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Assessment of Final Year Projects in Undergraduate Engineering Programs: An Advisor-Jury Evaluation Mechanism Under the Outcome Based Education System

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The article introduces an assessment mechanism and results of final year engineering projects evaluations under an Outcome Based Education and Assessment (OBE&A) system. Pakistan Engineering Council (PEC); undergraduate engineering degree accreditation body, has recently become the full signatory member of International Engineering Alliance i-e Washington Accord. Since OBE&A system is in infancy phase in Pakistan, the assessment and evaluation of FYP is one of the big challenge. Data of the advisors and Jury evaluations for all students in project phase is collected. The FYP learning outcomes, rubrics and criteria have been developed and implemented practically. The results have been analyzed and presented to assist practitioners to adopt the FYP assessment mechanism in their engineering programs within Pakistan and worldwide.

Keywords: *Final year projects; learning outcomes; assessment rubrics; evaluation mechanism; OBE&A*

Introduction

A Final Year Project (FYP), also known as senior design project, is one of the most important endeavor that students undertake during their undergraduate degree in Engineering. It requires the students to think beyond the theoretical knowledge and understand problems related to practical development of a product (Sandra Fernandes, 2014). In a way, the performance of students in the FYPs is a reflection of engineering knowledge and other attributed they achieve at its completion. Hence it is very important for the institutions to evaluate the outcome of the FYPs effectively.

In engineering schools of Pakistan, the FYPs are therefore evaluated carefully and rigorously. Apart from the knowledge and skill, students are expected to demonstrate several other attributes such as ability to work as a team, communication skills and the understanding of the cotemporary societal issues (Rasul, 2009). Moreover, the introduction of Outcome Based Education and Assessment (OBE&A) system in the Pakistani universities has put greater emphasis on systematic evaluation of FYPs. The system is being implemented by the country's accreditation board, known as Pakistan Engineering Council (PEC), after having signed the Washington Accord (WA) (International Engineering Alliance, 2017). 12 Program Learning Outcomes (PLOs) have been defined by the PEC that need to be achieved by the end of the degree program. These PLOs are achieved by defining the Course Learning Outcomes (CLOs) for each course and mapping them with the PLOs.

Just like the ordinary courses, Course Learning Outcomes (CLOs) along with their taxonomy levels (Anderson, Krathwohl, & al, 2001) need to be defined and evaluated for the FYPs as well. This this article, the CLOs have been mapped with bloom's taxonomy levels (Anderson, Krathwohl, & al, 2001). In a way, it provides a framework for systematic evaluation of FYPs on multiple criteria. Since the system is still in its infancy in Pakistan, there is a limited understanding of how to implement these requirements set

forth by Pakistan Engineering Council and the Washington Accord.

In most institutions in Pakistan, the evaluation of the students is carried out jointly by the project advisor (a member of the faculty) and a departmental committee (referred to as Jury from now on) composed of senior faculty of the department. However, the distribution of weightage given to their evaluation differs from one institution to the other. Sometimes these may differ within departments in a single institution. No matter what distribution formula is used, it is necessary for both parties (advisor and jury) to have a fair understanding of the requirements and expectations from the students. In this article, we present the FYP evaluation mechanism implemented at the Faculty of Engineering, at the In the University of Central Punjab, Lahore Pakistan. We then study how well the evaluation done by project advisors and the jury are in agreement with each other by analyzing the evaluation data collected for one of the two semesters dedicated for final year engineering projects.

The article is organized as follows: in section 2, we present the methodology adopted for the implementation and evaluation of the FYPs as well as the course learning outcomes. Section 3 elaborates the data collection process while the results are presented in section 4. Section 5 concludes the article.

1. METHODOLOGY

In the University of Central Punjab (UCP), the evaluation of FYPs is carried out in two semesters separately. A project groups comprises of 3 students. Each student in a group is evaluated individually at least twice during a semester by the jury while once by the project advisor (a faculty member) at the end of the semester. The jury consist of senior faculty of the department with at least the rank of an Assistant Professor. The evaluation from both sides carry equal weightage.

Under the framework of OBE, learning outcomes have been defined for the projects separately for each semester. All course learning outcomes must be mapped with the PLOs defined by the PEC. Moreover, each learning outcome is assessed in a specific domain and level defined by Benjamin Bloom in the famous Blooms taxonomy. The outcome relates to one of the three categories known as Cognitive (C), Affective (A) and Psychomotor (P). Interested reader may refer to (Anderson, Krathwohl, & al, 2001) for detailed description of the taxonomy.

Table 1 and 2 show the course learning outcomes, their mapping with the PLOs and Blooms taxonomy levels. The detailed description of each PLO is given in the Appendix A (Pakistan Engineering Council, 2014).

Table: 1

7th semester CLOs, PLOs and Blooms Taxonomy Mapping Matrix

CLO NO.	CLO STATEMENT	Program Learning Outcome	Taxonomy Level	Assessed by	
				Advisor	Jury
1	The student applies engineering principles to tackle the problems at hand	Problem Analysis (2)	Applying (C3)	✓	✓
2	Analyzes the literature correctly to reach substantiated conclusions and identify gaps	Investigation (4)	Analyzing (C4)	✓	✓
3	Understands the need to use his project to solve societal issues	Engineer and Society (6)	Valuing (A3)	✓	

4	Exhibit active contribution to the project and demonstrates team work coordination with his members	Individual and Team Work (9)	Internalizing Value (A5)	✓	
5	Present and argue his project progress in a focused and organized manner	Communication (10)	Internalizing Value (A5)	✓	✓

Table 1 shows that internal monitoring is effective regarding an increase in teachers' attendance, on-time arriving of teachers in school, controlling teachers' absenteeism by disciplinary actions and checking the attendance of the teachers by the head teacher as the mean score of 3.10, 3.16, 3.18 and 3.57 respectively are in support of these areas. Further, the mean value of 3.09 indicates that internal monitoring is effective about teachers' full-time presence.

Effect on Teachers' Attitudes

Table: 2

8th semester CLOs, PLOs and Blooms Taxonomy Mapping Matrix

CLO NO.	**CLO STATEMENT**	**Program Learning Outcome**	**Taxonomy Level**	**Assessed by**	
				Advisor	**Jury**
1	The student consistently applies the engineering principles to evaluate and analyze the project task at hand	Engineering Knowledge (1)	Evaluating (C5)		✓
2	Develops workable design solutions to the project related problems	Design and Development of Solution (3)	Creating (C6)	✓	✓
3	Respects ethical principles and codes of engineering practice	Ethics (8)	Valuing (A3)	✓	
4	Exhibit active contribution to the project and demonstrates team work coordination with his members	Individual and Team Work (9)	Internalizing Value (A5)	✓	✓
5	Sets and follows time-bound goals with careful budget assessment	Project Management (11)	Organization (A4)	✓	
6	Explains his project in the broader context of technological development	Life Long Learning (12)	Internalizing Value (A5)	✓	✓

For each CLO, the students are assessed on standardized rubrics developed by the department (Appendix B). Both the advisor and the jury are provided with the same rubrics where each student in the group is evaluated separately for each attribute on a scale of 1-10. Each member of the jury gives his/her own assessment, which are then averaged for final result.

3. DATA COLLECTION

For the present study, the data is collected for the graduating batch of Mechanical Engineering for year 2016-17. Only the data from 7th semester is considered here which contains 5 CLOs out which 3 are assessed by both project advisor and the jury (CLO 1, 2 and 5, c.f. Table 1). Hence, for our analysis, we only consider these 3

common CLOs and study the pattern of evaluations. The aim is to evaluate how well the evaluation from both parties agree with each other and what needs to be improved for better evaluation in future.

The advisors and jury are considered to be in agreement if the difference between the jury and advisors assessment do not exceed 5% (0.5 points). 61 students were enrolled in the course of which one student missed the jury evaluation. His result is thus excluded and the population size of 60 is considered. i.e. a total of 180 evaluations.

4. RESULTS

The results are shown in Figure 1 to 3. For all 3 CLOs, the students' average score is between 7 and 8 on the scale of 10. Figure 1 shows the assessment scores, averaged across subjects, separately for advisor (in grey) and the jury (in black). An interesting pattern is observed. The advisors' scores are slightly higher for all 3 CLOs. On average, the difference is not large though and is in the range of 8-12%.

Looking closely at the evaluation of CLO 1 (c.f. Figure 2), it is observed that the advisors tend to give 0.5-2 marks more than the jury does on a scale of 10.

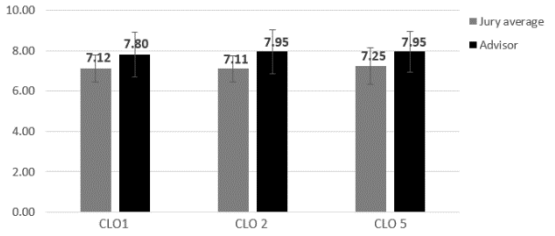

Figure 1: Advisors and jury marking for 3 Common CLOs

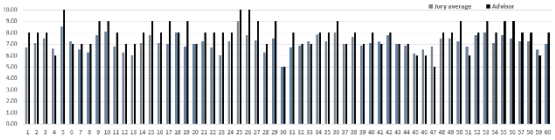

Figure 2: Pattern of Advisors and jury marking on CLO 1

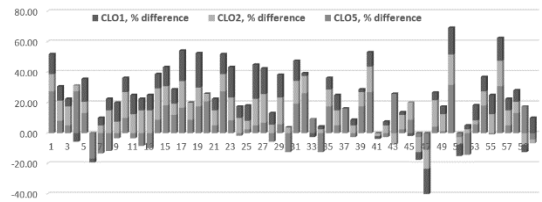

Figure 3: Percentage Variation in jury vs. Advisor CLO marking

Figure 3 shows the stacked graph of percentage difference between both evaluations for all CLOs and for all 60 students. The positive values show the instances where advisors have given more marks to the corresponding CLO and vice versa. The largest percentage difference between the jury and the advisor's evaluation is observed in CLO 5. Both results differ by more than 20% at 8 instances for this CLO that is more than the instances for the other two CLOs combined.

Overall, for a total of 180 evaluations for the three CLOs, at 56 occasions (31%), the advisor and jury evaluation is within the range of 5% (a difference of less than or equal to 0.5 points on the scale of 10). On most occasions (80%), the advisor has awarded the same or more marks to a student than the jury. On fewer occasions (8%) the difference between the two evaluations is more than 20% (difference of 2 marks on a scale of 10). A closer look at the data reveals that most of this difference is due to CLO 5 which is mapped to PLO 10 i.e. communication skills. It has the largest average difference and the greatest variation (c.f. Figure 3). Out of 14 instances where the difference of marks is greater than 20%, CLO 5 accounts for the 8 of them.

5. CONCLUSION

The results show considerable agreement between the jury and the advisor evaluations. In about one-third of the evaluations, the difference between both evaluations is less than 5%. This is primarily due to the use of standardized scoring rubrics. Further improvement is possible by training of the faculty on improved understanding of these rubrics. Particularly more training is needed for CLO 5 that shows the largest variation between evaluations. This is consistent with our general observation that the program

learning outcomes falling into the affective domain of Bloom's taxonomy are difficult to assess objectively.

In future, we shall gather and analyze more evaluation data from other engineering programs after focused training on the affective domain outcomes. Moreover, students shall be surveyed to assess their own perception regarding the achievement of these CLOs and the results shall be compared with the existing results.

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