



Frederick Community College  
*Assessment of Student Learning*

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# Science Department

3<sup>rd</sup> Assessment Cycle 2012-2015

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## Final Report

General Education Competency

Scientific Reasoning and Critical Thinking

BI120 Microbiology for Allied Health

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## Background

The Science Department's 3<sup>rd</sup> Course Level Assessment of student learning focused on the BI120 (Microbiology for Allied Health) course, beginning in the Fall semester 2012. Since BI120 is a prerequisite course for the Nursing program, it is a high enrollment course. BI120 has enrollments of around 90-100 students each semester. Furthermore, the students cannot take BI120 more than twice before they apply for the Nursing program. Therefore, the students must do quite well in the BI120 course in order to be eligible for the Nursing program. With this information in mind, the department had decided it was necessary and critical to use the BI120 course to assess students' learning achievement.

The department assessed the students' **Critical Thinking** and **Scientific Reasoning** skills during the assessment. These two competencies served as the core Course Learning Outcomes for the assessment project, along with the General Education Learning goals. A few main **Core Learning Outcomes** of BI120 were assessed:

- "Relate the structural, physical, and metabolic characteristics of microorganisms to pathogenicity and human disease."
- "Identify microorganisms through structural, physical and metabolic characteristics."
- "Apply microbial virulence factors to the transmission of disease and the microbe's ability to disturb homeostasis in humans."

In order to fulfill the CLO's of the BI120 course, the students have to critically think and use scientific reasoning skills.

Since bacteria are too small to be seen by the naked eye, the students in general have difficulty learning the abstract subjects of the course. For this project, we implemented video clips using new technologies in an effort to improve student learning. Students were able to watch the videos which cover specific course materials that were assessed. This helped students follow the complex processes and understand the concepts more easily. This technology also appealed to the interests of students in this generation. These video clips were accessible via iPhone, Smartphone, iPad, and other devices so the students could watch them whenever it was convenient for them. Today's students are more proactive and engaged in learning when electronic devices are used. This assessment project aimed to use videos to enhance lectures on a variety of topics which can greatly increase students' ability to learn course content. These videos in the end can dramatically improve the students' critical thinking and scientific reasoning skills.

# Methodology

A comprehensive, 65 question, multiple-choice exam covering the core content of the BI120 Core Learning Outcomes was administered to BI120 students using a pre-test and post-test format, beginning in the Spring 2013 semester. Test items were created by Microbiology instructors based on outcomes and linked to one of the two Gen. Ed. Outcomes Assessment Competencies chosen for assessment in the 3rd Cycle: **Critical Thinking** or **Scientific Reasoning**. Some questions on the exam tested both competencies.

Performance on **critical thinking** items reflects on a student's ability to think critically about the concepts presented in the course. Performance on the **scientific reasoning** items reflects on a student's knowledge and scientific reasoning skills developed during the course.

Additionally, the assessment was designed to see how often students utilized tutorial videos provided by the instructors. The instructors wanted to see if students benefited from the use of these videos.

Based on the assessment questions, videos clips were selected from the McGraw-Hill publisher website (please see the attached list). Instructors posted video links on the Blackboard sites; students could watch them via Blackboard access. Further, during the lecture, instructors used video clips to facilitate students' understanding of the specific materials.

In general, the pre-test was taken by the students within the first/second weeks at the beginning of the semester. Towards the end of the semester, the students finished the post-test.

The Science Department collected data utilizing the PARSCORE Analysis program. The Office of Planning, Assessment, and Institutional Research scanned PARSCORE results into a .pdf format, converted the file into Excel, and then analyzed the results using SPSS statistical analysis software. Results were tabulated using an assessment key that linked each question to an Assessment Competency. In addition to normal evaluation of the BI120 exam, the department used this report to evaluate changes to the structure of the BI120 course and textbook.

Data was collected for the pilot assessment during the Spring 2013 semester, the Fall 2013 semester, the Spring 2014 semester and the Fall 2014 semester. By comparing the results from the Spring 2013 and the Fall 2013 semesters, the department modified assessment questions, as we took several specific detailed questions out of the assessment tests. Also due to the time limitation for the instructors to use the pre- and post-tests, the department limited the assessment test to 40 questions, beginning in the Fall 2013 semester. The department also added one question asking the students whether they watched the video clips or not.

# Analysis of Data

Data was collected beginning in the Spring 2013 semester and ended in the Fall semester 2014. The science Department performed ParScore item analysis on all the BI120 assessment tests at the end of each semester. The ParScore program allowed for a rapid analysis of individual test questions within the BI120 student population.

In addition to the Science Department ParScore analysis, all the BI120 assessment pre- and post-tests were evaluated by the Senior Researcher, Assessment and Institutional Effectiveness, using SPSS Statistics Stata Analysis software. The OAC representative performed an item analysis and provided this information to the Office of Planning, Assessment, and Institutional Research. The Science Department supplied a key that contained each question and detailed which ones assessed students' (1) **critical thinking** or (2) **scientific reasoning** competency. Data from question 41 provided information about whether or not students indeed watched the video clips.

The Office of Planning, Assessment, and Institutional Research provided a report of the data analysis to the Science Department and the Outcome Assessment Council for evaluation and discussion. The report contained information surrounding:

- The standard mean for overall performance, results for each individual assessment question and each GenEd competency, and an analysis of additional statistical patterns in student performance.
- The assessment pre-and post-tests Reliability Coefficient
- P value
- Point Biserial

The report was presented in no more than two pages to help provide succinct assessment data that could be reported to all BI120 instructors. The Science Department's OAC representative disseminated the report to all BI120 instructors each semester and to the Department Chair at the end of the cycle.

The Course Level Assessment Report was analyzed by the instructors, and then the Science Department evaluated assessment results based on internal discussions and determined how to use BI120 assessment data to help future students.

# Results

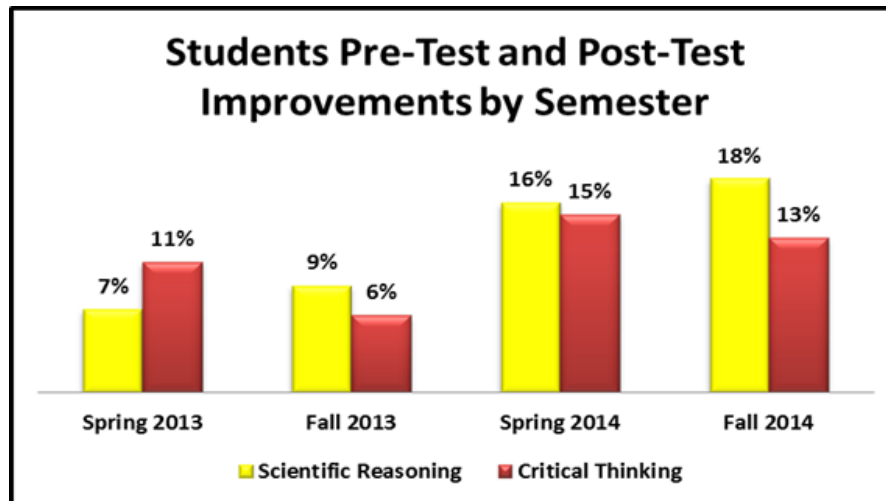


Figure 1 --- Overall BI120 student performance improvement (by competency and semester) comparing the pre- and post-tests.

As noted in Figure 1, there was a modest (6% to 11%) improvement in the percentage of students that responded correctly to both scientific reasoning and critical thinking questions from the Spring 2013 semester to the Fall 2013 semester. However, there was a significant (13% to 18%) improvement in the percentage of students that responded correctly to both scientific reasoning and critical thinking questions from the Spring 2014 semester to the Fall 2014 semester. Overall, the students performed slightly higher on critical thinking questions (+6%) than scientific reasoning questions.

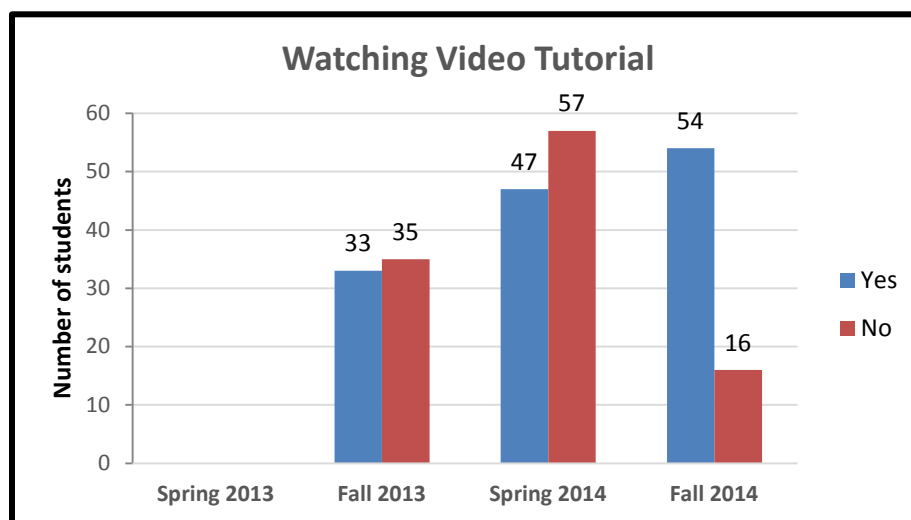


Figure 2 --- Overall BI120 students' use of the video tutorials during their classes.

In Figure 2, as for the Spring semester 2013, we did not ask students whether they watched the video clips or not; there was no data collection. For the Fall semester 2013, near 50% of students watched the video clips. However, in the Spring semester 2014, there were fewer students (45%) who watched the video clips. In the Fall semester 2014, there was a significant increase of students who watched the video clips (77%). Overall, the number of students who watched the video clips increased each semester.

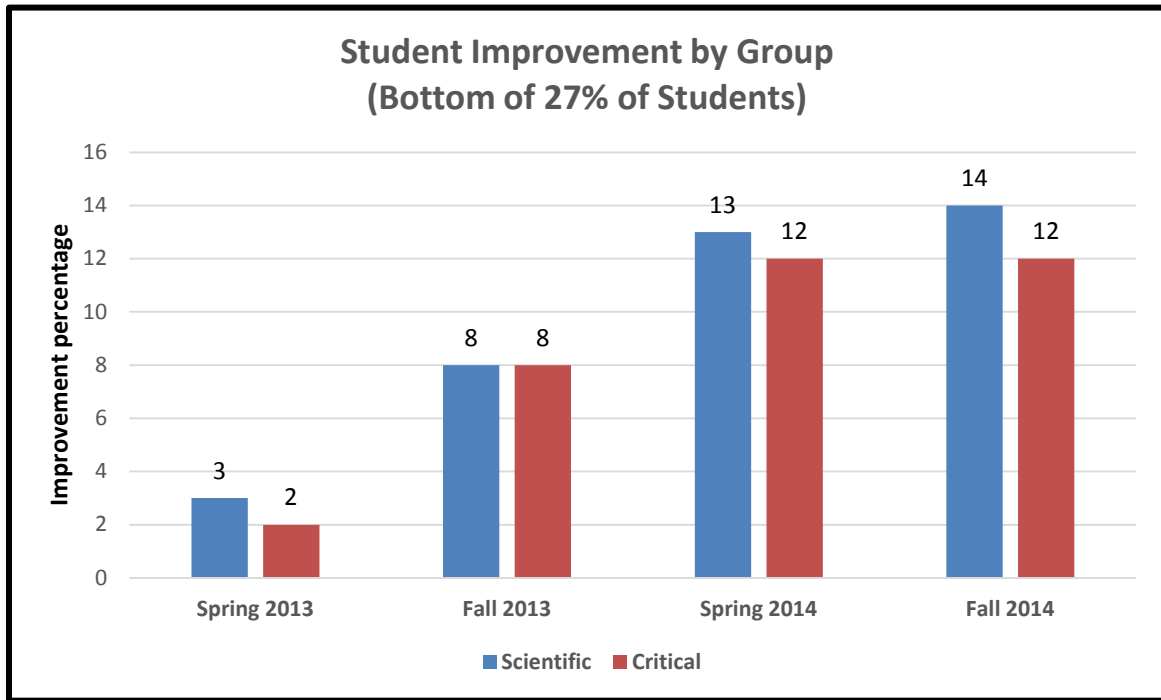


Figure 3 --- BI120 student improvement by the bottom of 27% of students.

From Figure 3, in comparison between pre- and post-test results, in the bottom 27% of students, there was a slight increase of student improvement in the Spring and Fall semesters 2013; and a significant increase of student improvement (from 8% to 13%) in the Spring and Fall semesters 2014. Overall, the bottom 27% of students got a 13% performance improvement both on scientific reasoning and critical thinking questions.

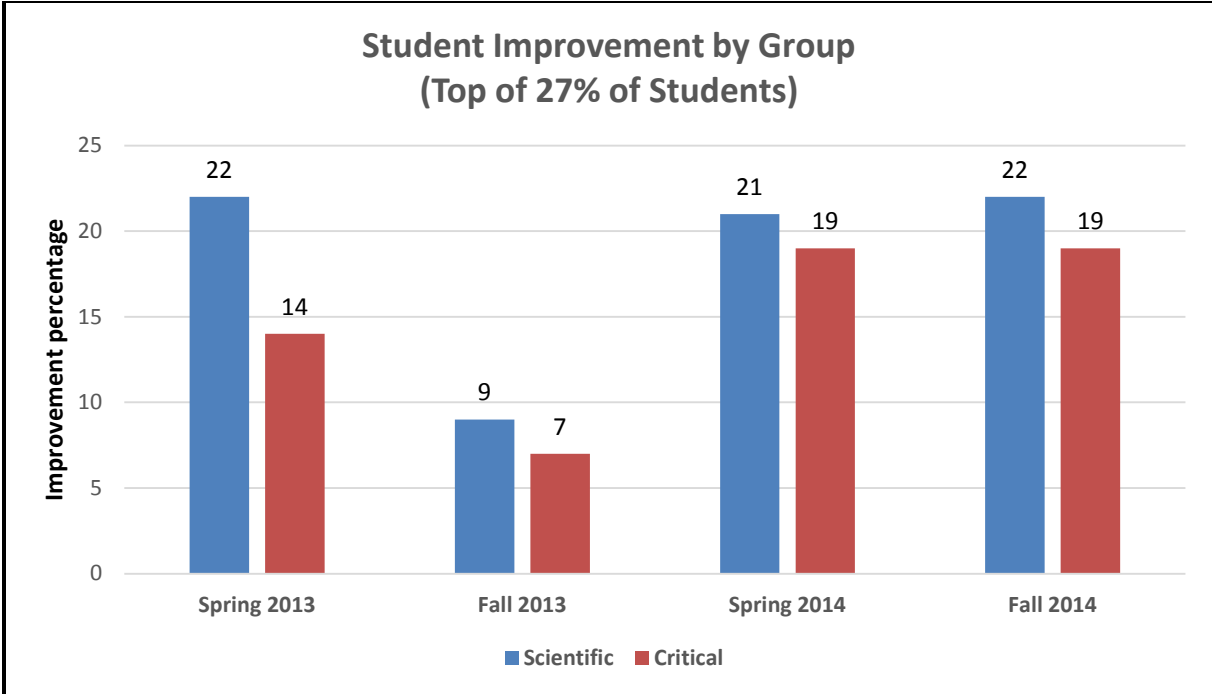


Figure 4 --- BI120 student improvement by the top of 27% of students.

As shown by Figure 4, the top 27% of students showed improvement. Except for the Fall semester 2013, the top 27% of students had significant performance improvement both on critical thinking and scientific reasoning questions (21%). The top 27% of students had slightly better improvement on scientific reasoning questions as compared to critical thinking questions.

In summary, as noted in Figures 3 and 4, students drastically improved their scores on the post-test in comparison with the pre-test. This can be specifically seen by comparing the top 27% and bottom 27% of student scores on both tests. This data shows significant growth in both groups from pre-test to post-test.

| Top 10 Missed Questions (All Students) |                      |             |           |                      |             |
|----------------------------------------|----------------------|-------------|-----------|----------------------|-------------|
| Pre-Test                               |                      |             | Post-Test |                      |             |
| Question                               | Outcome              | Avg%Correct | Question  | Outcome              | Avg%Correct |
| 12                                     | Scientific Reasoning | 4%          | 12        | Scientific Reasoning | 9%          |
| 2                                      | Critical Thinking    | 14%         | 5         | Scientific Reasoning | 22%         |
| 9                                      | Scientific Reasoning | 14%         | 34        | Scientific Reasoning | 22%         |
| 22                                     | Scientific Reasoning | 15%         | 2         | Critical Thinking    | 31%         |
| 33                                     | Scientific Reasoning | 17%         | 22        | Scientific Reasoning | 34%         |
| 4                                      | Scientific Reasoning | 19%         | 37        | Both                 | 34%         |
| 5                                      | Scientific Reasoning | 19%         | 26        | Scientific Reasoning | 37%         |
| 36                                     | Scientific Reasoning | 20%         | 33        | Scientific Reasoning | 38%         |
| 35                                     | Scientific Reasoning | 22%         | 36        | Scientific Reasoning | 42%         |
| 37                                     | Both                 | 23%         | 28        | Scientific Reasoning | 43%         |

This chart above showed the top 10 missed questions. There was a noticeable difference in the % Average Correct that students received on the hardest exam questions from pre-test to post-test. Students showed improvement on all of the most frequently missed questions during the Fall 2014 semester.

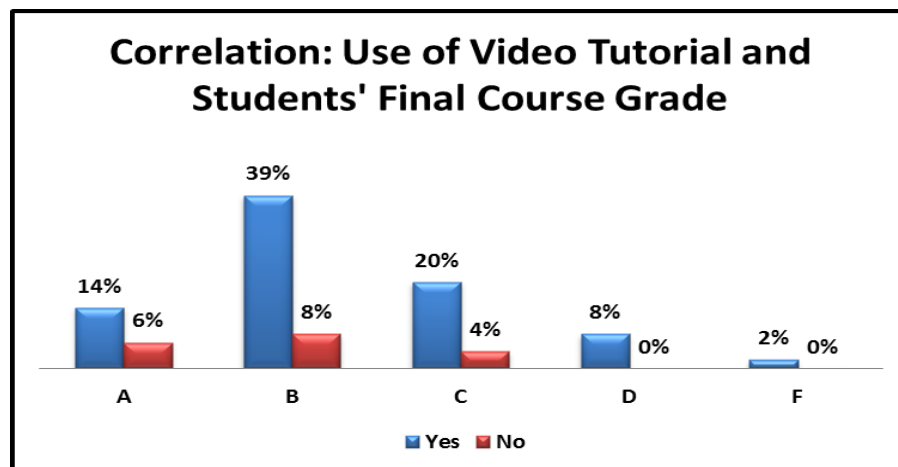


Figure 5 --- The correlation between the use of video tutorial and a student's final course grade.

Figure 5 showed that students who did not watch the videos do well in the course. However, the students who watched the video clips have higher success rates in the course than those students who did not watch the video clips. Overall, implementing videos was an effective instructional tool for improving student learning.

In summary, based on the BI120 student performance improvement (by critical thinking and scientific reasoning competency, the top and bottom 27% of students, and other semester data), students dramatically improved their scores on the post-test in comparison with the pre-test. Therefore, these assessment data results support our initial project aim --- using the video clips as an effective instructional tool to enhance students' learning and improving students' critical thinking and scientific reasoning skills during the semester.



# Recommendations

Microbiology course instructors have utilized the data analysis to re-evaluate current teaching methodologies and technologies to modify teaching pedagogies to facilitate student achievement within the Core Learning Outcomes. This evaluation process has provided a discussion platform for instructors and staff to research and implement current technologies that benefit student success at attaining critical thinking and scientific reasoning skills. More adjunct participation, consistent use of scantrons, and collection of all needed data would improve future assessment projects.

On a more interesting note, this assessment helped to demonstrate that watching video clips aids students' in learning course content and improve their critical thinking and scientific reasoning skills.

## Further Research

The Science Department will continue to assess the BI120 course competencies of scientific reasoning and critical thinking in the future. We will also modify some content taught in the BI120 course and update and implement new technologies to facilitate student success.

In addition, the Science Department will seek publisher assistance on implementing new portable technologies in different devices/platforms, such as cell phones and tablets, so students can access them anytime and anywhere.