University of Puerto Rico at Bayamón

2013-2016 Cycle

Continuous Improvement Report
Computer Science

This report provides the analysis of the achievement of the Student Outcomes for the Computer Science emphasis area of the Computer Science Department

Introduction

This document presents the assessment of the Student Outcomes (SO) of the Computer Science emphasis area (program) of the Department of the Computer Science for the University of Puerto Rico at Bayamón for the cycle 2013-2016. Analysis of the SOs is performed using two main tools: post-test and the graduate (exit) questionnaire. If there is a discrepancy between these tools data obtained from the courses is analyze for triangulation.

Remark on the Post-Test Results

Most of the data to evaluate the outcomes are made through Performance Indicators (PI). At least two questions are drafted in the post-test to measure most PIs. This is evident after the post-test revision of 2015. However, some of the data used for our analysis have included results prior to this revision. We harmonized results from the previous post-test and the revised them in order to prepare this report.

Computer Science Program - Student Outcomes Data Analysis

This section presents the analysis of the Student Outcomes for the Computer Science program (emphasis area) at the University of Puerto at Bayamón. Each outcome was further divided into performance indicators and were analyzed using at least two instruments: one direct measurement and one indirect measurement. The main direct measurement for most of the outcomes was the post-test given to all students enrolled in our Capstone course (SICI 4038). The other outcomes were assessed using data obtained from the courses either by rubrics or analyzing the coursework. The main indirect measure is a survey administered to the students in our Capstone course named the Graduate Questionnaire. Whenever a discrepancy is found, relevant materials from the courses are analyzed.

As in previous cycles we used the results from the post-test questions for further analysis. The analysis assumed the following scale:

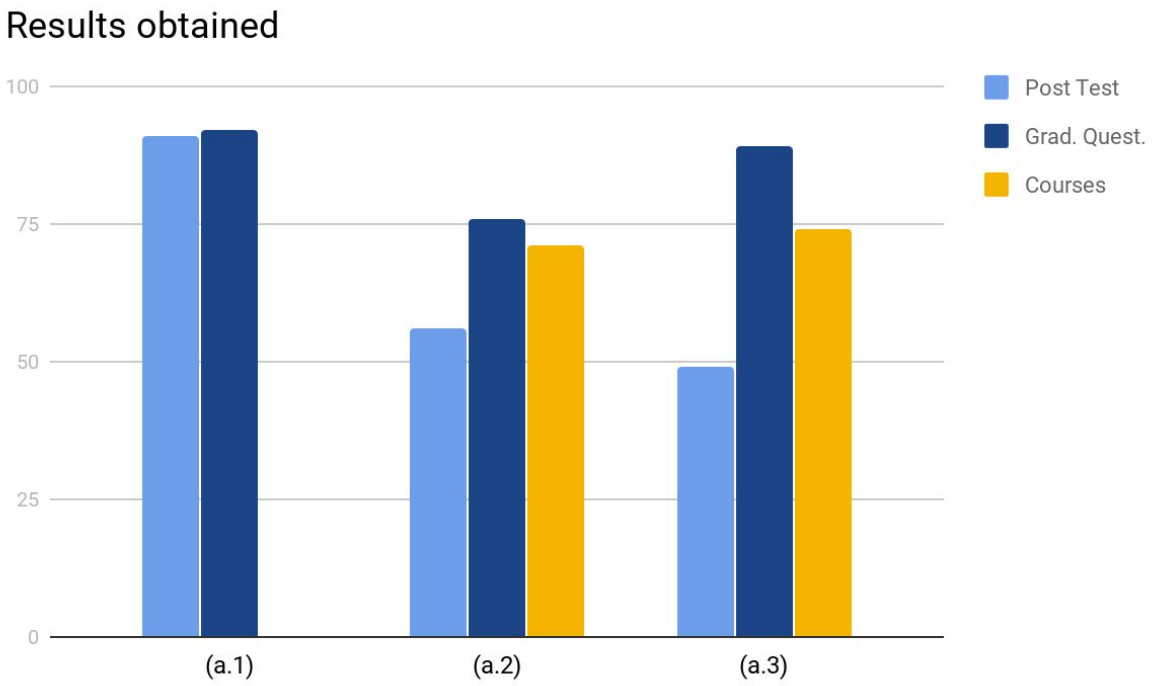
- Satisfactory – the question was correctly answered by at least 75% of the students.
- Developing – the question was correctly answered by at least 50% of the students but less that 75%.
- Unsatisfactory – the question was correctly answered by less than 50% of the students.

For the student 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.

Student Outcomes Analysis

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



This outcome is measured by three main performance indicator.

(a.1) Select the appropriate algorithm for an specific situation

On average 91% of our student answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of A in average 92%. 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 56% of our student answered the questions related to this PI correctly. We considered this results to be Unsatisfactory. However, all the students that completed the graduate questionnaire gave this indicator a grade of 76% (high C). We analyze data obtained from Quiz #2 of the SICI 4036-Data Structures. These were the first 5 questions of section 1. After grading only this part for 18 quizzes we obtained a median of 71%. Therefore, we concluded that the achievement level for this PI is developing.

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

On average 49% of our student answered the questions related to this PI correctly. However, all the students that completed the graduate questionnaire gave this indicator a grade of 89%. We analyze data obtained from question 3 part III of Exam 3 and question 2, part II of Exam 2 from SICI 4037-Data Communication course . After grading only these questions a median of 74% was obtained. Therefore, we concluded that the achievement level for this PI is developing.

Previous Cycle Comparison

Comparing last assessment cycle with this one we can see that for PI (a.1) there has been a 7% of improvement on the results obtained from the post-test. Also the students gave this indicator a strong satisfactory grade. On average 56% of the students answered the questions correctly for performance indicator (a.2) for this and for the last cycle. There has been no improvement whatsoever obtained from the post-test for this performance indicator. However, after analyzing the results from the courses there was an improvement of 10% in this performance indicator.
Comparing last assessment cycle with this one we can see that for PI (a.3) there has been a 10% of improvement on the results obtained from the post-test. Also there was an improvement of 14% in the level of satisfaction that the students perceived when answering the graduate/exit questionnaire.

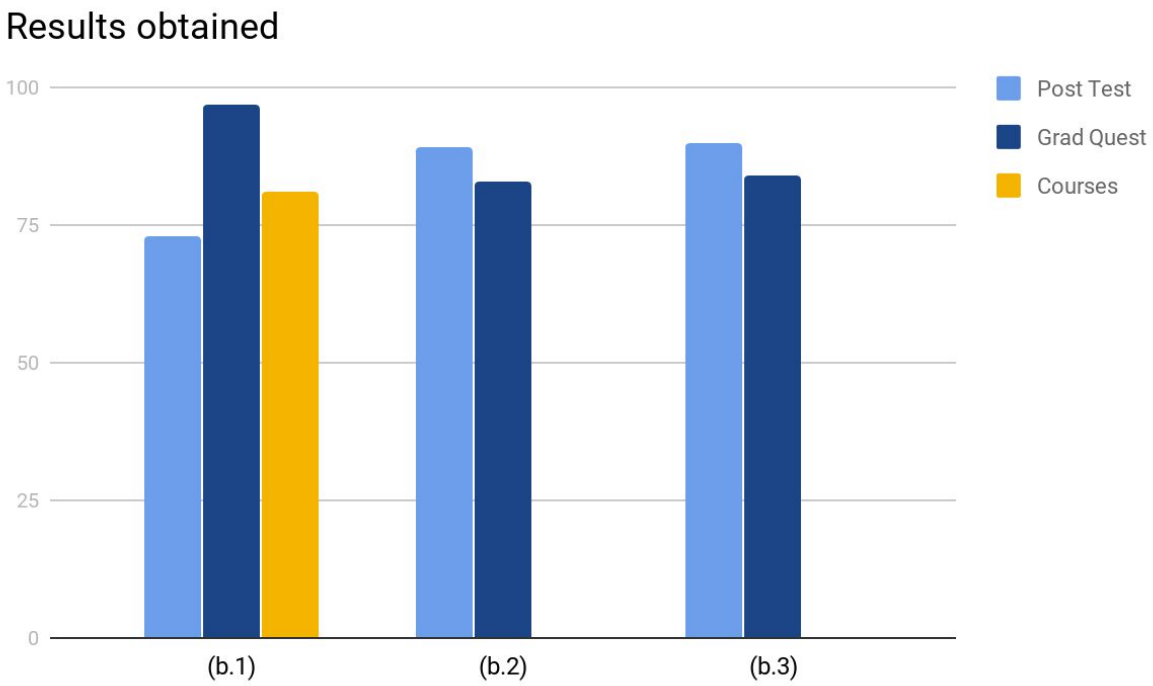
Conclusions and Recommendations

The AAC concluded that this outcome is partially met. There have been improvement in the achievement level of the outcome. Moreover, the committee recommends:

- Improvement on PI (a.2) : Emphasize on asymptotic analysis during next cycle. COTI-4255 Analysis of Algorithms have been introduced as a new course in our last curricular revision. However, we must analyze if the questions that are included in the post test are in tune with this performance indicator. Also, we have to analyze if the material in the courses is sufficient to meet this PI.
- Reinforcement of PI (a.3) : An analysis of the questions that are included in the post test needs to be done. An achievement level of 56% on the post-test is too low.

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

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



(b.1) Analyze a problem

Only 73% of the student answered this question correctly. However, they show confidence in this PI on the graduate questionnaire since they graded themselves with 97%. The AAC decided to analyze data obtained from the course SICI 3015 Analysis and Design. In most of the practical exams given by the professor the students have to read a problem, analyze it and design a solution for the problem. We have decided to analyze the grade for the partial exam #2. The mean grade obtained in this exam was 81%. Therefore, the AAC concluded that the achievement level of this PI was met.

(b.2) Identify and define the computational requirements needed in a real situation
On the post-test 89% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B (an average of 83%). 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 90% of the students answered the questions related to this PI correctly. Also, all the students that completed the graduate questionnaire gave this indicator a grade of B (as in previous PI an average of 84%). Therefore, the AAC concluded that the achievement level of this PI was met.

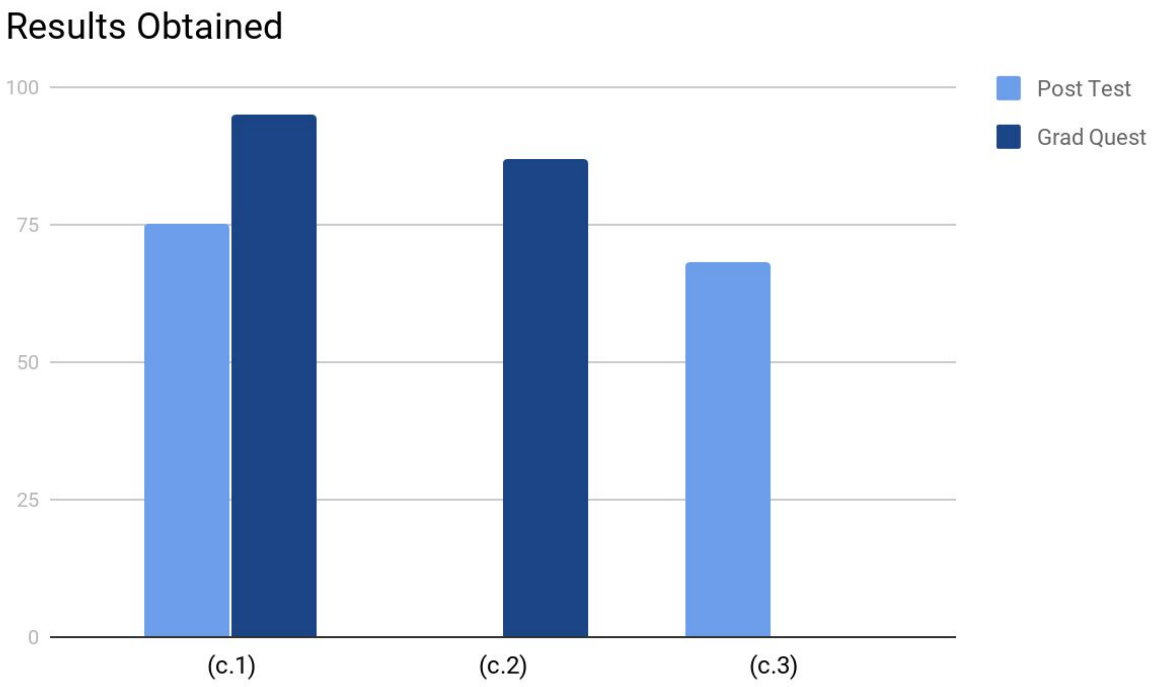
Previous Cycle Comparison

For PI (b.1) there has been a 6% of improvement on the results obtained from the post-test. Also the students gave this indicator a strong satisfactory grade. There has been a 16% of improvement on the results obtained from the post-test in this cycle when compared to the last one for PI (b.2). Also the students gave themselves a satisfactory grade. Also, there has been a 5% of improvement on the results obtained from the post-test for PI (b.3).

Conclusions and Recommendations

The AAC concluded that this outcome was met.

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 three performance indicators. This PIs are the following:

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

On the post-test 75% of the students answered the questions related to this PI correctly. Also, all the students that completed the graduate questionnaire gave this indicator a grade of A (as in previous PI an average of 95%). Therefore, the AAC concluded that the achievement level of this PI was met.

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

All the students that completed the graduate/exit questionnaire gave this indicator a grade of B (an average of 87%). A requirement of the CS program is COTI 4039 Comparison of Programming Languages. In this course, students implement in three different language paradigms and languages. Also, after examining the SICI 4038 (Capstone Course) projects we can conclude that students are able to implement a system in almost any language. We have seen many projects in Microsoft and Non Microsoft environment, for example, Android, Web based and even using the concept of Internet of Things. This have been evident to us when looking to the posters presented by the students in the capstone course. Therefore, the committee declared that this PI was met.

(c.3) Perform both unit and system testing

All the students that completed the graduate questionnaire gave this indicator a grade of D (an average of 68%). We now that just lately we have added this to the courses. Some students indicated on the graduate questionnaire that they don't have knowledge about this and this is true. All students that take course SICI 4036 Data Structures are using JUnit to test their programs. We now that just lately we have added this to the course. Some students have mentioned that they don't have knowledge about this and is true. However, many students performed unit and system testing when building programs of varying complexity but couldn't identify the type of test they were performing as a unit or system. They just only knew they test the program by "including and testing" each method/procedure or function they were added to the system. Therefore, the AAC classify this PI as developing.

Previous Cycle Comparison

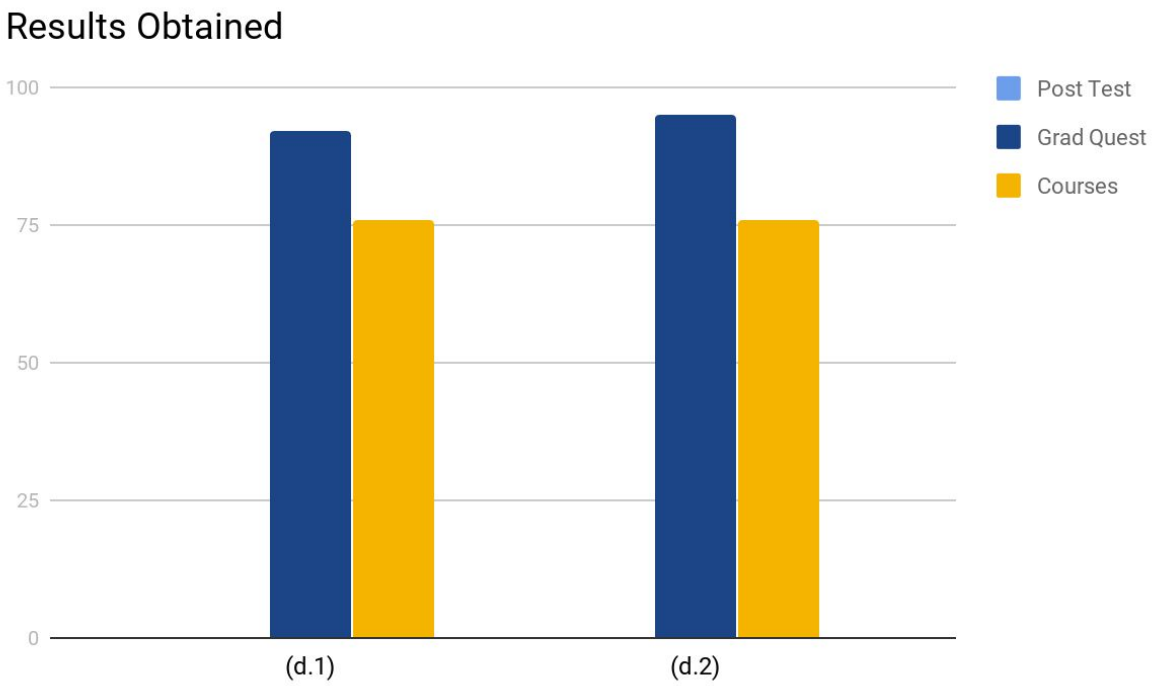
There were changes on the performance indicators related to this outcome during 2013-2016. Performance Indicator (c.1) previously was PI (3.d). Students that answered the questions on the post-test related to (c.1) showed a satisfactory grade vs. last cycle. There was in improvement on the students of the CS program. Performance indicator (c.2) previously was PI (3.c). Students have increased their confidence level when analyzing the data obtained from the graduate questionnaire from last assessment cycle to this one for PI (c.2). Performance indicator (c.3) was unsatisfactory and therefore, not met in last assessment cycle. However, it has increased to developing on this assessment cycle.

Conclusions and Recommendations

The AAC concluded that this outcome is partially met. The committee recommends:

- Reflection: Performance Indicator (c.3) should be met in next assessment cycle. It is envision that all the students would have an experience using Junit in the upcoming years. Students would understand the difference between the type of testings they are performing.

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



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

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

All the students that completed the graduate questionnaire gave this indicator a grade of A (an average of 92%). 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 76% 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 graduate questionnaire gave this indicator a grade of A (an average of 95%). We use the same instrument as the previous PI. After analyzing this instrument we found out that more that around 76% 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.

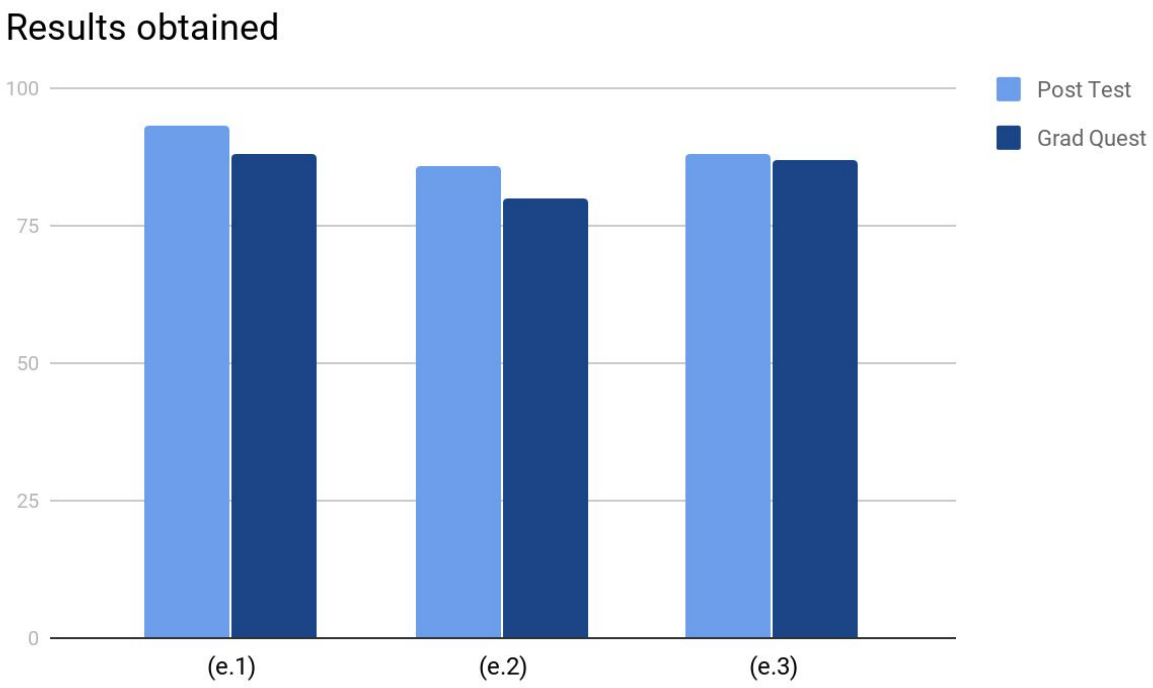
Previous Cycle Comparison

Comparing last assessment cycle with this one we can see that for PI (d.1) both results obtained from the rubric were 76%. This is an acceptable satisfactory grade. Also the students gave this indicator a strong satisfactory grade. There is an increased of 2% from previous cycle for the results obtained when assessing PI (d.2).

Conclusions and Recommendations

This outcome was met.

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



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

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

On the post-test 93% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 88%. 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 86% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 80%. 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 88% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 87%. Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

Comparing last assessment cycle with this one we can see that for PI (e.1) there was a 3% of difference between last cycle and this one (96% - 93%). The AAC sees this difference as negligible. Also the students gave this indicator a strong satisfactory grade. On the post-test 86% of the students answered the questions related to PI (e.2) correctly. There were no questions for this PI on the previous version of the post-test. Also, on previous cycle, the AAC use data from the courses to assess this PI. Last Cycle, the AAC classified this PI as developing. This cycle has been classified as satisfactory. There has been a 15% of increased on the achievement level. On the post-test 88% of the students answered the questions related to PI (e.3) correctly. There were no questions for this PI on the previous version of the post-test. The AAC used data from the courses to assess this PI on previous cycle. This PI has been has been classified as satisfactory.

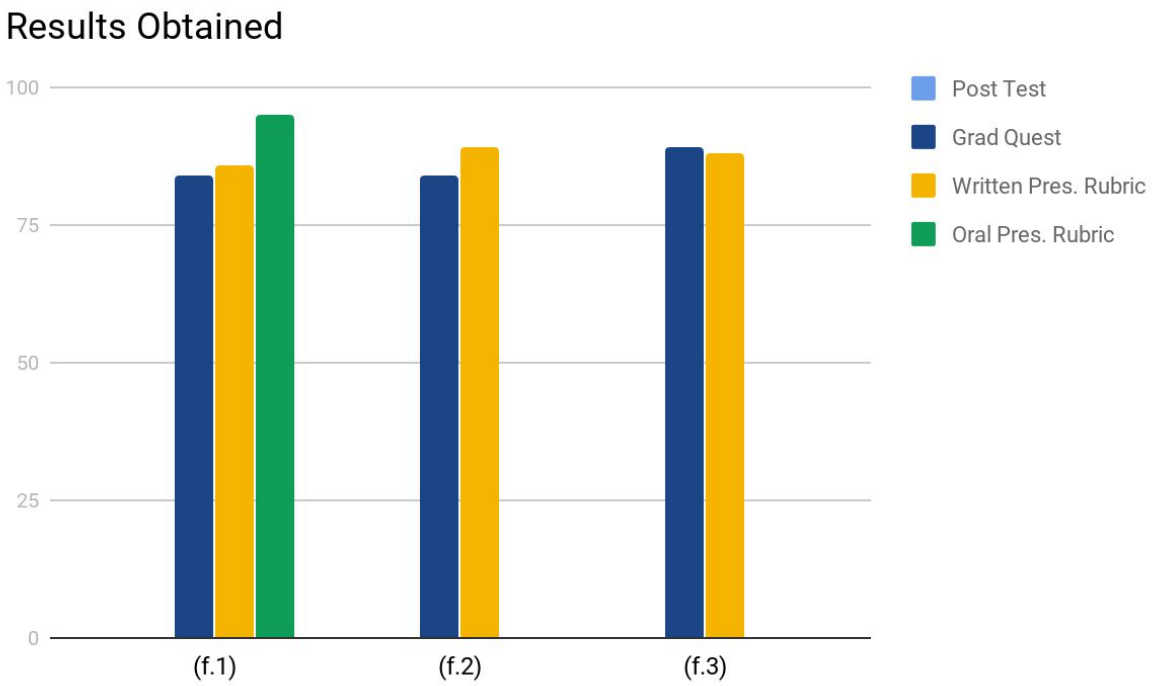
Conclusions and Recommendations

The AAC decided that this outcome was met. The AAC recommended the addition of a course in ethics and social impact of computing on the last assessment cycle. This course was created and currently been offered. Course is COTI 3305 Computing Ethics and Society. The addition of this 2 credit course on ethics have made our student more aware in their ethical behaviour. The AAC have focus on this cycle into improving outcomes e, and g.

- Reflection: Our curriculum has a course in Information Security and we don't have a performance indicator or a question in the test related to that. We need to at at least one PI on this outcomes that measures security aspects.

- Reflection: The legal aspects that are related to the field are covered in the course COTI 3305. However, there is no question in the post-test that address this. We need to add at least one PI or one question that measures this part of the outcome.

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



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

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

All the students that completed the graduate questionnaire gave this indicator a grade of B (an average of 84%). The AAC decided to analyze the grade obtained from the first row of the rubric for the SICI 4019 Computer Architecture Term Paper. Moreover, the AAC decided to analyze the grade obtained from the oral presentation rubric from the SICI 4037 Data Communication course. The average grade obtained analyzing the first rubric was 17.22/20.00 = 86 %. The average obtained by analyzing the oral presentation rubric is 95.8%. 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 graduate questionnaire gave this indicator a grade of B (an average of 84%). The AAC decided to analyze the rubric for the SICI 4019 Computer Architecture Term Paper

specifically the 4th row. The average grade obtained analyzing this row was 17.85/20.00 = 89 %. 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 graduate questionnaire gave this indicator a grade of B (an average of 89%). The AAC decided to analyze the overall grade obtained from the rubric used for the SICI 4019 Computer Architecture Term Paper. The mean grade obtained after analyzing the data was 88% (87.7). Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

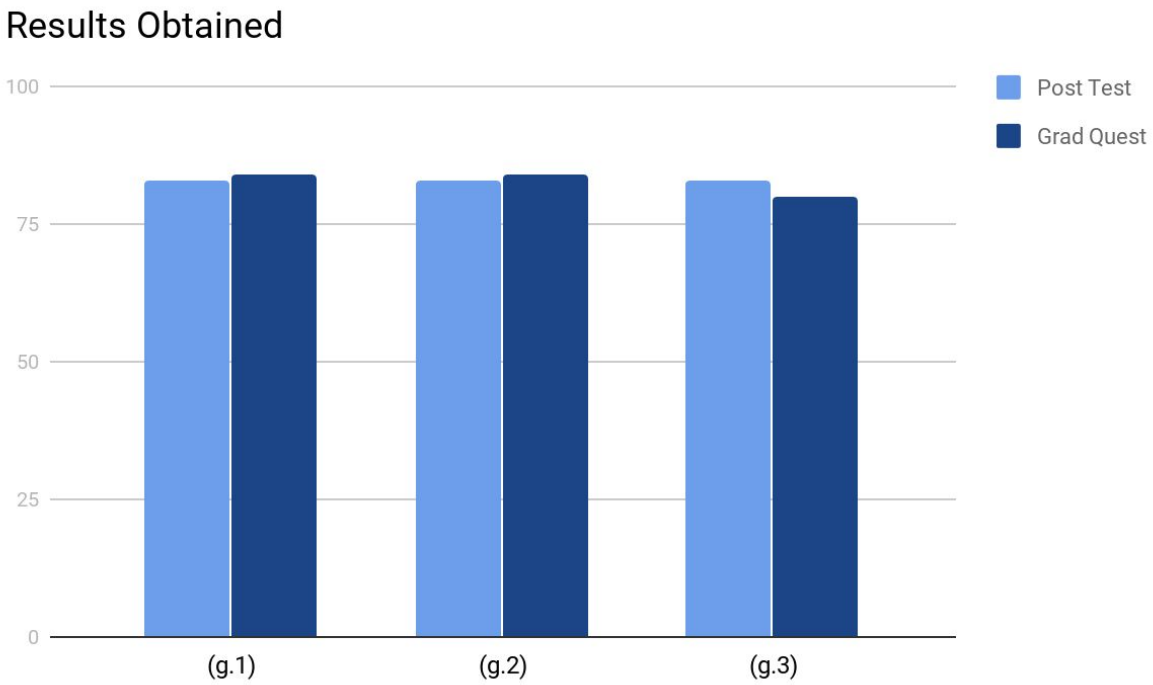
Comparing last assessment cycle with this one we can see that for PI (f.1) and PI (f.2) there was an improvement of 9% on the results obtained from the Graduate Questionnaire. This is very important for us, since, this tool measures the perception that students have on themselves. A larger improvement of 40% was found on the results obtained for PI (f.3).

Conclusions and Recommendations

The AAC decided that this outcome was met.

- Reflection: This outcome was met solidly on this cycle,however, we have analyzed the attainment of this outcome using mostly the data obtained from the SICI 4019 Term Paper and the SICI 4037 Final Project presentation. The outcome is An ability to communicate effectively *with a range of audiences*. Does the data obtained from these courses is sufficient? Where is that range of audience? Does professors and students is sufficient? Would it be better to measure this outcome in SICI 4038 our capstone course? The AAC must reflect about this.

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. This PIs are the following:

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

On the Post-test 83% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 84%. 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 83% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 84%. 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 Post-test 83% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 80%. Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

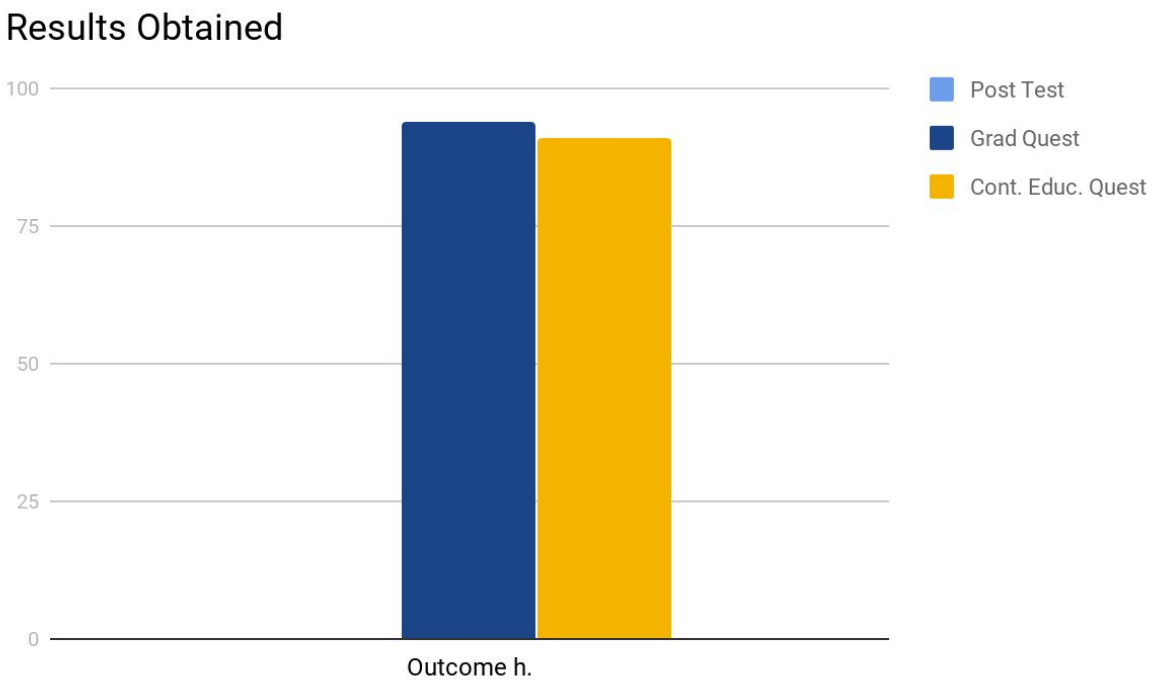
The performance indicators for this outcome received a major overhaul from previous cycle to this cycle. Therefore, each PI cannot be compared directly.

Conclusions and Recommendations

The AAC decided that this outcome was met.

- Reflection: Students that took the test show that they achieve all the PIs satisfactory. The AAC have focus on this cycle into improving outcomes e, and g. The changes on the course of SICI 4037 Data Communications and COTI 3305 Computing Ethics and Society has made us improve substantially on this outcome since last assessment cycle.

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



This outcome does not have any performance indicator. We are measuring the outcome directly.

All the students that completed the graduate questionnaire gave this indicator a grade of A (an average of 94%). All the students take a lecture on *Continuous Education and Career Paths* on their Capstone Course (SICI 4038). They also answer a questionnaire about this outcome during this course. After analyzing the data 91% recognize the need to engage in continuing professional development. Therefore, the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

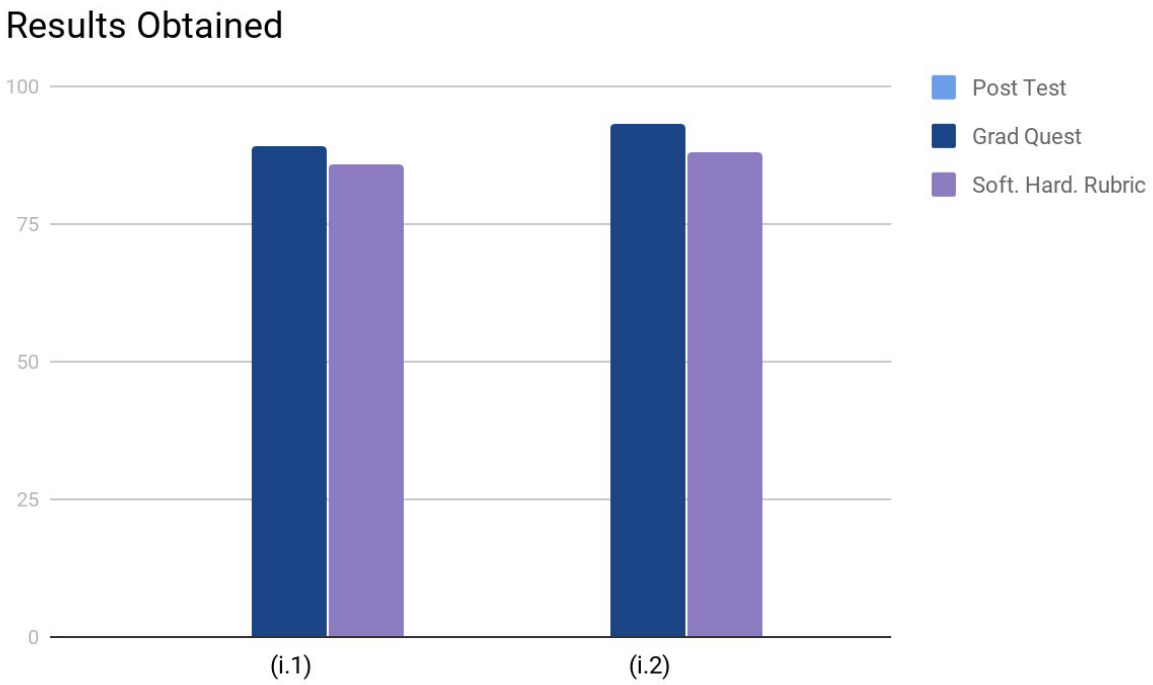
The AAC recommended developing suitable instruments to measure this outcome during the last cycle. Also, the AAC recommended the revision of all the performance indicators that were part of this outcome. The PIs were eliminated. Therefore, there was no way to compare each PI. However, a lecture on Continuous Education and Career Paths as a requisite of the SICI 4038 (Capstone course) was added to measure this outcome. Also, the students take a questionnaire after this lecture.

Conclusions and Recommendations

This outcome was met. Special attention was taken to this outcome during this cycle. Around 18% of the students indicated that they plan to pursue graduate school.

- Reflection: The AAC needs to analyze if this is too low. A discussion with the department needs to be schedule to analyze this. Also some professors have raised a concern that this lecture should be given earlier.

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



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

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

Around 86% of the students used hardware and software tools currently available. This was obtain by looking at the results from the Rubric to Evaluate Software and Hardware Tools. All the students that completed the graduate questionnaire gave this indicator a grade of B (an average of 88%).

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

Around 93% of the students use current techniques and skills during the courses. This was obtained by looking at the results from the Rubric to Evaluate Software and Hardware Tools. All the students that completed the graduate questionnaire gave this indicator a grade of B (an average of 88%).

Previous Cycle Comparison

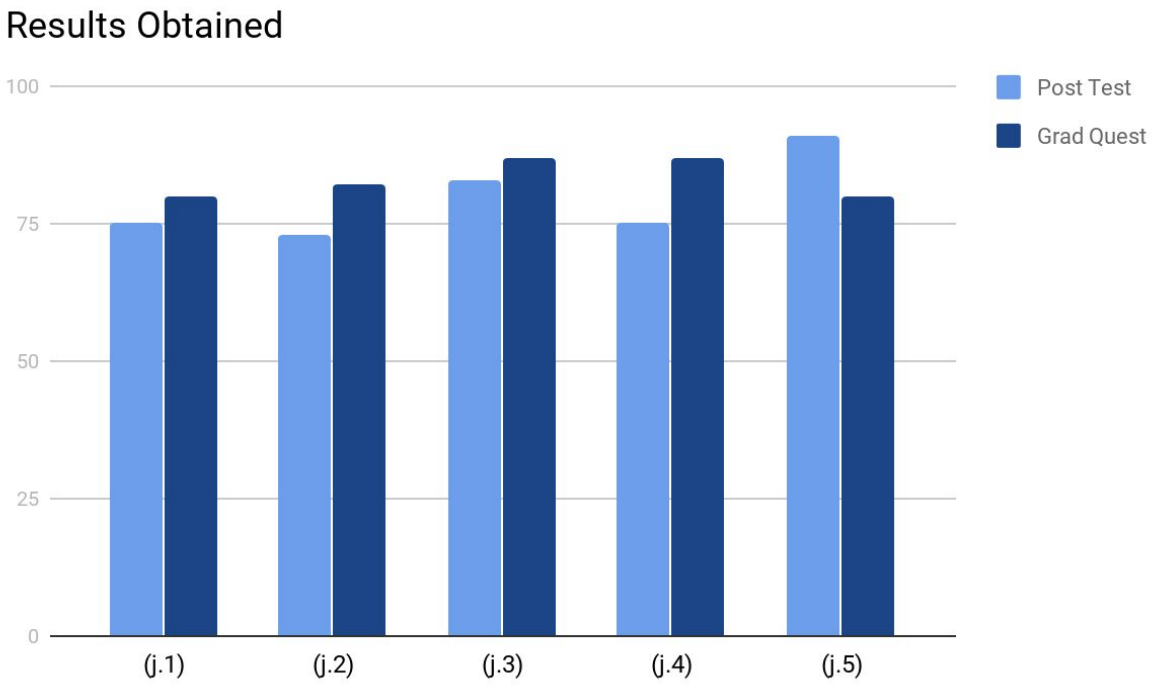
Current cycle percentages are even higher than on the previous cycle. Also the attainment level for this outcome was satisfactory.

Conclusions and Recommendations

Although this outcome was met:

- Recommendation: The only experience our students have is on the environment of Microsoft Windows. It is our knowledge there are students that own MAC or have installed linux on their laptops. However, this is not the norm. Some faculty have a concern on this matter. The department has set as a goal to add a Linux partition in every hard drive of the PCs of our laboratories. However, this task have not been completed. The AAC recommends that this goal should be set with a definitive deadline.

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. This PIs are the following:

(j.1) Solve the problems using the principles of discrete mathematics.

On the Post-test 75% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 80%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.2) Solve the problems using the principles of continuous mathematics.

On the Post-test 73% of the students answered the questions related to this PI correctly. However, All the students that completed the graduate questionnaire gave this indicator a grade of B in average 82%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.3) Determine the most appropriate data structures needed to solve a given problem

On the Post-test 83% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 87%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.4) Appraise whether a given problem has a computational solution.

On the Post-test 75% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 87%. Therefore the AAC concluded that the achievement level for this PI was met.

(j.5) Determine the most appropriate programming paradigm needed to solve a problem

On the post-test 91% of the students answered the questions related to this PI correctly. All the students that completed the graduate questionnaire gave this indicator a grade of B in average 80%. Therefore the AAC concluded that the achievement level for this PI was met.

Previous Cycle Comparison

Performance indicator (j.1) and (j.2) were part of only one PI on our previous cycle. This was done to know specifically in which mathematics our students were so low. The AAC used data obtained from the courses SICI 4009 Numerical Analysis and COTI 4250 Theory of Computing. The Post-test included 4 questions regarding PIs (j.1) and (j.2) during this cycle. This time there was an improvement of at least 43% on the attainment level based on the scores obtained from the post-test. Also the students graded themselves on the survey with a satisfactory grade (80%). Therefore, taking special attention to PIs (j.1) and (j.2) paid off.

Improvements on PIs (j.3), and (j.5) has been attained. There is a slight 5% of improvement on the attainment level of PI (j.3) compared to last cycle. However, for PI (j.5) there is a big improvement (24%) when analyzed against last cycle.

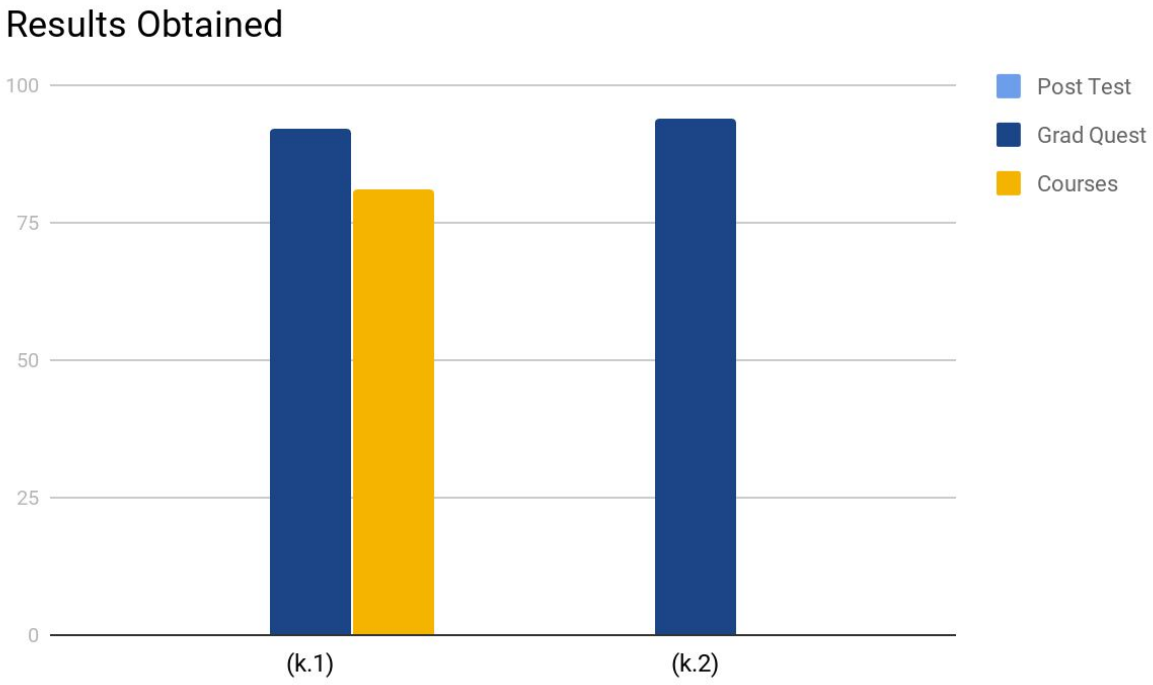
However, for PI (j.4) there has been a reduction of 14%.

Conclusions and Recommendations

The AAC decided this outcome was met.

- Recommendation: There is a reduction on the attainment level of PI (j.4) and (j.2) is borderlined developing. There has been a great improvement on PIs (j.1) and (j.2) and therefore the AAC decided that the outcome was met. However, there is space for improvement. The AAC must analyze the questions on the post-test for PI (j.4). Does this questions suffer a major overhaul during the revision of the post-test? This is a concern that must be addressed.

Outcome k: An ability to apply design and development principles in the construction of software systems of varying complexity.



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

(k.1) Perform object oriented and structured analysis and design of software systems.

All the students that completed the graduate questionnaire gave this indicator a grade of A (an average of 92%). The post-test did not have a question to measure this PI. Therefore, the AAC decided to analyze data from the SICI 3015 Analysis and Design. On the second practical exam the students have to analyze a problem and design a system using the structural approach. The mean grade obtained from this test was 81%. On the final exam the students have to analyze a problem and design a system using

the object oriented approach. The mean grade obtained from this exam was 82%. Therefore the AAC concluded that the achievement level for this PI was met.

(k.2) Construct software systems of varying complexity

All the students that completed the graduate questionnaire gave this indicator a grade of A (an average of 94%). After analyzing the projects that have been develop for SICI 4038 (Capstone Course) the AAC concluded that this performance indicator was met. Students have develop projects that span from an Appointment Notification System for Smartphones to Self Aligning Antennas.

Previous Cycle Comparison

The performance indicators for this outcome changed from previous cycle to this cycle. Therefore, we can analyze only the ones that remain. During previous cycle there was no suitable instruments to measure PI (k.1). Also, students present a satisfactory grade in previous cycle. In this cycle the data analyzed from the courses also gave us a strong satisfactory grade. Moreover, we were able to find a more suitable place to measure this PI on the SICI 3015 Analysis and Design on software systems. For PI (k.2) there was an improvement of 19% on the results obtained from the Graduate Questionnaire. This is relevant, since, this tool measures the awareness that students have on themselves.

Conclusions and Recommendations

Therefore, the AAC classify this outcome as met.

- Remark: It is evident that our students construct software systems of varying complexity since the first course (COTI 3101) to the last course (SICI 4038 Capstone Course). Students have even incorporated technologies that are not taught in many of our courses. For example, we have seen lately many Capstone projects using IoT (Internet of Things) or incorporating Arduino boards and programming. Also there are students that use Node.js and Angular on their projects.