University of Puerto Rico at Bayamón

Continuous Improvement Report

Computer Science

2019-2022 Cycle
September 2024 Revision

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

area of the Computer Science Department

A note about the Updated Student Outcomes

The Computer Science program aims to be re-accredited by the Computing Accreditation Commission (CAC) of the Accreditation Board of Engineer and Technology (ABET). The document Criteria for Accrediting Computing Programs for those programs effective for review during the 2024-2025 Accreditation Cycle clearly stipulates on page 4: *The program **must** have documented and publicly stated student outcomes that include (1) through (5)*. Furthermore, a sixth student outcome is required for the *Computer Science and Similarly Named Computing Programs*. This revised document includes the updated student outcomes.

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 1: Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.

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 1

Legend: ■ Post Test ■ Exit Survey ■ Courses
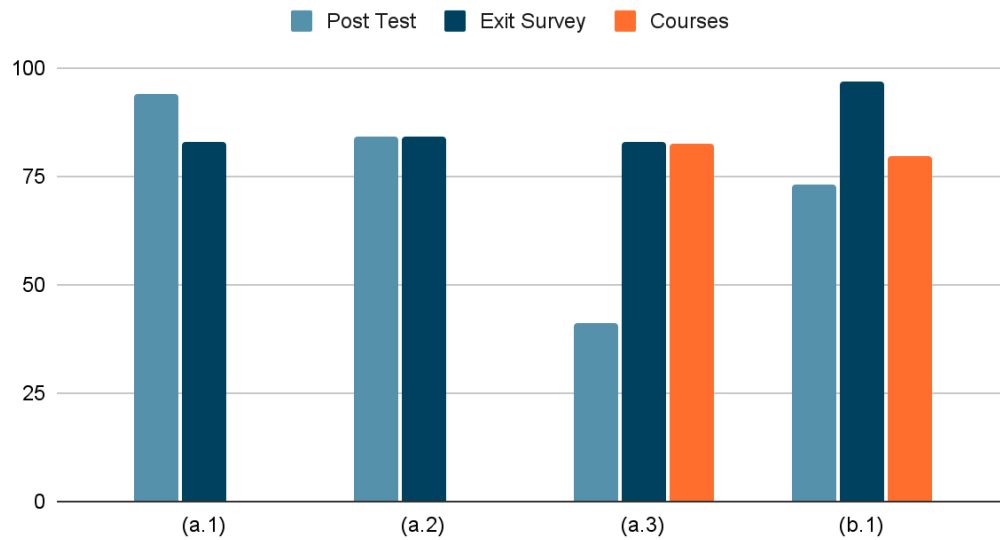
The PIs are the following:

(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.

(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.

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.

For (b.1), 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).

Reflexion: The above performance indicators were geared towards an older version of the outcome. However, the AAC aligned the performance indicators to this outcome as it suffices. Moreover, we can attest that our students, at the capstone course, develop projects that meet the scope of this outcome even further. This is evident from the diversity of projects they develop and present in their posters. The AAC recommends including some way of measuring, or presenting this in a more tangible way in a version of this report in the future. Also, the AAC recommends a revision of the performance indicators on the next assessment cycle.

Outcome 2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

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

Outcome 2
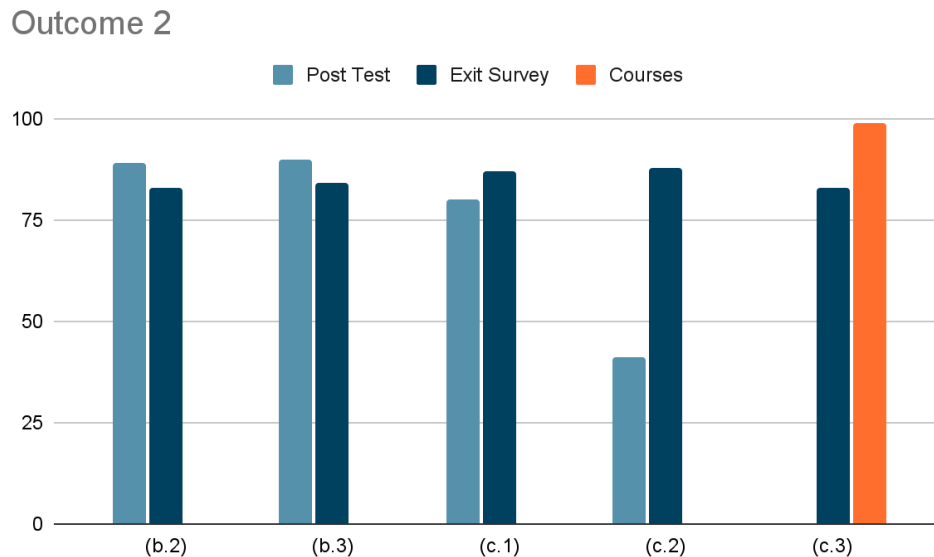
This PIs are the following:

(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.

(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, Recommendations and Reflexion

The AAC concluded this outcome was met.

Outcome 3: Communicate effectively in a variety of professional contexts.

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 3

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

(f.1) (f.2) (f.3)
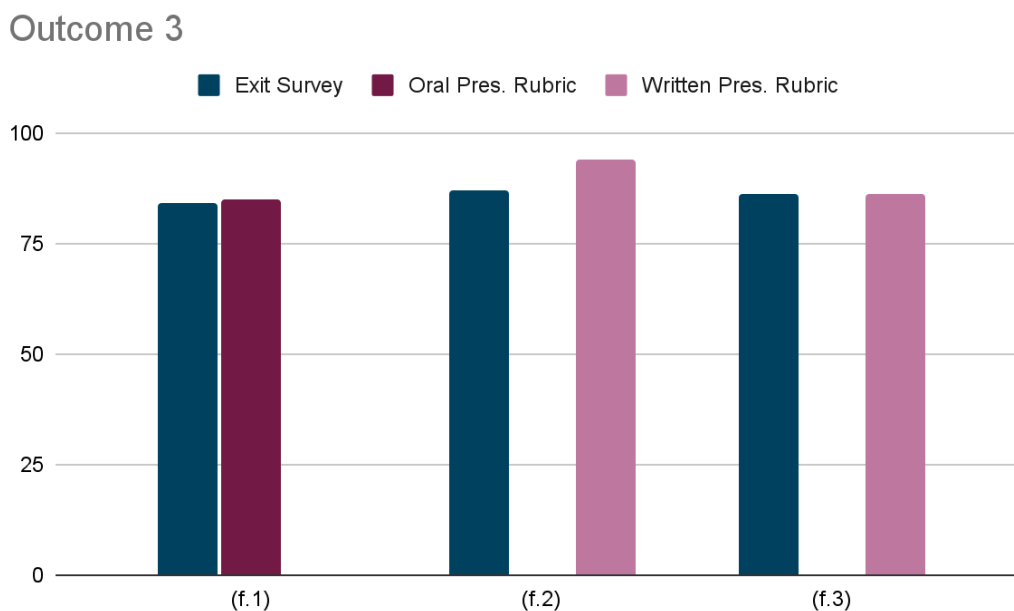
The PI are the following:

(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 4: Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

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

Outcome 4

Post Test   Exit Survey
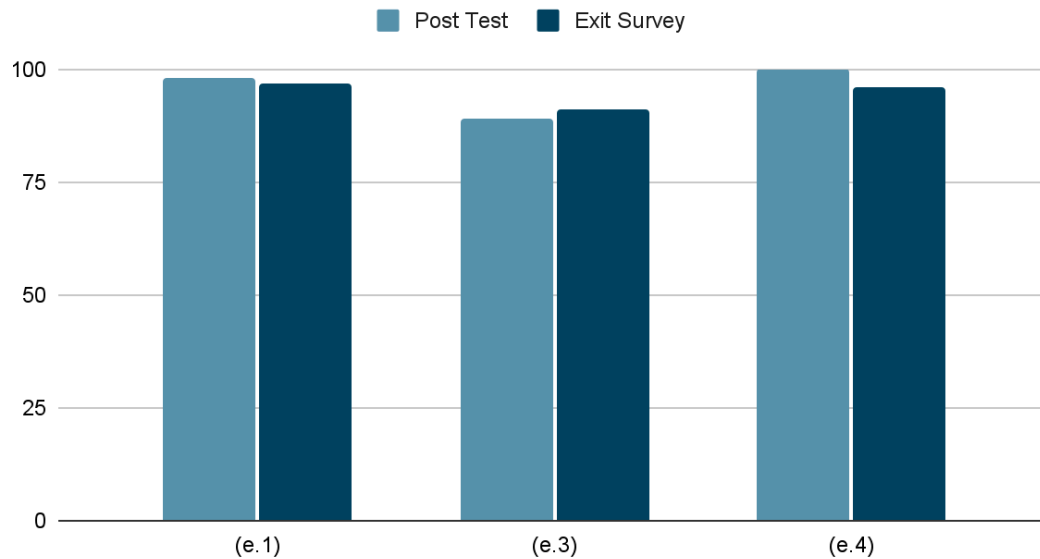
The PIs are the following:

(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.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.

Previous Cycle Comparison

There were no substantial differences on the results obtained from the post-test on performance indicators (e.1) and (e.3). Performance indicator (e.4) was 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) for the first time. We analyze this PI based on three semesters. We are very pleased with the achievement level of this outcome.

Outcome 5: Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

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 5
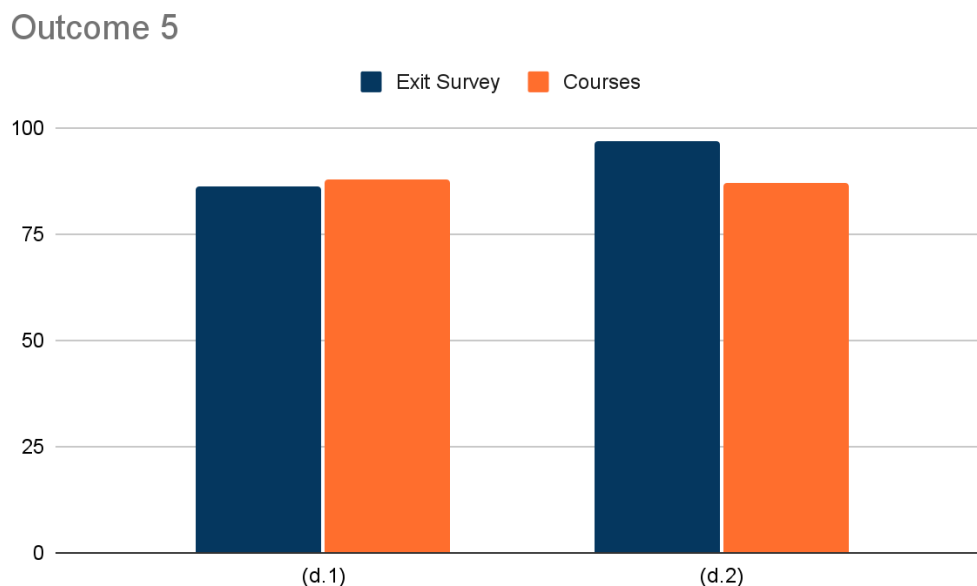
The PIs are the following:

(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.
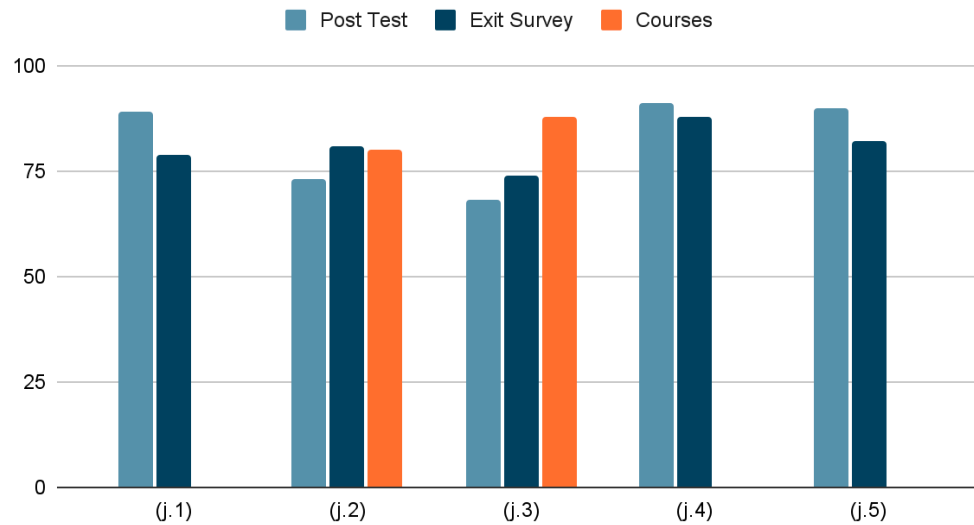
Conclusion

This outcome was met.

Outcome j: Apply computer science theory and software development fundamentals to produce computing-based solutions.

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:

Outcome 6

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.

Criterion 5: Curriculum Assessment Tools

The document Criteria for Accrediting Computing Programs for those programs effective for review during the 2024-2025 Accreditation Cycle present on page 5, three (3) topics that must be included in the curriculum. These are:
1. Techniques, skills and tools necessary for computing practice.
2. Principles and practices of security and privacy in computing.

3. Local and global impacts of computing solutions on individuals, organizations, and society.

The instruments that we have already implemented have helped us to know the attaintment of 1, 2 and 3. In this section we are going to present our findings.

Topic 1: Techniques, skills and tools necessary for computing practice:

The following histogram summarizes the results obtained from the exit survey and a rubric.
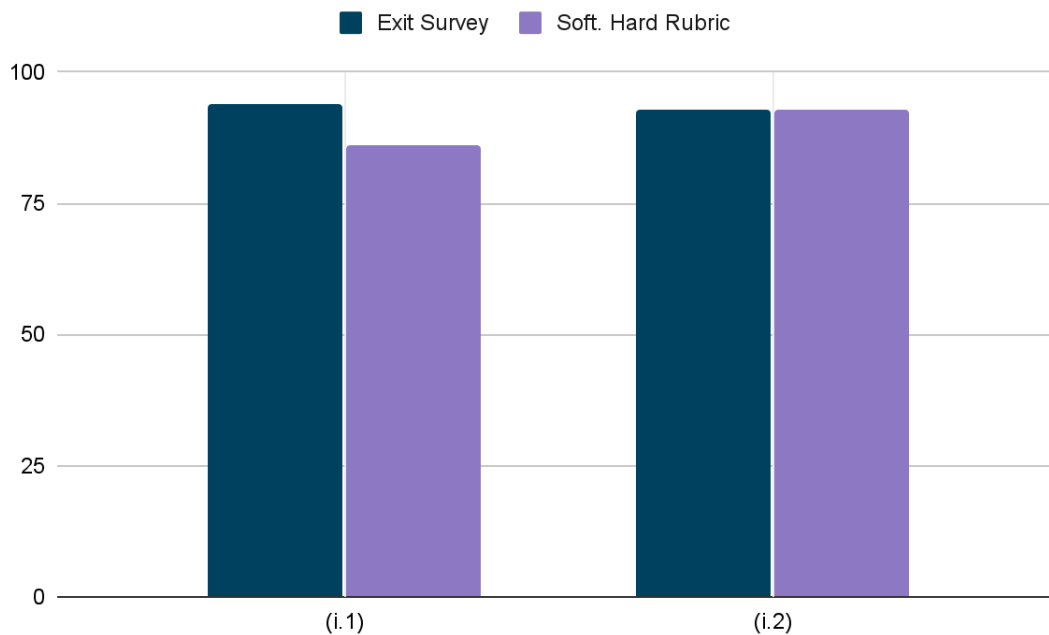
These were performance indicators used in a previous cycle. We have measured them into this cycle as well. Therefore we use it to validate the coverage of the topic. The following PIs were used:

(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
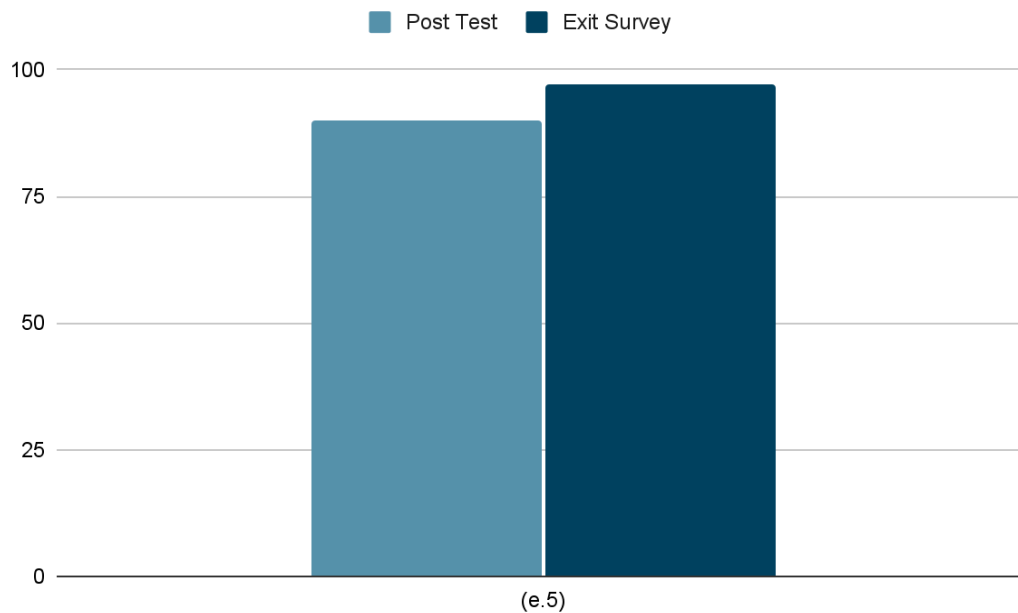
looking at the results from the Rubric to Evaluate Software and Hardware Tools.   Therefore the AAC concluded that the achievement level for this PI was met.

Conclusion

This topic was covered with excellence.

Topic 2: Principles and practices of security and privacy in computing.

The following histogram summarizes the results obtained from the post-test and the exit survey.

This performance indicator was used in a previous cycle. We have measured it into this cycle as well. Therefore we use it to validate the coverage of the topic.

(e.5) Understand the vulnerabilities of a system to guarantee a high level of security of the data that needs to be secured.
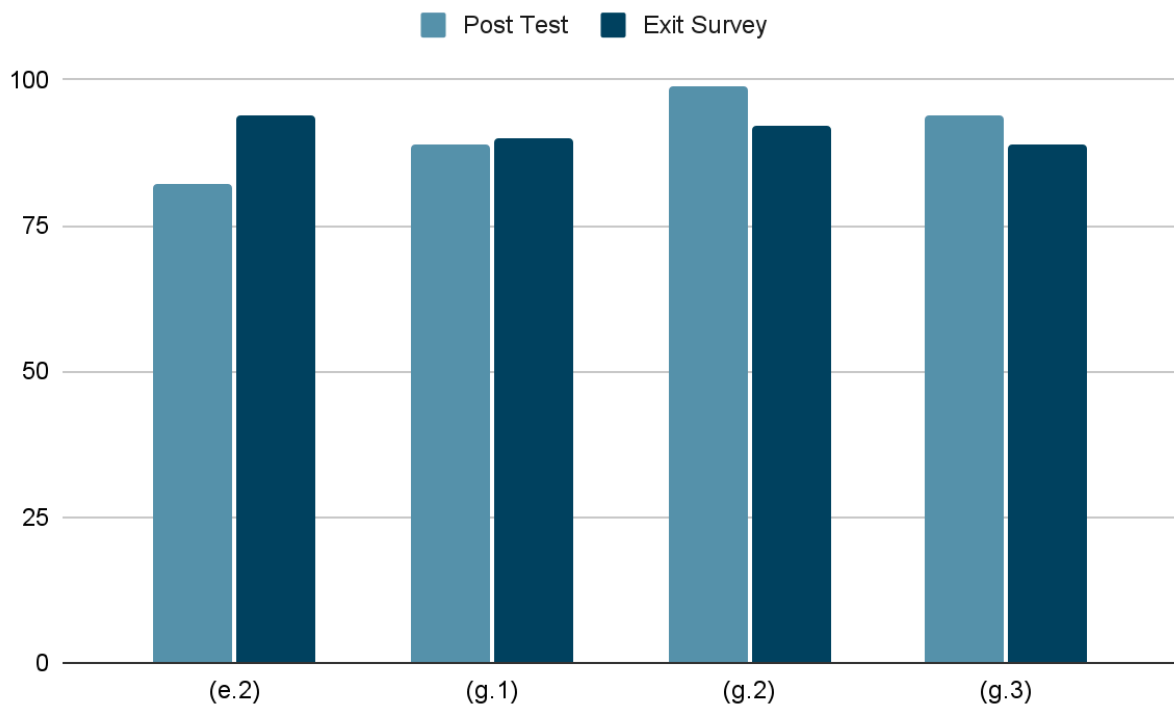
On the Post-test 90% of the students answered the questions related to this PI correctly. All the students that completed the exit survey gave this indicator a grade of A (an average of 97%).   Therefore the AAC concluded that the achievement level for this PI was met.

Conclusion

This topic was covered with excellence.

Topic 3: Principles and practices of security and privacy in computing.

The following histogram summarizes the results obtained from the post-test and the exit survey.

These were performance indicators used in a previous cycle. We have measured them into this cycle as well. Therefore we use it to validate the coverage of the topic. The following PIs were used:

(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.

(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.

Conclusion

This topic was covered with excellence.