Assessment of Program Outcomes by Using POMAS

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***Abstract* - The Department of Computer Engineering of Istanbul Technical University significantly modified its approach for the assessment of program outcomes in Spring 2005. First, for each outcome, the courses, which substantially contribute, were determined. The faculty was asked to assign specific problems, projects and exam questions that were designed to directly measure the abilities of individual students with regard to a specific outcome. For two years, at the end of each term, the faculty have submitted the normalized grades obtained from the related items contributing to an outcome together with the definition of these items. In order to collect/maintain this data and evaluate achievement levels of the program outcomes, a tool called POMAS (Program Outcomes Monitoring and Assessment System) has been developed. The information kept in the database is used to measure the extent to which each student has fulfilled a certain outcome throughout her/his education based on the contributions of the courses taken. The results obtained gave us a chance to evaluate both the students and the program on the selected outcomes. Moreover, an electronic portfolio like system is established for each student on these outcomes.**

Index Terms - Program outcomes, assessment, evaluation, measure.

INTRODUCTION

Nowadays, most of the engineering programs develop continuous improvement processes in order to enhance their quality of education. Moreover, they apply to the international/national accreditation bodies, such as ABET (Accreditation Board for Engineering and Technology), EUA (European University Association), MUDEK (Higher Education and Accreditation of Engineering Programs in Turkey) for evaluation in order to certify their quality of education [1, 2, 3]. The Computer Engineering program of Istanbul Technical University, like many other engineering programs at the university, started to design the process of continuous improvement for the program in 2002. Program Educational Objectives, Program Constituencies, Program Outcomes, and many other components/items taking part in the continuous improvement process are formed. One of the important issues in a continuous improvement process is to demonstrate that the outcomes and the objectives of the program are being measured [4].

The program outcomes of the The Computer Engineering program of Istanbul Technical University were determined as:

a) an ability to apply knowledge of mathematics, science, and engineering,
b) an ability to design and conduct experiments, as well as to analyze and interpret data,
c) an ability to design a system, component, or process to meet desired needs,
d) an ability to observe and examine an existing structure or system in a criticizing attitude and finally correct or enhance it,
e) an ability to function on multi-disciplinary teams,
f) an ability to identify, formulate, and solve engineering problems,
g) an understanding of professional and ethical responsibility
h) an ability to communicate effectively,
i) the broad education necessary to understand the impact of engineering solutions in a global and societal context,
j) a recognition of the need for, and an ability to engage in life-long learning,
k) a knowledge of contemporary issues,
l) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice,
m) an ability to adapt to changing conditions.

To determine the effectiveness of the offered program, the department, initially, developed an assessment plan which is mainly based on course portfolios, survey questions for students and employers. However, later, we realized that student self-assessment, opinion surveys, course portfolios, and course grades are not, by themselves or collectively, sufficient to assess the quality of program outcomes. Then, the program has significantly modified its approach for assessment of program outcomes. The faculty has been in the process of assigning specific problems, projects and exam questions that are designed to directly measure the abilities of individual students with regard to each outcome. In order to collect/maintain data and evaluate achievement levels of the program outcomes, we developed a tool called POMAS (Program Outcomes Monitoring and Assessment System). POMAS has been implemented using C# and ACCESS database under .NET environment. Unfortunately, due to the complexity of the system and the amount of the data to be collected, it has been decided to work on a limited number of outcomes which are (a), (c), and (h).

In this paper, we present the evaluation results obtained for the selected outcomes by using the data collected during the period of Fall 2004 – Spring 2006. The data collection and evaluation process for the selected outcomes is described in the following section. Some example cases are also presented. The paper is concluded by giving current evaluation and possible enhancement of the process in the future.

TABLE 1
THE COURSES AND TERMS FOR WHICH DATA HAVE BEEN COLLECTED AND CONSIDERED FOR THE EVALUATION OF OUTCOMES (A), (C) AND (H)

Outcomes	**Related Courses**							
Outcome(a)	Data Structures BLG221 2005fall 2006fall	Analysis of Algorithms BLG232E 2005 spring 2006 spring	Formal Lang. and Automa. BLG311 2005fall	Artificial Intelligence BLG435 2004 fall 2005 fall	Discrete Event Simulation BLG443E 2004 fall 2005 fall	Signals and Systems TEL252E 2005 spring 2006 spring		
Outcome(c)	Microprocess or Systems BLG212 2006 spring	Computer Organiz. BLG222 2005spring	Computer Architect. BLG322 2005spring 2006spring	Database Systems BLG361 2004 fall 2005 fall	Software Eng. BLG411E 2005fall	Computer Projects-I BLG439 2004fall 2005fall	Graduation Project BLG492 2005spring 2006spring	Advanced Data Structures BLG381E 2005fall
Outcome(h)	Software Eng. BLG411 2005fall	Computer Ethics BLG412 2005spring 2006spring	Computer Projects-I BLG439 2004fall 2005fall	Graduation Project BLG492 2005spring 2006spring	English 201 2005spring 2005fall 2006spring	Turkish 102 2005spring 2006spring		

DATA COLLECTION AND EVALUATION PROCESS

We started to collect data for POMAS on the courses shown in Table 1 in the Fall 2004 semester (term). The results in this paper are based on the following 4 semesters: Fall 2004, Spring 2005, Fall 2005, and Spring 2006. Table 1 shows the courses contributing to the selected outcomes. The course codes and the semester for which we obtained data are also shown in the table:

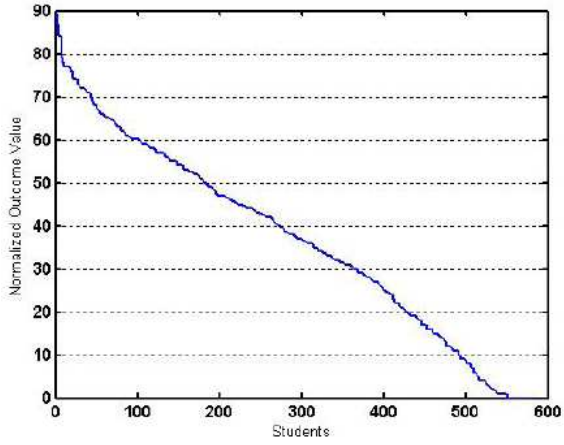
We have gathered data for nearly 700 students. A student may have taken 1 to 6 courses per program outcome within the time frame considered. A total of 20 courses contributed to the measurements we made on these outcomes.

I. Assessment of the Data Collected for Outcome (a)

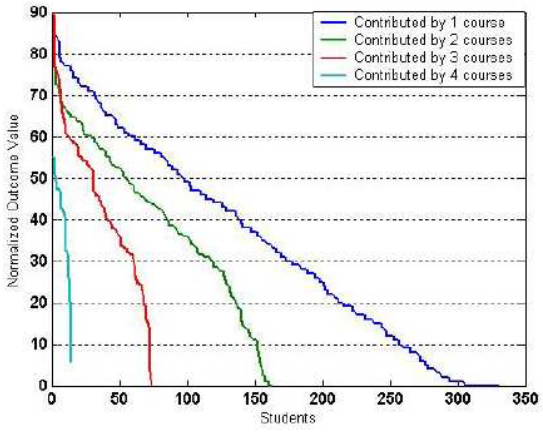
For Outcome(a), we collect data from six courses. These courses are taken in the following order by the students:

- Data Structures (BLG221), 3rd semester
- Signals and Systems (TEL252E), 4th semester,
- Formal Languages and Automata Theory (BLG311), 5th semester
- Analysis of Algorithms (BLG232E), 6th semester
- Artificial Intelligence (BLG435), 7th semester
- Discrete Event Simulation (BLG443E), 7th semester

We considered nearly 550 students for this program outcome. Although a student has to take all these courses in order to graduate, due to the fact that we have been gathering data only for the last two years, the maximum number of courses a student has taken from this list is four right now. The number of students who have taken 4, 3, 2, 1 courses are 14, 74, 163 and 330, respectively. Figure 1 shows the performance of our students on Outcome(a). Each point on the x axis corresponds to an individual student in Figure 1(A), while Figure 1(B) shows the performance of students who have taken only 1, 2, 3 or 4 of the specified courses.



(A)



(B)

FIGURE 1
THE NORMALIZED VALUES FOR PROGRAM OUTCOME(A). A) FOR ALL STUDENTS, B) FOR THE GROUPS OF STUDENTS CATEGORIZED BASED ON THE NUMBER OF SPECIFIED COURSES TAKEN.

Figure 2 shows the histogram of the scores of students for Outcome(a). Since we did not want the average to be noisy, we calculated a filtered average by not considering the

scores between 0-5 and 95-100. The filtered average value for the outcome was 41 and the standard deviation was 19. The filtered median was 42. The average computed over only the 47 students who have taken 3 courses is 44. We believe that as we collect more data over the years, students who have taken more classes will increase and the average will become more reliable.

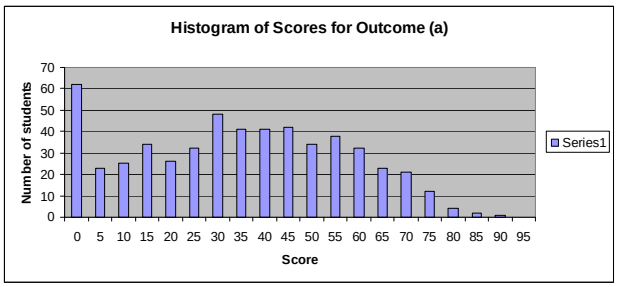


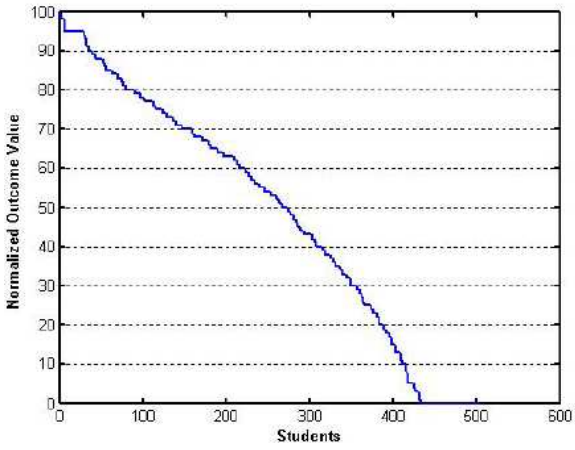
FIGURE 2
HISTOGRAM OF THE NORMALIZED OUTCOME (A) SCORES FOR ALL STUDENTS WHO HAVE TAKEN 1, 2, 3 OR 4 COURSES CONTRIBUTING TO OUTCOME (A).

II. Assessment of the Data Collected for Outcome (c)

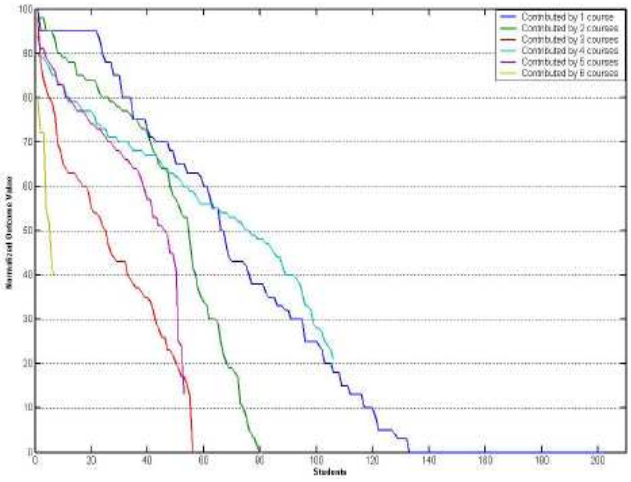
For Outcome(c), we collect data from eight courses. These courses are taken in the following order by the students:

- Microprocessor Systems (BLG212), 4th semester
- Computer Organization (BLG222), 4th semester
- Database Systems (BLG361), 5th semester
- Advanced Data Structures (BLG381E), 5th semester
- Computer Architecture (BLG322), 6th semester
- Software Engineering (BLG411E), 7th semester
- Computer Projects-I (BLG439), 7th semester
- Graduation Project (BLG492), 8th semester

We considered nearly 500 students for this outcome. Although a student has to take all these courses in order to graduate, due to the fact that we have been gathering data only for the last 2 years, the maximum number of courses a student has taken from this list is six right now . The number of students who have taken 6, 5, 4, 3, 2, and 1 courses are 7, 53, 106, 56, 81 and 202, respectively. Figure 3 shows the performance of our students on Outcome(c). Each point on the x axis corresponds to an individual student in Figure 3(A), while Figure 3(B) shows the performance of students who have taken only 1, 2, 3 ,4 ,5 or 6 of the specified courses.



(A)



(B)

FIGURE 3
THE NORMALIZED VALUES FOR PROGRAM OUTCOME(C). A) FOR ALL STUDENTS, B) FOR THE GROUPS OF STUDENTS CATEGORIZED BASED ON THE NUMBER OF SPECIFIED COURSES TAKEN.

Figure 4 shows the histogram of the scores of students for Outcome(c). The filtered average was similarly calculated by disregarding the scores between 0-5 and 95-100. The filtered average score value for the outcome was 55 and the standard deviation was 31.

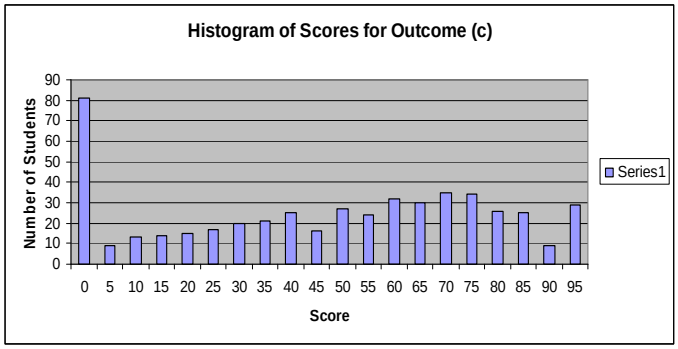


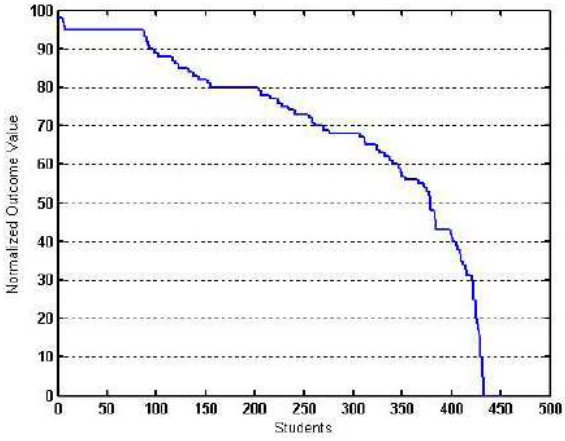
FIGURE 4
HISTOGRAM OF THE NORMALIZED OUTCOME (C) SCORES FOR ALL STUDENTS WHO HAVE TAKEN 1, 2, 3, 4,5 OR 6 COURSES CONTRIBUTING TO OUTCOME (C).

III. Assessment of the Data Collected for Outcome (h)

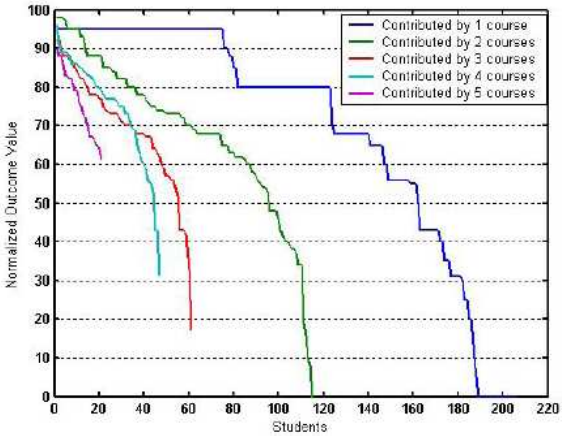
For Outcome(h), we collect data from six courses. These courses are taken in the following order by the students:

- Turkish 102, 2nd semester
- English 201, 3rd semester
- Software Engineering (BLG411), 7th semester
- Computer Ethics (BLG412), 8th semester
- Computer Projects-I (BLG439), 7th semester
- Graduation Project (BLG492), 8th semester

We considered nearly 450 students for this outcome. Although a student has to take all these courses in order to graduate, due to the fact that we have been gathering data only for the last 2 years, the maximum number of courses a student has taken from this list is five right now. The number of students who have taken 5, 4, 3, 2, and 1 courses are 21, 47, 61, 116 and 206 respectively. Figure 5 shows the performance of our students on Outcome(h). Figure 5(A) shows the performance of all the students, while Figure 5(B) shows the performance of students who have taken only 1, 2, 3 ,4 or 5 of the specified courses.



(A)



(B)

FIGURE 5
THE NORMALIZED VALUES FOR PROGRAM OUTCOME(H). A) FOR ALL STUDENTS, B) FOR THE GROUPS OF STUDENTS CATEGORIZED BASED ON THE NUMBER OF SPECIFIED COURSES TAKEN.

Figure 6 shows the histogram of the scores of students for Program Outcome(h). The filtered average was similarly calculated by disregarding the scores between 0-5 and 95-100. The filtered average score value for this outcome was 67 and the standard deviation was 17.

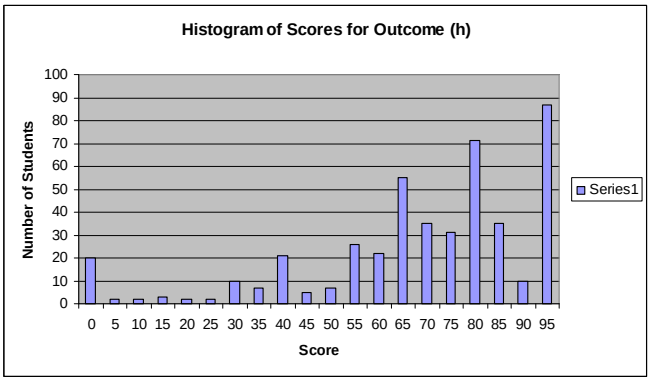


FIGURE 6.
HISTOGRAM OF THE NORMALIZED OUTCOME (H) SCORES FOR ALL STUDENTS WHO HAVE TAKEN 1, 2, 3, 4 OR 5 COURSES CONTRIBUTING TO OUTCOME (H).

AN EXAMPLE CASE

By using POMAS, we can monitor the performance of any student for Outcomes (a), (c), and (h). Moreover, an electronic portfolio like system is also established for each student on these outcomes. In order to give a better idea, we selected three students. Let's call them Student Green, Student Red, and Student Yellow. In Figure 7, the performance of these three students are marked for all of the outcomes under consideration. We can observe from the figure that Student Green (marked by a green circle) has a good performance on Outcome(c) while he performs poorly on Outcome(a). On the other hand, Student Red (marked by a red diamond) is successful on all of the outcomes considered. The performance of Student Yellow (marked by

a yellow square) on Outcome(h) is superior to his performance on Outcome(a) and (c). In the figure, only a portion of the students are shown in order to expand scales.

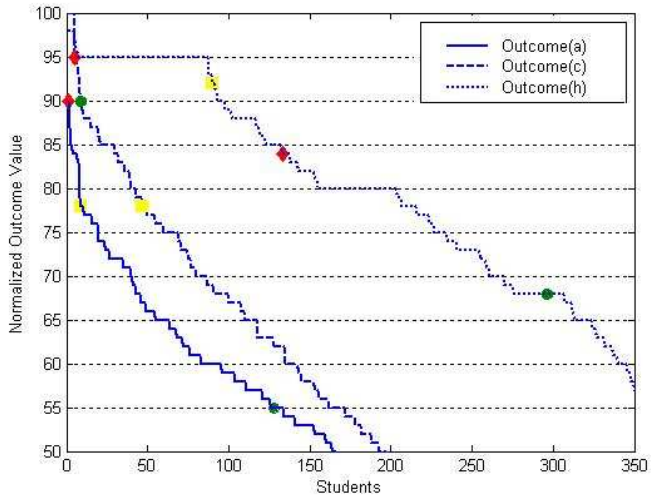


FIGURE 7
. PERFORMANCE OF THE SELECTED THREE STUDENTS ON OUTCOME(A), (C), AND (H).

CONCLUSIONS

Considering the median scores for Outcomes (a), (c) and (h), which were 42, 53 and 75, respectively, we realized that our students show good performance on Outcome (h) while we need to improve our students' performance on Outcome (a). Performance of the students on Outcome (c) seems to be satisfactory. These findings have been communicated to our Curriculum Enhancement Committee. The committee has started to take actions to improve our students' performance in Outcome (a). The course evaluation process might be reconsidered [5]. Moreover, this issue will be discussed at the External Executive Board meeting that will be held in 2007.

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