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Inculcating Research Culture with an Outcome-Oriented Technical Project Evaluation Framework

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***Abstract*—The Outcome of the Teaching-Learning Process of any specific subject or course is measured using a standard statistical method, the majority of which relies on the marks obtained by each learner, according to procedures and guidelines defined by numerous national-international consortiums, boards, or councils for Outcome-Based Education (OBE). Rarely has it been linked to documentary evidence demonstrating the attainment of competency expected to emerge following successful completion of the course.**

At the same time, a significant number of technical institutes across India are in desperate need of good research, which leads to massive publications, IPR, startups, and cash. For the previous few decades, the faculty has been the torchbearer for the cause. The paradigm is changing toward learners now that NEP 2020 has been implemented. Students' projects are now solemnly regarded as a major contributor to research and a source of creativity. Calculating the outcome of project-based courses and analyzing them with sufficient transparency to produce research-based results is a mammoth task.

To improve the institute's image, the article developed a novel technique for outcome-oriented technical project evaluation that focuses on instilling a research culture among the learners.

***Keywords*—Engineering Projects, Inculcating Research Culture, OBE, Project Evaluation guidelines, Research enhancement framework, Technical Project evaluation,**

I. INTRODUCTION

In the counties like India, huge numbered technical undergraduate and post-graduate institutions are working hard to produce quality engineers for centuries. Achieving the mentioned goal with the standard framework of the education system is a herculean task even under the umbrella of different state- or privately-owned universities or else with autonomous status.

Numerous annual ranking surveys and accreditation processes are executed which measures and publish the quality of the technical institutions across the country. The mentioned framework focuses more on research outcomes and research achievements of the institute. The statistics show that 25% to 35% of weightage is devoted directly or indirectly to the research. In fact, research outcomes are a huge spectrum consisting of national- international publications, IPR (copyright, patent, trademark, etc.), research funds, consultancy, etc. Details can be referred from the references cited herewith which include NIRF Ranking framework (2021), AICTE Examination reform (2018), UGC evaluation reforms (2019),

The research responsibility was on the shoulders of the teachers or faculty members for more than decades. However; strong emphasis on OBE by various accreditation bodies like the NBA and the introduction of National Education Policy 2020 (NEP 2020) have shifted the same towards students. The generalized the NBA Guidelines (2019) are enclosed for more understanding about the same.

The article provides the brief framework for outcome-based project evaluation methodology with a special focus on inculcating research culture.

The Next section highlights the significance of the project and answer the question “Why this article focuses on the project?” Section III states the problem definition and objectives. Section IV includes the draft of the proposed methodology. Section V sum up the advantages and challenges observed in the implementation of the proposed methodology. Section VI represents the results of the case study undertaken. Section VII concludes the findings.

II. SIGNIFICANCE OF THE PROJECTS

The project being a major contributor and one among the 5 pillars of improvement proposed by NBA, requires special attention. Novel projects may lead to immediate employment even immediate entrepreneurship for the learners. Such a project also brings reputation to the institution through project competitions, conferences, and awards. Even, the project mainly addresses the major chunk of Program Outcomes, defined as per the Washington Accord, but not being mapped by other technical courses during the graduation. However, the unique self-paced nature of the project without an actual classroom Teaching-Learning process makes it significantly challenging for execution as well as for the calculations of Course Outcome attainment. Even though in selected cases projects are contributing to research-based outcomes but few

verticals remain unclaimed and the same verticals get addressed repeatedly.

Alongside the stack holders should understand that there is a huge gap between learner's goals, expected learning outcome driven by the existing OBE system, 12 Program Outcomes (POs) defined as per the Washington Accord, and research-based outcomes expected by ranking frameworks and the accreditation institutions.

In contrast with premium institutions, lack of clarity in expected outcomes or blur projection of expected outcomes from the project-based courses is a major reason for failure in meeting the expected standards of the industry. Existing project evaluation methodologies are project guide centric and may lack the transparency and accountability for ensuring the expected standard Gaussian population distribution of project marks. Lack of standard methodology in implementation and evaluation of the project as well as linking it with research contributions and other overall development of the students is adding up to the problem which results in continuously enhancing the burden on project supervisor or guide.

III. A IM AND OBJECTIVES

The prime aim of the article is to propose the integrated methodology for analyzing individual learners' performance by performing the outcome-driven evaluation of the projects as well as to enhance the research contribution of the institute for the society focusing on the universal raking framework. Arviansyah, Halle, and Hillegersberg(2015) have handsomely summarized the challenges of project evaluation.

The objectives of the proposed work are as below: -

The proposed methodology should,

1. *Results in enhancing incorporating and research culture of the institution by creating enough awareness among students*
2. *Focus on identifying and conveying the spectrum of the research outcomes of the project among the learners.*
3. *Contributes in establish faith and transparency about the assessment system by conveying the expected outcomes to students in advance.*
4. *Bring clarity about the roles and responsibilities of each individual along with a proper schedule.*
5. *Integrate flexibility by allowing the learners to choose the expected outcomes which are supposed to be in line with his/her carrier goal.*

IV. PROPOSED METHODOLOGY

Implementation of the project needs step by step approach. The standard waterfall model or even agile methodologies can be utilized as a guidelines model to ensure timely completion of the project with maximum efficiency. However, said models focus more on implementation and don't have any guideline regarding time bound and transparent assessment.

The main challenge in the evaluation of the project is that it is a continuous process and hence required continuously varying sets of generalized and personalized rubrics to ensure consistent and on track growth of the work. Likewise, any specific project may have some specific additional requirements and distinct timeline which make the job of the project evaluator further multifaceted. The set of rubrics needs to be revised and reframed again according to a few or all of the following arguments.

1) *Type and nature of the project*
2) *The current phase of the project*
3) *The specific requirements of the project*
4) *Individuals' contribution*
5) *The expected outcome for the said duration*

For example, the turnkey project may not need the market survey to gather requirements or product specifications in contrast with another type of projects. Hence rubrics need to be changed accordingly.

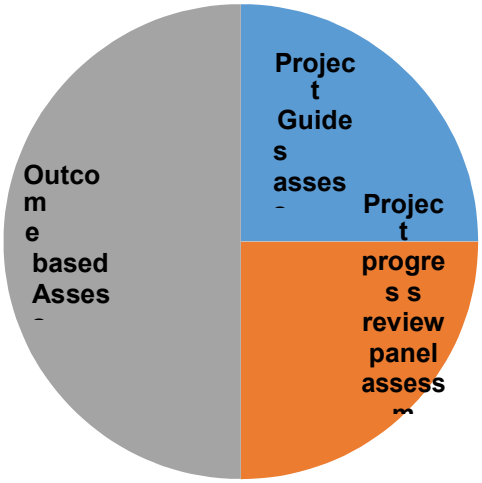

Fig.1. Recommended weightage for each phase of evaluation.

The article proposes a methodology incorporating all aforementioned actualities for reliable and faithful evaluation of the project. Each evaluation stage is given with the weightage. The same is shown in the graph shown in Figure 1.

The detailed methodology with different steps of evaluation along with distribution of marks is explained below. The framework also incorporates responsibilities along with rubrics, if any.

1) The project Guides assessment
   a. The project guide will evaluate each individual out of 100 Marks
   b. The same is scaled down to 25%
   c. Said assessment should be based on rubrics based on expected results at various stages of the project.
   d. Rubrics should be designed in such a way that the individual's contributions should be analyzed.

   Luft (1999) proposed the concept of rubric development in general.

2) The project progress review panel assessment
   a. 25% weightage is given to assessments performed by the internal progress review

committee, from time to time, constituted by the Project coordinator or Head of the department.

b. Rubrics parameters will vary based on various stages defined in the project plan. Contributions of individual students should be respected through the proper rubrics.
c. The review panel should be constituted at the start of the academic year.
d. The same review panel members should track the progress of the assigned the project group throughout the academic year to maintain a consistent work pace.
e. Guidelines for review panel formation
    i. It is recommended to have 2 members in the review panel.
    ii. The project guide should not be the part of the review committee
    iii. Both the panel members recommended by the head of department should be as follows: -
    iv. One member, nominated as an internal reviewer, is recommended to be from the same course.
    v. The second member, nominated as an External Reviewer, is recommended to be from other allied courses.
f. Roles and responsibilities of the panel members
    i. The internal reviewer is responsible for analyzing the technical feasibility, choice of methodology, component and devices selection and test cases undertaken.
    ii. The external reviewer is responsible for keeping the projects growth on track and ensuring the ethical code of conduct, applicability and patentability of the topic.
g. For the final evaluation $1/3^{rd}$ of the weightage is to be given for the assessment of the external examiner and $2/3^{rd}$ of the weightage is to be given for the internal examiner's evaluation.
h. For the major project, it is recommended to have 5 reviews spanning a year with equal spacing between them. Each phase may have unequal weightage. Refer the table II for the weightage and corresponding rubrics.

3) The Outcome-Based Assessment: -
a. The remaining 50% weightage is to be reserved for the outcome.
b. As a project can have a common outcome, these marks will be the same for all the students in the project group.

TABLE I
OUTCOME BASED ASSESSMENT

Sr No	Proposed Outcome	Parameter	Weightage
1.	Sponsored project/ Consultancy/ turnkey projects	Sponsorship Amount >Rs. 10K.	100%
		Sponsorship Amount <Rs. 10K.	90%
		Sponsorer is reputed industry & the project expenses are born by them (based on industry)	90%
		Sponsorship without financial assistance	80%
2.	Publication	International Journal (Scopus/SCI)	100%
		National Journal (Scopus/SCI)	100%
		International Conference (Scopus/SCI)	100%
		National Conference (Scopus/SCI)	90%
		Open Access (Paid) Journal	80%
		Conference (Other)	75%
3.	Research grant or funding	New Proposal Filled (along with faculty)	100%
		Assistance in Already Sectioned Project	90%
		Individual Application filled (any amount)	100%
4.	Patent	Patent application Filled Successfully	100%
5.	Startup	If the startup registered with Government	100%
		If incubated in the institute incubation Center	100%
6.	National/International project competition.	Secure Winner position	100%
		1^{st} Runner Up 2^{nd} Runner Up	100% 100%
		Participated (International)	95%
		Participated (National)	85%
		Participated (State)	80%
		Participated (Regional)	75%
7.	Projects addressing special problems of society.	If successfully implemented and accepted by the intended client (training to next year student for operation and maintenance is a must)	100%
8.	Projects addressing the special need of the department or institute.	If successfully implemented in Campus (training to next year student for operation and maintenance is a must)	100%

c. The evaluation done by the internal and the external examiners at the time of the final examination will be scaled down to the following weightage.
d. The table I summarizes the weightage with the corresponding evaluation rubric.

TABLE II
PROPOSED RUBRICS AND WEIGHTAGE FOR PROJECT EVALUATION

Review no.	Agenda	Assessment		Review Assessment Weightage	Over all Weightage
		Evaluation by Guide	Evaluation by review panel		
1	Project Synopsis/ Proposal Evaluation	Rubric GR1	Rubric PR1	4+4=8	25+25 = 50
2	Project Design Evaluation	Rubric GR2	Rubric PR2	5+5=10	
3	Project Implementation Evaluation	Rubric GR3	Rubric PR3	7+7=14	
4	Project Testing Evaluation	Rubric GR4	Rubric PR4	5+5=10	
5	Project Report & DPR Evaluation	Rubric GR5	Rubric PR5	4+4=8	
Outcome Based Evaluation		Rubric defined in Table I		50	50
Total				100	100

To ensure transparency throughout the process of assessment some additional rules may need to be enforced. A few recommended rules are as follows

1) It is mandatory to include documented proof of the outcome in the final project report.
2) It is mandatory to upload a video demonstrating the working model on the official departmental social media page.
3) It is mandatory to include photographs if participating in any event.
4) It is mandatory to upload the Project Report (PDF) on the departmental Digital Laboratory Page.

The table II integrates proposed rubrics and weightage for the project evaluation. For each review, it is expected to have distinct rubrics for guide evaluation as well as evaluation by the panel. GR# indicates rubric for guide evaluation and PR# indicates rubric for panel evaluation for respective review number represented as #. Tuysuzoglu (2015) explains the importance and automated process of designing rubrics.

Pang and Feng (2006) propose an adaptive model for evaluation of the project using linguistic as well as subjective information.

Along with traditional evaluation parameters following Parameters are recommended for inclusion in Evaluation Rubric preparation: -

1) Novelty and Innovation
2) Market or product Survey
3) Justified Per unit cost
4) The business model or DPR
5) Promotional strategy

In exceptional cases, the department may modify evaluation guidelines, on request of the corresponding project guide, if properly justified.

V. ADVANTAGES AND CHALLENGES

The proposed methodology carries numerous advantages over existing evaluation methods. A few major advantages are enlisted below:

1) Transparent and reliable method of assessment.
2) Flexibility in choosing the outcomes from a bank of the predefined area of interest
3) Clear goal results in the directive and focused efforts.
4) Enhance the research outcomes which in turn results in an improvement in institution ranking.
5) The clarity in roles and responsibilities of the project guide, co-guide, review panel, internal and external examiner as well as the learners.
6) The predefined schedules can help in keeping the projects on track.

Likewise, the proposed methodology has many challenges too as enlisted below:

1) Diversified outcomes with a distinct schedules make attainment calculation challenging
2) Producing evidence of the outcome achieved is a must to ensure authenticity.
3) Many a time proof of the outcome like patent sanction letter, Acceptance letter from an international journal editorial board, etc. is dependent on third parties and may not become available at the time of the project examination conducted as per the schedule defined either by the university or institute. It might be significantly challenging in a few cases.
4) Universities may have some strict evaluation guidelines and hence may not allow the institution to execute the outcome-based evaluation.

VI. CASE STUDY AND RESULT: -

The proposed methodology was adopted and implemented in one of the departments of a private engineering institute located in Maharashtra for an academic year. The findings are as follows: -

1) The department performed the SWOT analysis based on the last 3 Years of raking framework data and deduced the list of Thrust Research areas to work on.
2) 100% awareness of the research outcomes as all students was informed in advance about the expected outcome.
3) Additionally, the initiative helped the learners to understand how to draft a paper or patent.
4) Significant improvement was observed in statistics related to

a. Patent filing
b. A research article published in reputed National

journal

VII. Conclusion

The integrated evaluation cum research enhancement methodology for in detail and transparent evaluation of the projects is proposed in the article. The methodology is significantly useful for increasing awareness about research across the torchbearers. The guidelines are found useful through the case study incorporated herewith.

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