contributed to the discussion assignment.	Measure 2: Target was met.	Measure 2: No curricular or pedagogical changes needed at this time.
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GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Metabolism and homeostasis. Living things obtain and use energy, and maintain homeostasis via organized chemical reactions known as metabolism.	Students will be able to identify the outcomes of the different central metabolic pathways.	Direct Measure 1: Multiple choice questions in Chi-Tester	70% of students earn 70% or better on 10 questions.	Measure 1: 47% of students earned 70% or better.	Measure 1: Target was not met.	Measure 1: More work needs to be done to identify concepts that students struggle with so that pedagogical interventions can be made.
		Direct Measure 2: Homework assignment	80% of students earn 80% or better on a homework assignment about metabolic poisons.	Measure 2: 74% of students earned 80% or better.	Measure 2: Target was not met. However, 17 students did not turn in the homework at all. Of those that turned in the homework, 93% earned 80% or better.	Measure 2: More effort will be made to encourage students to turn in homework assignments.
		Indirect Measure 2: Canvas Discussion Assignment	80% of students participate in a discussion about the importance of regulating metabolism.	Measure 2: 81% of students contributed to the discussion assignment.	Measure 3: Target was met.	Measure 3: No curricular or pedagogical changes needed at this time.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Genetics and evolution. Shared genetic processes and evolution by natural selection are universal features of all life	Students will understand the basics of bacterial genetics including DNA replication and protein synthesis. Students will be able	Direct Measure 1: Multiple choice questions in Chi-Tester	70% of students earn 70% or better on 10 questions.	Measure 1: 53% of students earned 70% or better.	Measure 1: Target was not met.	Measure 1: More work needs to be done to identify concepts that students struggle with so that pedagogical interventions can be made.

	to summarize how mutations and horizontal gene transfer contribute to bacterial evolution.	Direct Measure 2: Homework assignment	80% of students complete an in-class activity or homework assignment where they run a simulation of the <i>lac</i> operon.	Measure 2: 75% of students earned 80% or better.	Measure 2: Target was not met. However, 15 students did not turn in the homework at all. Of those that turned in the homework, 91% earned 80% or better.	Measure 2: More effort will be made to encourage students to turn in homework assignments.
		Indirect Measure 3: Canvas Discussion Assignment	80% of students participate in a debate about whether it's okay to patent genes.	Measure 2: 83% of students contributed to the discussion assignment.	Measure 3: Target was met.	Measure 3: No curricular or pedagogical changes needed at this time.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Target Performance	Actual Performance	Interpretation of findings	Action Plan/Closing the Loop
Ecological interactions. All organisms, including humans, interact with their environment and other living organisms.	Students will be able to discuss the roles of microbes in biogeochemical nutrient cycles. Students will be able to describe beneficial and harmful interactions between microbes and plants, animals, or humans.	Direct Measure 1: Multiple choice questions in Chi-Tester	70% of students earn 70% or better on 20 questions.	Measure 1: 78% of students earned 70% or better.	Measure 1: Target was met.	Measure 1: No curricular or pedagogical changes needed at this time.
		Indirect Measure 2: Canvas Discussion Assignment	80% of students participate in a discussion about the ecological roles of microbes.	Measure 2: 74% of students contributed to the discussion assignment.	Measure 2: The target was not met. Some improvement can be seen, but more work is needed.	Measure 2: More effort will be made to encourage students to participate in this discussion assignment.
		Direct Measure 3: Rubric-graded Signature Assignment	80% of students earn 80% or better.	Measure 3: 77% of students earned 80% or better.	Measure 3: Target was not met. However, 20 students did not turn in a Signature Assignment, at all.	Measure 3: Greater emphasis will be placed on completing the Signature Assignment.

Data is from two courses:

- Fall 2022 (online course with 49 students)
- Spring 2023 (online course with 35 students)

Thresholds set at 80% of students will earn 80% or better for most assignments. Which would mean that most students are understanding material at a B- or better level. Some assessments were set lower because students find the concepts more difficult, especially on proctored multiple choice assessments.