University of Puerto Rico at Bayamón

Continuous Improvement Report

Computer Science

2019-2022 Cycle

This report provides the analysis of the Student Outcomes achievement level, for the Computer Science emphasis

area of the Computer Science Department

Computer Science Program - Student Outcomes Data Analysis

The analysis was performed using triangulation. The tools used were: the post-test (direct),the exit survey (indirect) and, if there was a difference that entailed seeking more information,data from the courses was obtained. There were outcomes that were not measured on the post-test, therefore, data from the courses and rubrics were used to gather information.

As in previous cycles, the AAC used the results from the post-test questions. The following scale was used:
- Satisfactory – the question was correctly answered by at least 75% of the students.
- Developing – the question was correctly answered by at least 50% of the students but less that 75%.
- Unsatisfactory – the question was correctly answered by less than 50% of the students.

For the exit survey, the analysis assumed the following scale:
- Satisfactory – the indicator was graded as A or B by the student.
- Developing – the indicator was graded as C by the student.
- Unsatisfactory – the indicator was graded as D or F by the student.

Outcome a: An ability to apply knowledge of computing and mathematics appropriate to the discipline

This outcome is measured by three main performance indicators. The following histogram summarizes the results obtained from, post-test, exit survey and from the data obtained from the courses:
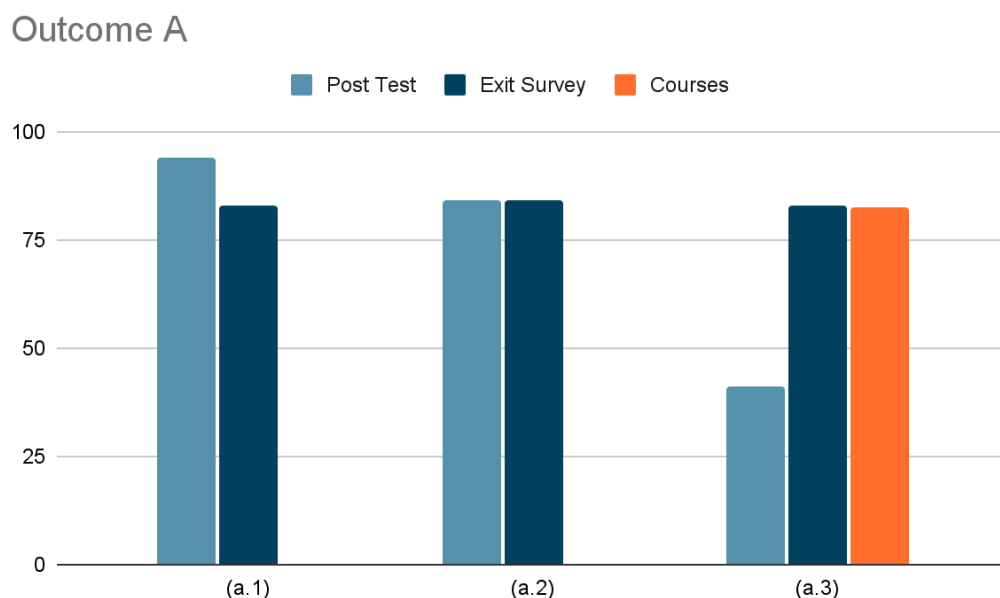
The PIs are the following:

(a.1) Select the appropriate algorithm for an specific situation
On average 94% of our students answered the questions related to this PI correctly.   All the students that completed the exit survey gave this indicator a grade of A on average 83%. Therefore the AAC concluded that the achievement level for this PI was met.

(a.2) Analyze the asymptotic running time of algorithms using big-O notation
On average 84% of our students answered the questions related to this PI correctly.   All the students that completed the exit survey gave this indicator a grade of A on average 84%. Therefore the AAC concluded that the achievement level for this PI was met.

(a.3) Apply mathematical concepts in the solution of a given problem

On average 41% of our students answered the questions related to this PI correctly. However, all the students that completed the exit survey gave this indicator a grade of 83%.   After a meeting, the AAC decided to analyze the data obtained from Exam I question 6 of COTI-4255 Analysis of Algorithm course. A median of 82.5% was obtained after analyzing exams from the previous three academic years. Therefore, we concluded that the achievement level for this PI was met.

Previous Cycle Comparison

Performance indicators (a.1) and (a.2) gave us results quite similar to what we obtained last time. On the other hand, there has been a remarkable improvement on PI (a.2). There has been an improvement of 28% on the posttest results. Course COTI-4255 Analysis of Algorithms has been reinforcing this PI since our last cycle. Performance indicator (a.3) seems to have the same problems as before.

Conclusion, Recommendations and Reflexion

The AAC concluded that this outcome was met. However, there are some things that need to be addressed.   There must be a problem with the questions regarding PI (a.3) on the posttest.   The use of Excel is needed to answer both questions related to this performance indicator efficiently. We know that this posttest does not count for a grade in any course. Students may be trying to answer the problem in a *fast* way without thinking too much. The AAC suggests finding questions that do not require the use of an electronic spreadsheet to answer it and efficiently measure the indicator.   These questions were not changed in the revision that was made in 2021. That is why we obtained a similar score to the one we had in the previous cycle (49%). The AAC recommends using questions from the course of COTI-4255 Analysis of Algorithms in the next post-test revision.

Outcome b: An ability to analyze a problem, identify and define the computing requirements appropriate to its solution.

This outcome is measured by three main performance indicators. The following histogram summarizes the results obtained from, post-test, exit survey and from the data obtained from the courses:
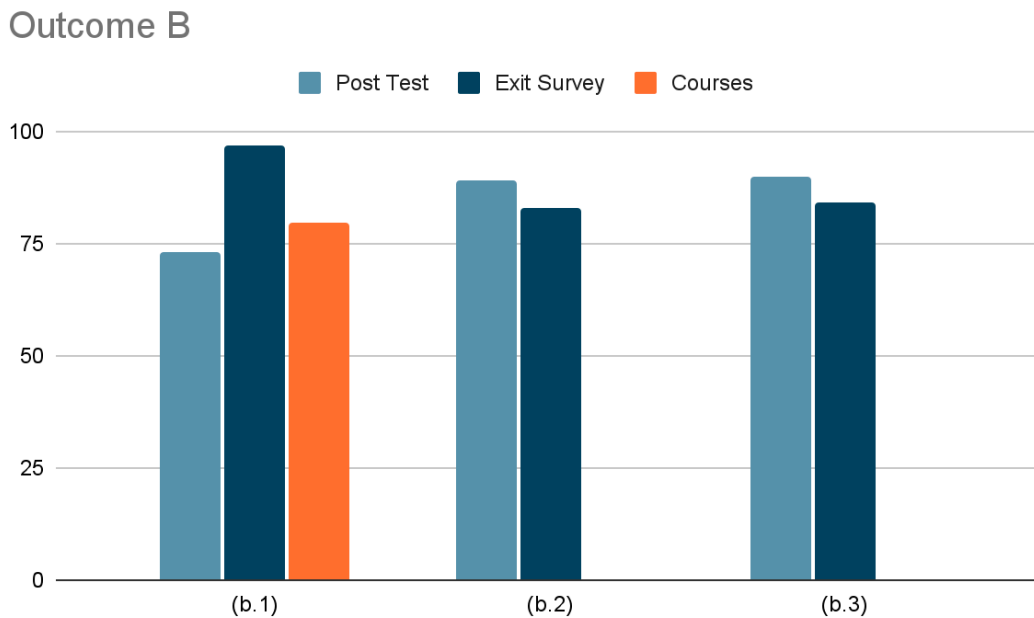
Outcome B

This outcome is measured by 3 performance indicators. This PIs are the following:

(b.1) Analyze a problem

Only 68% of the students answered this question correctly. However, they show confidence in this PI on the exit survey since they graded themselves with 95%. The AAC decided to analyze the data obtained from Question V of Exam 2 of COTI-4250 Intro. To The Theory of Computation course and the programming question of Exam 1 of COTI-4255 Intro. To The Analysis of Algorithms . A median of 79.6% was obtained after analyzing the data. Therefore, we concluded that the achievement level for this PI was met.

(b.2) Identify and define the computational requirements needed in a real situation
On the post-test 80% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of B (an average of 84%). Therefore, the AAC concluded that the achievement level of this PI was met.

(b.3) Choose the appropriate software and/on hardware tools to meet the desired goals

On the post-test 84% of the students answered the questions related to this PI correctly. Also, all the students that completed the exit survey gave this indicator a grade of B (as in previous PI an average of 82%).   Therefore, the AAC concluded that the achievement level of this PI was met.

Previous Cycle Comparison

There has been a change of an average of -6% on the results obtained on the post-test in all of the PIs of this outcome. However, the AAC does not consider this to be substantial since all the PIs were met. Two factors that could contribute to this slight decrease in performance could be related to the non-traditional methods we used to give our lectures during the COVID-19 pandemic we all faced. Another factor that could contribute to this slight decrease could be related to the post-test revision. However, all performance indicators were met.

Conclusion, Recommendations and Reflexion

The AAC concluded this outcome was met. However, students were able to answer very well the questions of the second exam of COTI 4250 Introduction to the Theory of Computation related to the union of two regular languages. This was part of a take home test. Data from a face-to-face exam was also analyzed from the course COTI 4255 Analysis of Algorithms. The average score was obtained with these two instruments.   We realized that there are problems in some exams in which students are doing very poorly for indicator b.1. Some of the questions of the SICI 4037 Data Communications course that needed analysis were answered very poorly. We need to reinforce the performance indicator (b.1).

Outcome c: An ability to design, implement, and evaluate a computer-based system, process, component or program to meet desired needs.

This outcome is measured by 3 performance indicators. The following histogram summarizes the results obtained from, post-test, exit survey and from the data obtained from the courses:

Outcome C

Post Test ▮ Exit Survey ▮ Courses ▮
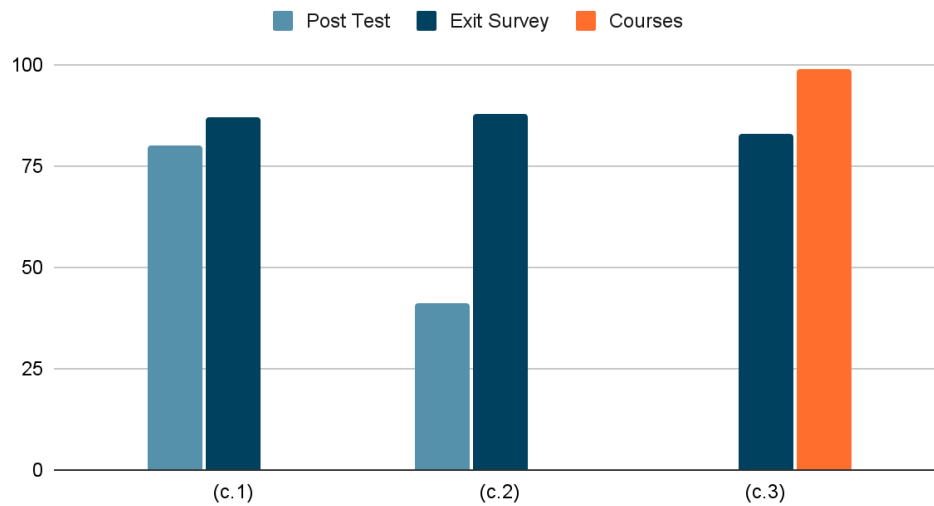
This PIs are the following:

(c.1) Design solutions using pseudo code, diagrams or natural languages.

One of the two questions related to this performance indicator suffered poor drafting. Therefore, we base our analysis on only one of the questions related to this PI. On the post-test 80% of the students answered the questions related to this PI correctly.   Also, all the students that completed the exit survey gave this indicator a grade of B (as in previous PI an average of 87%). Therefore, the AAC concluded that the achievement level of this PI was met.

(c.2) Implement an algorithm using the appropriate programming language

On the post-test 41% of the students answered the questions related to this PI correctly.   All the students that completed the exit survey gave this indicator a grade of B (an average of 88%). After examining the projects students submitted to the capstone course (SICI 4038) the AAC concluded that students were able to implement a system in a variety of languages. We have seen many diverse capstone projects. Some of them are in different environments and paradigms such as: mobile, Internet of Things (IOT), web development and more. This has been evident to us by analyzing the posters produced by the students on the capstone course. Therefore, the AAC declared that the achievement level of this performance indicator is met.

(c.3) Perform both unit and system testing

All the students that completed the exit survey gave this indicator a grade of B (an average of 83%). Since this PI cannot be measured in the post-test we decided to analyze data from the course SICI 4036 - Data Structures. Unit testing is an essential part of the homeworks of this course.   Unit testing is embedded throughout all the courses. Students perform unit and system testing when building

programs of varying complexity using JUnit and running it on Eclipse. A requirement of all the homeworks of this course is using JUNIT. Therefore, the AAC classifies this PI as met.

Previous Cycle Comparison

Performance indicator (c.1) improved 5% when the post-test results are compared to the ones obtained on the previous cycle. The AAC decided to compare the exit-survey results from performance indicators (c.2) and (c.3) since there were no questions on the previous version of the post-test (specially for c.2). The confidence levels obtained from the exit survey for performance indicator (c.2) are almost the same for both cycles.

A prediction was made by the AAC in the Continuous Improvement Report of our last assessment cycle related to performance indicator (c.3). The prediction was that the confidence level for (c.3) should increase during the current assessment cycle. Students indeed showed more confidence in performing unit and system testing. They showed a 15% increase.   This is related to the fact that they are using JUNIT in most of the homeworks assigned in the course of SICI 4036 - Data Structures.   This was not a requirement on the previous assessment cycle.

Conclusion and Recommendations

This outcome was met, however, there is room for improvement. We need to revise one of the questions of (c.1) to get better results for that PI. However, the analysis we made using only one question was in accordance with the result obtained from the exit survey. We concluded that the achievement level of this PI was met.

Questions for (c.2) in the post-test needed more analysis. The AAC reflected on this PI and decided that implementing an algorithm using the appropriate programming language is difficult to be measured precisely on the post-test. The post-test could be used to take a glance about how they approach the problem, however, this is a skill that can be analyzed in our capstone course. However, the questions that measured this PI on the post-test need to be reviewed (or revised).

Outcome d: An ability to function effectively on teams to accomplish a common goal

This outcome is measured by two performance indicators. The following histogram summarizes the results obtained from the exit survey and data obtained from the courses:

Outcome D
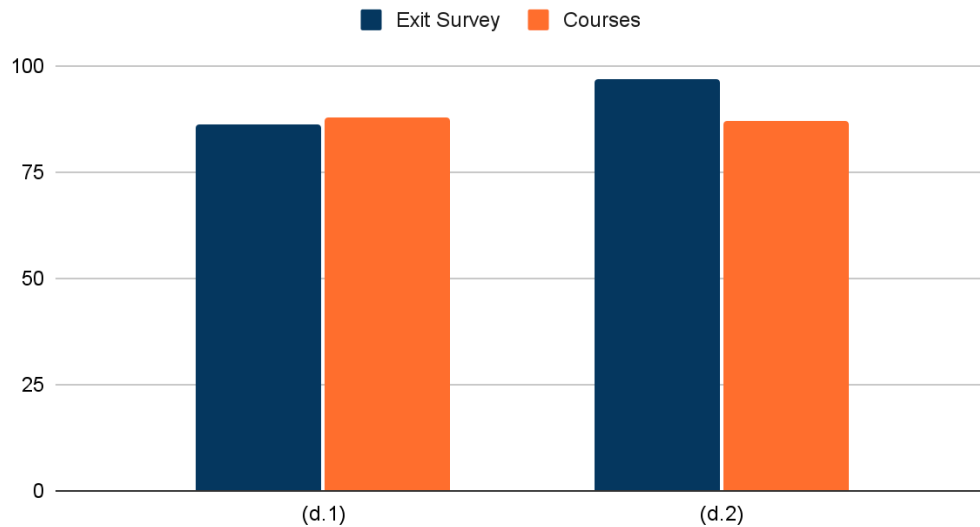
The PIs are the following:

(d.1) Evaluate a given problem within a team environment

All the students that completed the exit survey gave this indicator a grade of B (an average of 86%). On SICI 4037-Data Communications students evaluate each other after finalizing the course project. They filled out the Group Skills rubric.   After analyzing this instrument we found out that more than 88% of the students gave their peers the highest grade (4/4) in the skills of: problem solving, work attitude and *ability of* working with others.   Therefore, the AAC concluded that the achievement level of this PI was met.

(d.2) Perform duties assigned when working on team

All the students that completed the exit survey gave this indicator a grade of A (an average of 97%).   We use the same instrument as the previous PI. After analyzing this instrument we found out that more that around 87% of the students gave their peers the highest grade (4/4) in the skills of: contributions and quality of the work.   Therefore, the AAC concluded that the achievement level of this PI was met.

Previous Cycle Comparison

There has been an increase in the results obtained from the Group Skills Rubric used on the courses on both performance indicators of an average of 11.5%. There was a slight difference of -2% on the confidence level obtained from the exit survey for both performance indicators. However, they performed very well when evaluated directly. This slight decrease in their confidence level could be attributed to the non-traditional way of imparting the course during the COVID-19 pandemic.

Conclusion

This outcome was met.

Outcome e: An understanding of professional, ethical, legal, security and social issues and responsibilities

This outcome is measured by five performance indicators. The following histogram summarizes the results obtained from the post-test and the exit survey.
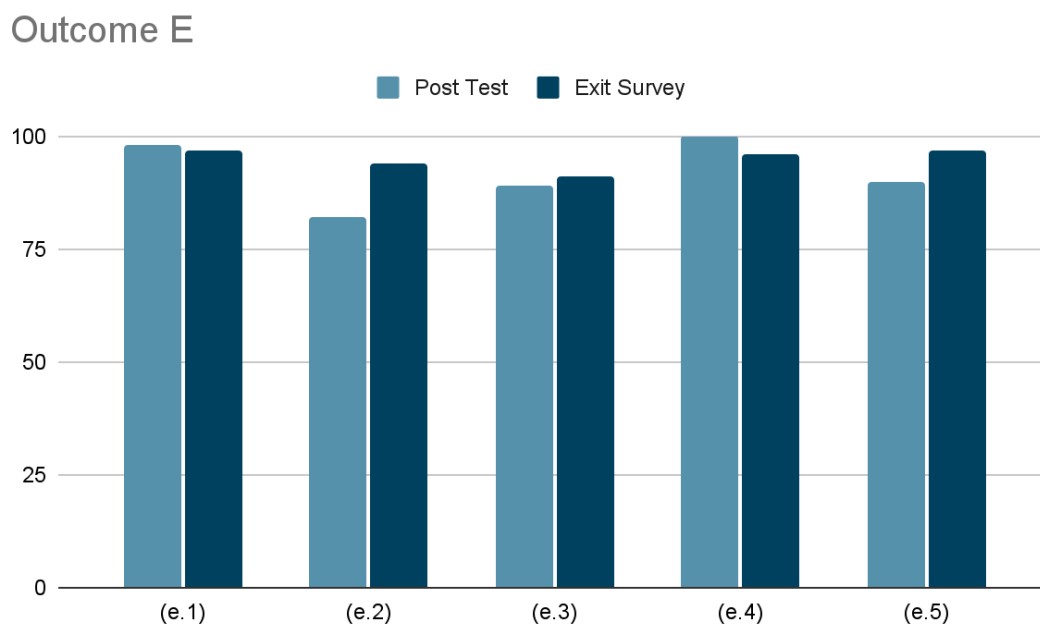
The PIs are the following:

(e.1) Evaluate the ethical implications of an issue in the computing discipline

On the post-test 98% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A on average 97%. Therefore the AAC concluded that the achievement level for this PI was met.

(e.2) Evaluate the social impact of a given computing technology

On the post-test 82% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A on average 94%. Therefore the AAC concluded that the achievement level for this PI was met.

(e.3) Recognize the responsibilities inherent to the profession

On the post-test 89% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A on average 91%. Therefore the AAC concluded that the achievement level for this PI was met.

(e.4) Evaluate the consequences when breaking the law
On the Post-test 100% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A (an average of 96%).   Therefore the AAC concluded that the achievement level for this PI was met.

(e.5) Understand the vulnerabilities of a system to guarantee a high level of security of the data that needs to be secured.

On the Post-test 90% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A (an average of 97%).   Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

There were no substantial differences on the results obtained from the post-test on performance indicators (e.1), (e.2) and (e.3). Performance indicators (e.4) and (e.5) were introduced in this assessment cycle based on the conclusions and recommendations of the previous one.


Conclusion

This outcome was met. The revision of the post-test included questions for (e.4) and (e.5) for the first time. We analyze these two PIs based on three semesters. We are very pleased with the achievement level of this outcome.

Outcome f: An ability to communicate effectively with a range of audiences.

This outcome is measured by three performance indicators. The following histogram summarizes the results obtained from the exit survey, oral presentation rubric and the written presentation rubric.

Outcome F

Legend: Exit Survey ■ Oral Pres. Rubric ■ Written Pres. Rubric

(chart categories: (f.1), (f.2), (f.3); y-axis 0 to 100)
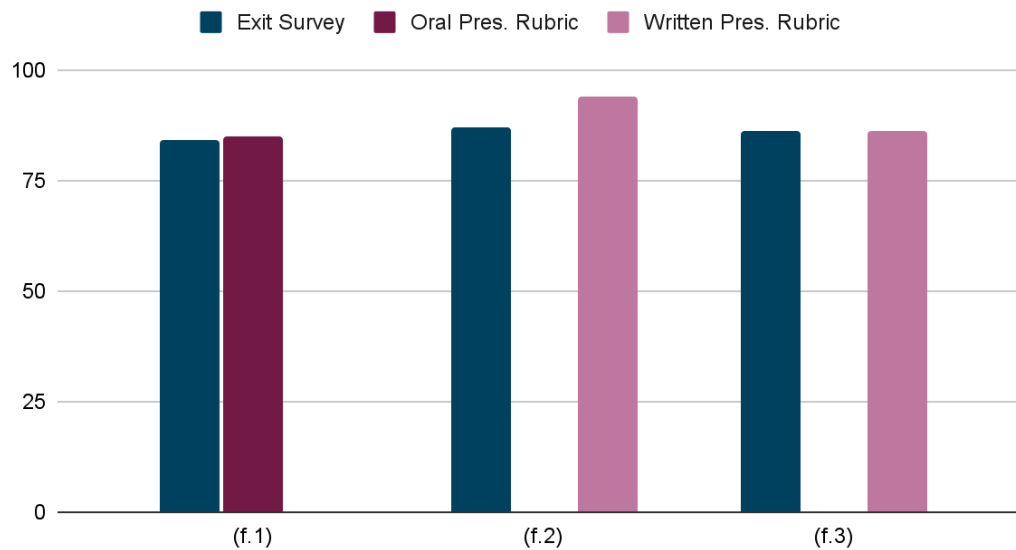
The PI are the following:

(f.1) Present different topics both orally and/or in writing

All the students that completed the exit survey gave this indicator a grade of B (an average of 84%).   The AAC decided to analyze the rubric used by the professors for grading the COTI 4306 - Undergraduate Seminar. In this course, students must present orally, the topic they presented on their Term Paper. Results were obtained from items 2 and 5 from COTI 4306-Presentation Day Rubric. The average grade obtained analyzing these rows is 85%. Therefore the AAC concluded that the achievement level for this PI was met

(f.2) Explain technical concepts using the correct terminology

All the students that completed the exit survey gave this indicator a grade of B (an average of 87%).   The AAC decided to analyze the rubric used by the professors for grading the COTI 4306 Undergraduate Seminar Survey Paper. Results were obtained from the 4th row of this rubric. The average grade obtained analyzing this row was 3.78/4 = 94.4 %. Therefore the AAC concluded that the achievement level for this PI was met

(f.3) Display knowledge of technical report writing

All the students that completed the exit survey gave this indicator a grade of B (an average of 86%). The AAC decided to analyze the rubric used by the professors for grading the COTI 4306 Undergraduate

Seminar Survey Paper. Results were obtained from the 5th row of this rubric. The average grade obtained analyzing this row was 3.44/4 = 86.1 %. Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

There were no substantial differences on the results obtained from the post-test on the performance indicators when compared with the previous cycle. The largest difference was an improvement of 5% on the performance indicator (f.2). However, the average increase of them all was 1%.

Conclusion and Reflection

This outcome was met. The students produced very well written Survey Papers in COTI 4306 Undergraduate Seminar. This is due to the fact that during the semester, students were working on their drafts towards a polished final article. Those students who worked hard on their drafts produced the best articles. Their polished articles resulted using a process where changes were suggested back and forth based on the drafts submitted during the semester. We recommend that this type of activity be implemented in other courses.

Outcome g: An ability to analyze the local and global impact of computing on individuals, organizations, and society.

This outcome is measured by three performance indicators. The following histogram summarizes the results obtained from the post-test and the exit survey.
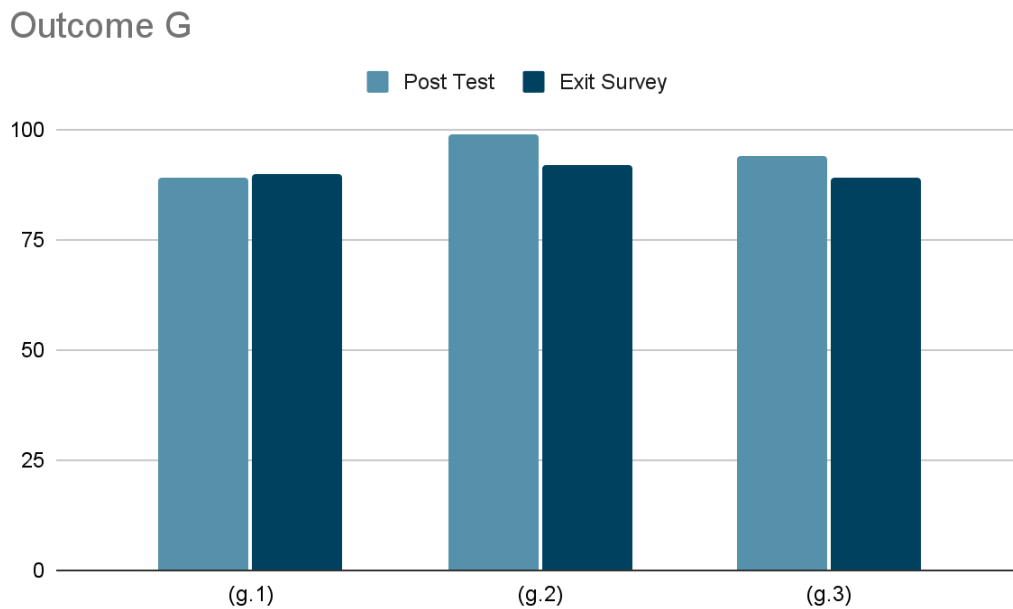
The PIs are the following:

(g.1) Understand computational or technological advances and their impact on individuals, organizations and society.

On the Post-test 89% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A on average 90%. Therefore the AAC concluded that the achievement level for this PI was met.

(g.2) Recognize the global and local impact of a given technology.

On the Post-test 99% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A on average 92%. Therefore the AAC concluded that the achievement level for this PI was met.

(g.3) Be aware of the state of the art in computing technology.

On the posttest 94% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of B on average 89%. Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

There was a slight increase in performance indicator (g.1) of 6%, an increase of 16% on (g.2) and an increase of 11% on (g.3) when compared to the last assessment cycle

Conclusion and Reflection.

This outcome was met. The increase in the percentage of attainment on all the questions related to this outcome on the post test can be attributed to the fact that this generation of students are more aware of the impact their actions have on society.

Outcome h: Recognition of the need for an ability to engage in continuing professional development

This outcome is measured directly and has no performance indicators. The following histogram summarizes the results obtained from the exit survey and a questionnaire.

Outcome H
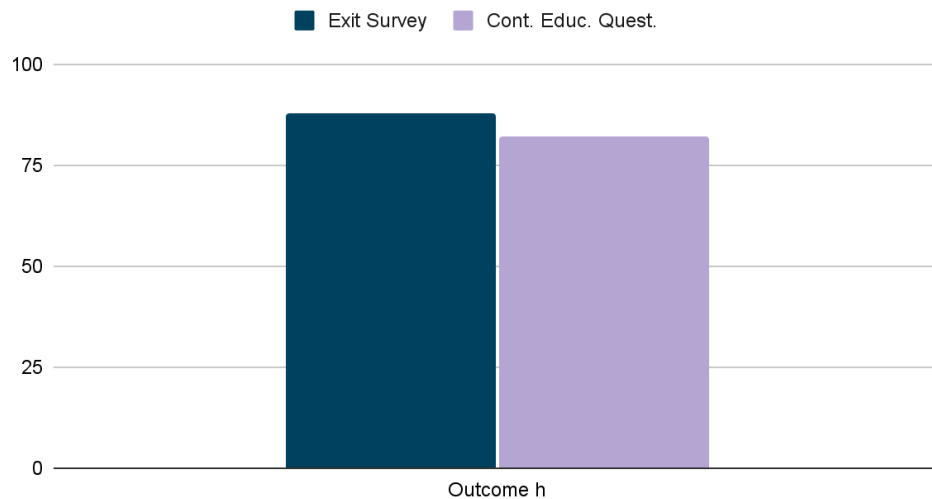
This outcome was measured directly using the Continuous Education and Career Path Questionnaire administered in SICI 4038 our capstone course.   All the students that completed the exit survey gave this indicator a grade of B (an average of 88%). A lecture in Opportunities after Graduation and Career Paths is given to all the students in the capstone course (SICI 4038). Students fill the Continuous Education and Career Paths Questionnaire after they take the lecture.   After analyzing the data from the questionnaire, 82% recognized the need to engage in continuing professional development. Therefore, the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

There has been a decrease in the results obtained from the exit survey and from the rubric when compared with the previous assessment cycle, however, is not substantial.
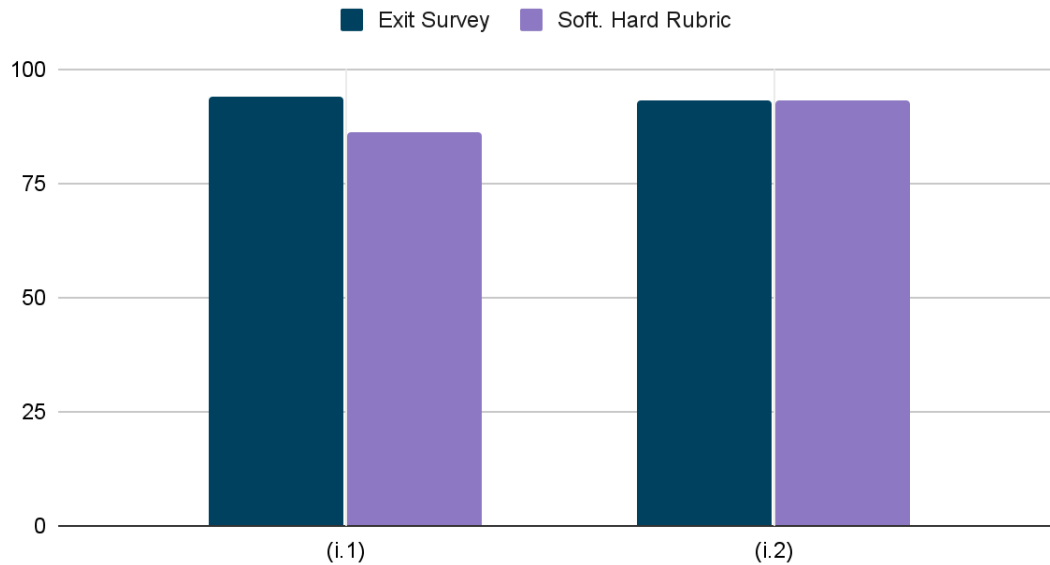
Conclusion

This outcome was met.

Outcome i: An ability to use current techniques, skills and tools necessary for computing practices.

This outcome is measured by two performance indicators. The following histogram summarizes the results obtained from the exit survey and a rubric.

Outcome I

Exit Survey ■ Soft. Hard Rubric ■

| | (i.1) | (i.2) |

The PIs are the following:

(i.1) Use hardware and software tools currently available

All the students that completed the exit survey gave this indicator a grade of A (an average of 94%). Around 86 % of the students used hardware and software tools currently available. This was obtained by looking at the results from the Rubric to Evaluate Software and Hardware Tools.   Therefore the AAC concluded that the achievement level for this PI was met.

(i.2) Use current techniques and skills in the practice of the profession.

All the students that completed the exit survey gave this indicator a grade of A (an average of 93%). Around 93 % of the students used current techniques and skills during the courses. This was obtained by looking at the results from the Rubric to Evaluate Software and Hardware Tools.   Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

Current cycle percentages are roughly the same results as on the previous assessment cycle.

Conclusion, Recommendations and Reflection

This outcome was met. However, the AAC pointed out that students only get an experience in one and only one operating system. They only use windows throughout all of the courses. This was a recommendation given in the previous cycle and an attempt was made to address it before the COVID 19

pandemic. However, in one of the upgrades that were made to the lab PCs, the Linux partition was removed. Our students should have experience, at least in one single course, with the Linux operating system, specifically on its command line. This recommendation came from the AAC.

Outcome j: An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.

This outcome is measured by five performance indicators.   The following is an histogram that summarizes the results obtained from the post-test, exit survey and the courses:
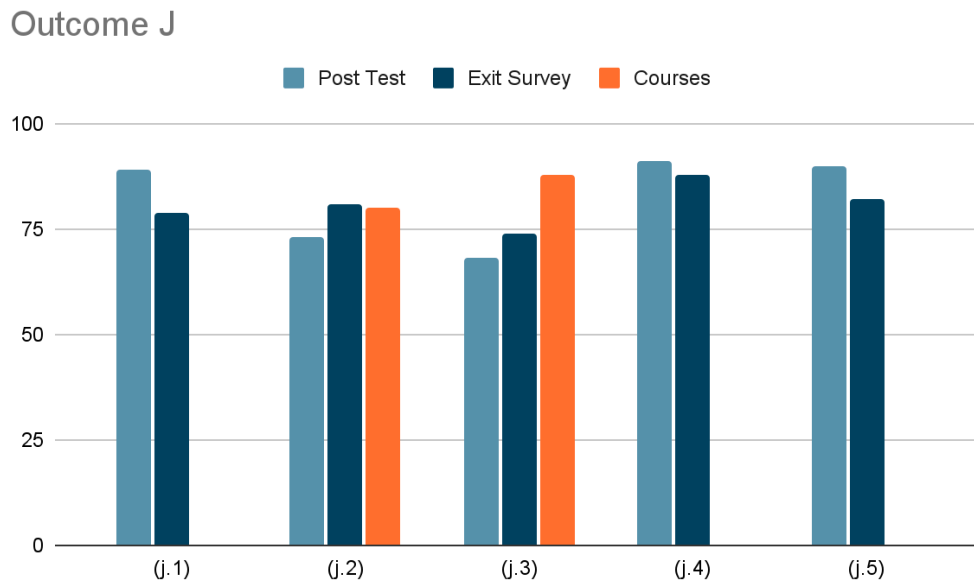
This PIs are the following:

(j.1) Determine the most appropriate data structure needed to solve a problem..

On the Post-test 89% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave a satisfactory grade of 79%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.2) Appraise if a given algorithm performed better than another.

On the Post-test 73% of the students answered the questions related to this PI correctly. However, All the students that completed the exit survey gave this indicator a grade of B on average 81%. The AAC decided to analyze the data obtained from the course SICI-4036 Data Structures specifically from Exam 1

or 2 depending on the Academic Year. A median of 80% was obtained after analyzing the data. Therefore, we concluded that the achievement level for this PI was met.

(j.3) Determine the most appropriate programming paradigm needed to solve a problem.

On the Post-test 68% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of C on average 74%. The AAC decided to analyze a sample obtained from the course COTI-4039 Comparative Programming Languages specifically from Exam 1 questions 4, 5 and 6. A median of 88% was obtained after analyzing the data. Since, students gave themselves a grade of C on their autoevaluation made in the exit survey, we concluded that the achievement level for this PI is developing.

(j.4) Perform object oriented and structured analysis and design of software systems.

On the Post-test 91% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of B on average 88%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.5) Construct software systems of varying complexity

On the Post-test 90% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of B on average 82%.   Also, our students have demonstrated this ability to develop projects of varying complexity on the SICI 4038 course (our capstone course), the AAC concludes that this PI was met. Students have developed projects in different environments (web, mobile, internet of things etc.).

Previous Cycle Comparison

The performance indicators of outcome J suffer a slight change for this assessment cycle. Therefore we have to compare them based on a mapping. There were not substantial changes for the values obtained from the post-test for performance indicators (j.1), (j.2) and (j.4). However, the post-test results for performance indicators (j.3) were -23% less compared to the ones obtained in the previous assessment cycle. The AAC decided to use data from the courses to analyze (j.3) directly. Performance indicator (j.5) was met with an improvement of 4%.

Conclusions Recommendations and Reflection

The outcome was met since most of the PIs were met. However, we have to reflect something about the performance indicator (j.3). Students graded themselves on the exit survey an average grade of 74%, however, when we analyze the sample obtained from the course, the average obtained was 88%. The performance indicator clearly indicates: *"determine the most appropriate programming paradigm needed to solve a problem"*. The sample obtained from COTI 4039 were a couple of multiple choice

questions from Exam 1. Is that appropriate for really measuring this PI? What do we really want to measure? Therefore, since there is a discrepancy we have classified that PI as developing. Also we need to really check the questions of the post-test related to that PI and reinforce this PI.