The novel evaluation scheme for Competency Based Learning, authentic assessment and its implementation strategies for universities of higher education

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Abstract—Competency based education and its continuous assessment creates a strong interest amongst all stakeholders involved in the laboratories. The initiatives in this paper are proposed to strengthen affiliating technical university curriculum in true spirit to adopt outcome-based (OBE) education practices at all levels of courses. These initiatives shall complement and supplement the Government of India initiative National Education Policy 2020 (NEP 2020) implementation. The main beneficiaries of this proposed work will be the students and faculty among important stakeholders. The initiatives proposed will help to ease the problems of identifying proper learning materials, identification of course pre-requisites, and for the effective Industry Academia Connect for better development of employable graduates with Industry required attributes and skills. Also, to ensure highest standards of Teaching -Learning experience which will lead towards academic excellence, ensures to become an active participant in their learning process. Pre-requisite courses to be mentioned for all courses. In Structure of the syllabus, periods can be modified to L T P C (Lecture Tutorial Practical Competency)

Keywords—Competency Based Learning (CBL); Competency Based Evaluation Scheme (CBES); Outcome Based Education (OBE); Student Assessment Management (SAM).

I. INTRODUCTION

The value of effective student learning outcomes, for faculty point of view, are the content of teaching, teaching strategies, the sorts of learning activities/tasks set for students, appropriate assessment tasks and course evaluation. In students' point of view, it informs the comparative effectiveness of cognitive skills, a solid framework to guide their studies and assist them to prepare for their assessment, the higher order skills opportunities, Knowledge Development, Skills Development, Attitudinal Change and Values Change.

Linking Student learning outcomes to competencies is challenging and also provides opportunity for individual overall development. Competencies are obtained or developed during the process of learning by the student/learner. Competencies actually represent a dynamic combination of knowledge, understanding, skills and abilities. Fostering competencies is the objective of educational programs developed in the university system. Competencies will be formed in various

course units and assessed at different stages of teaching learning process. Time and attention should also be devoted to the development of generic competences or transferable skills.

Types of generic competencies are as follows

- Instrumental competences are cognitive abilities, methodological abilities, technological abilities and linguistic abilities;
- 2. Interpersonal competences are individual abilities like social skills (social interaction and co-operation);
- Systemic competences are abilities and skills whole systems concerning (combination of understanding, sensibility and knowledge; prior acquisition of instrumental and interpersonal competences required).

Everyone has the capacity to learn, it simply happens at a different rate and maybe in different ways for each one of us. They are assessed right exactly when they are confident to demonstrate their competencies. Competency based learning or knowledge-based training is a massive reformation from traditional time-based learning to learning-based learning.

Competency component assessed with the below mentioned items

- 1. Task Skills Performing individual tasks.
- 2.Task Management Skills- Managing a range of different tasks.
- 3. Contingency Management Skills Responding to contingencies or breakdowns.
- 4.Team/role Environment Skills Dealing with the responsibilities of the workplace, including working with others.

Competency based learning is heterogeneous approach to teaching, learning, curriculum, and assessment and is effective to all higher education today.

II. LITERATURE SURVEY

The curriculum refers to learning opportunities and learning experiences provided and planned by a university system to learners as mentioned in (Print, 1993). In (Wojtczak, 2002) mentioned that description of curriculum with the technical approach describing that curriculum comprise the lesson plans, including learning objectives to be achieved, the topics to be



discussed, and the methods to be adopted for teaching, learning and assessment. In view of these curriculum will help to master and demonstrate skills, provides opportunities with relevant required resources to mastery the concept and excel in particular domain. This indicates, curriculum evaluation scheme and its assessment components play a vital role in the growth of Individual during the journey of education. These components need to be flexible in nature as one expert cannot assess all the learning competencies. Hence there is a need to involve subject matter experts' team for the assessment of these competencies from an Academia, Industry and Start-up/Incubation ecosystem.

In (Cheryl & Michelle,2021), work mainly focuses that assessment experts in education system must provide strong opportunities to support and assess the progressive, lifelong development of relevant knowledge and skills. Here one of the challenges highlighted that is the lack of instructional guidance specific to a competency-based approach. This has been addressed in this paper with the help of SAM process model.

In (Gullickson & King, 2019; JM & Clinton, 2019), analysis suggests that there is much work to be done to understand the needs for evaluation and assessment, to outline standards for quality in both teaching-learning process and practice, to identify the inputs and processes most effective for addressing those needs, and to document its ultimate impacts. These challenges have been exploited and addressed in the proposed model at two levels.

In a competency-based curriculum (Griffith & Lim, 2014), students are rewarded only for successful completion of authentic tasks. both students and teachers need to step out of their comfort zones and adopt new roles for successful and effective implementation. As these paper authors explains the success of this process is depends on new roles and process used. Hence, continuous assessment and CBES structure will help to identify individual progress at any time.

Large number of students still struggle to graduate on time within traditional systems because of accessibility and availability of resources outside university campuses. Hence higher education systems are shifting their focus to ensure curriculum and employment readiness is a realistic and attainable aim for all students. In this work (Blumenthal & Rasmussen, 2015), opportunity for CBE model and one novel model to support university system for utilizing the benefits of CBE has been demonstrated.

The initiative to introduce the CBES into higher education university system curriculum will give a new momentum, opportunity to foster the creative potential & new direction that curriculum should provide for the students for continuous learning and their ability to cope with ongoing educational requirements.

III. PROPOSED MODEL

There is a need for new approaches of learning management in education for providing more personalized learning experiences, while ensuring that every student has a strong foundation in the STEM concepts, skills and competencies required to succeed in the 21st century (Jose Ramon & Yolanda, 2018).

In CBES, curriculum needs to be designed by considering objective-based and self-paced learning approaches. Students learn based on their abilities and interests. Hence, teachers should provide individualized support to ensure deep learning. Further, students' assessment (Goldie, Andrew & Utkarsh, 2016) is done through demonstration of knowledge, skill and competency acquired. Students will progress through grades based on demonstrated competency in particular subject of assessment. Through this CBES, students are benefitted with the flexibility to learn according to their preferred style, at their preferred time and on their favourite device (Osama, 2021).

The Fig.1 provides the proposed CBES structure for developing syllabus for complete graduation or post-graduation programs. The Fig.2 elaborates components used for teaching-learning process (U.P. Kulkarni & Indira R. Umarji, 2017) and number of periods per course. These components provide opportunity for students to learn any course either through regular practical's or by demonstrating course competencies through their preferred time and style. Fig.3 shows the Assessment Components used in CBES for both internal & external assessment (Maruti, Anandrao & M. S.Patil, 2018).

The student assessment management (SAM) process is proposed to assess each student for each course by the teacher using proposed four categories. They are Direct Tools, Indirect Tools, Certifications obtained and Amount spent per student. Each category is assessed in a scale of 10. The assessment components will provide progress indication that how student is acquiring competencies in each category. For example, to acquire a mastery through demonstration of skills by implementing any project or prototype or case study with data analysis requires a budgetary provision to create a resource required and for recurring expenditure. Hence amount spent per student during their study period will fetch score in a scale of 10. Similarly, the Fig.4 shows the details of assessment components and total score of each student. Fig.5 & Fig.6 shows how each main assessment component is further assessed for each subject student is studying. All assessments are shown in this paper is in a scale of 10.

СТ	Calss Test
TA	Teacher Assessment
PA	Practical Assessment
CA	Comptency Assessment
TE	Theory End Semester
PE	Practical End Semester
CE	Comptency End Semester

Fig. 3. Proposed Evaluation Scheme Structure

This SAM process has been implemented in one semester to observe student progress by considering sample size of 300 students and Six subjects. In each subject, assessment is done



by the team of faculty, lab staff and Industry or Start-up/Incubation expert (Balasubramani, 2019).

Benefits:

- 1. Student work on their own identified problem and project with required resources.
- 2. Flexibility and opportunity to gain real-world experience.
- 3. Personalized way of teaching and timely support.
- 4. Recognition of prior learning.
- 5. A novelty in assessment and grading (Tamer & Christopher, 2017).
- 6. A different strategy for communication progress.
- 7. A skill-based training program that ensures quality.

SI. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Subject1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total Score
1 20EC135			Accountability	10	10	8	5	10	4		
			Communication	8	7	7	10	10	6		
			0018 Aditya Gupta	Team Work	10	4	8	5	10	4	7.88
	20EC135	2000910310018		Innovation	6	6	9	10	10	8	
				Planning and Organizing	7	8	7	5	10	10	
				Continuous Improvement	10	8	5	10	10	10	
				Sub Total Score :	8.65	7.25	7.1	7.75	10	7.3	
				Accountability	6	4	10	7	10	4	
				Communication	8	7	10	5	10	6	
				Team Work	10	4	10	10	10	4	
2	20EC136	2000910310034	Amisha Pandey	Innovation	6	6	10	6	10	8	8.16
				Planning and Organizing	7	8	10	7	10	10	
				Continuous Improvement	10	8	10	10	10	10	
				Sub Total Score :	8.05	6.35	10	7.75	10	7.3	

				<u>Critical Thinking</u>							
Sl. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Subject1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total Score
1 20EC135 2000910310018		Analytic Reasoning	6	10	8	10	10	4			
		Adhus Gunta	Concepts and Understandings	8	7	7	8	8	6		
	2000010210010		Evidence to meet constraints	7	4	8	5	10	4	7.82	
	2000133	2000910310018	warya cupta	Data Analization	7	6	9	10	8	8	7.82
				Own Implications	7	8	7	8	10	10	
				Conclusions	10	8	5	10	10	10	
				Sub Total Score :	7.75	7.25	7.1	8.65	9.4	7.3	
				Analytic Reasoning	6	4	10	7	10	4	
				Concepts and Understandings	8	7	8	5	10	6	
				Evidence to meet constraints	10	10	10	10	10	4	
2	20EC136	2000910310034	Amisha Pandey	Data Analization	6	6	8	6	10	8	8.22
				Own Implications	7	8	10	7	10	10	
				Conclusions	10	8	10	10	10	10	
				Sub Total Score :	8.05	7.25	9.4	7.75	10	7.3	

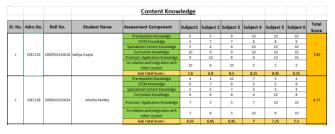
Fig. 5. Proposed Evaluation Scheme Structure Assessment Components -I

TABLE I
ACADEMIC PERFORMANCE INDEX OF CBES STUDENTS

 ACADEM	IC I EKI	JKWIANCE IND	EX OF CDES STO	DENIS
Section	N	Mean	Standard Deviation	P-Value
Section 1	60	7.78	0.41	0.08
Section -2	60	7.86	0.27	0.07
Section-3	60	8.23	0.15	0.05
Section-4	60	8.29	0.13	0.04
Section-5	60	8.33	0.11	0.02
AVG	60	8.09	0.21	0.05

TABLE II SUCCESS INDEX OF CBES STUDENTS

Section	N	Mean	Standard Deviation	P-Value
Section 1	60	0.91	0.013	0.1
Section -2	60	0.94	0.026	0.07
Section-3	60	0.95	0.006	0.08
Section-4	60	0.93	0.005	0.1
Section-5	60	0.96	0.006	0.1
AVG	60	0.938	0.011	0.10



SI. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Subject1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total Score
1 20EC135 20009103100			Commitment	6	4	8	10	10	4		
			Integrity	8	7	7	8	8	6		
			Respect for Diversity	8	6	8	10	10	- 4		
	20EC135	2000910310018	Aditya Gupta	Professionalism	9	6	9	10	8	8	7.55
				Compassion/ Caring	7	8	7	8	4	10	
				Social Responsibility	10	8	5	4	10	10	
				Sub Total Score :	8.20	6.65	7.10	7.90	8.50	7.30	
				Commitment	6	4	10	7	10	- 4	
				Integrity	8	7	8	5	10	6	
				Respect for Diversity	10	10	10	7	9	- 4	
2	20EC136	2000910310034	Amisha Pandey	Professionalism	6	6	8	6	7	8	7.36
				Compassion/ Caring	7	8	1	7	7	10	
				Social Responsibility	10	8	2	10	10	10	
				Sub Total Score :	8.05	7.25	6.05	7.30	8.95	7.30	

Sl. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Subject1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total Score
				Driving and managing change	6	4	8	10	10	- 4	
1 2050125			Aditya Gupta	Strategic thinking	8	7	7	8	8	6	7.97
	20EC135	2000010210010		Making quality decisions	10	4	8	10	10	4	
		2000310310010		Building partnerships	10	6	9	10	8	8	
				Leading and empowering others	7	8	7	8	10	10	
				Managing performance	10	8	5	10	10	10	
				Sub Total Score :	8.65	6.35	7.1	9.4	9.4	7.3	
				Driving and managing change	6	4	4	7	2	4	
				Strategic thinking	8	7	8	5	2	6	
				Making quality decisions	10	10	10	2	4	4	
2	20EC136	2000910310034	Amisha Pandey	Building partnerships	6	6	8	6	5	10	5.72
				Leading and empowering others	7	8	10	7	8	5	
				Managing performance	2	8	2	2	2	2	
				Sub Total Score :	6.05	7.25	6.5	4.55	3.65	4.85	

				Percentage of Marks							
SI. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Total Score
			8 Aditya Gupta	CIA-I	6	4	6	6	6	6	
1 20EC135				CIA-II	8	8	8	4	2	4	
	20EC135			CIA-II	10	8	7	9	7	7	7.76
		2000910310018		UE	6	10	8	8	8	8	
				Feed Back	7	8	6	10	8	4	
				Mini Project / Case Study	10	10	10	10	8	10	
				Sub Total Score :	8.05	8.2	7.75	8.05	6.65	6.85	
				CIA-I	6	4	6	6	8	6	
			Amisha Pandey	CIA-II	10	8	8	4	8	4	
				CIA-II	10	8	8	9	8	7	
2	20EC136	2000910310034		UE	10	10	8	8	8	8	8.01
				Feed Back	7	8	6	10	8	4	
				Mini Project / Case Study	8	10	10	10	8	10	
			I	Sub Total Score :	8.45	8.2	7.9	8.05	8	6.85	

			Amount Spent (Re	curring + N	on Recurr			
SI. No.	Adm.No.	Roll No.	Student Name	Fee	Recurring Expenditure	Non Recurring Expenditure	Special Project / Any Other	Total Score
1	20EC135	2000910310018	Aditya Gupta	100000	50000	20000	0	0
2	20EC136	2000910310034	Amisha Pandey	100000	50000	20000	5000	10
3	20EC137	2000910310086	Krati Agrawal	100000	50000	20000	4000	0
4	20EC138	2000910310188	Vikas Singh	100000	50000	30000	0	10
5	20EC139	2000910310077	Himanshu singh	100000	50000	20000	0	0
6	20EC140	2000910310146	Saumya Tiwari	100000	50000	40000	0	10
7	20EC141	2000910310192	Vipul Singh	100000	50000	20000	10	0
8	20EC142	2000910310126	Rishabh Kumar Tiwari	100000	50000	20000	10	0
9	20EC143	2000910310137	Samarth kumar	100000	50000	20000	10	0

Fig. 6. Proposed Evaluation Scheme Structure Assessment Components -II

			Student Ass	essment Management (SAM)	Process				
Sl. No.	Adm.No.	Roll No.	Student Name	Assessment Component	Tool Score	Indirect Tool Score (B)	Amount Spent per Student (in a scale of 10) (Recurring + Non Recurring) (D)	Certifications (Industry/Innovation/Entre prenership/Higher Studies) (E) (2 points per certificate/Minimum 5 certicates per Semester)	Total Score
				Core Competencies	7.88	10.00			
			Aditya Gupta	Critical Thinking	7.82	10.00	0.00		
				Content Knowledge	7.87	10.00			
		2000010310018		Core Values	7.55	10.00		10.00	7.84
	2000233	2000910310018		Managerial Competencies	7.97	8.00			7.04
				Percentage of Marks (in Scale of 10) / CGPA	7.76	10.00			
				Sub Total Score :	7.80	9.70	0.00	10.00	
				Core Competencies	8.16	10.00			
				Critical Thinking	8.22	7.00			
i				Content Knowledge	6.77	7.00]		
	2050125	2000910310034	Aminho Bonder	Core Values	7.36	10.00	10.00	10.00	8.40
- 4	2000130	2000910310034	Amisha Pandey	Managerial Competencies	5.72	7.00			8,40
				Percentage of Marks (in Scale of 10) / CGPA	8.01	9.00			
ı				Sub Total Score :	7.43	8.40	10.00	10.00	

Fig. 4. Proposed Evaluation Scheme Structure

IV. RESULTS AND DISCUSSION

The results obtained for the Five Academic Years have been Tabulated in Table I and Table II for Academic Performance index and Success Index (R Senthil, 2020) respectively. Inputs are considered from two Engineering Programs with the data set of 300 students. Mean values around 80 percent and standard deviation below 0.21. P-value is compared with null hypothesis of 100 percent achievement. P -value is greater than 0.05 for all the sections.

V. CONCLUSION

The proposed CBES structure model and SAM process assessment results shows the enhancement of higher order level competencies, soft skills and quality. Practice of CBES model and SAM process assessment contributed in enhancing academic performance index around 90 percent & Success Index around 94 percent. These models have contributed in the enhancement of Teaching-Learning process of CBES curriculum and its assessment of competencies. Further, the proposed models in this paper can be enhanced and strengthened by tracking individual students learning styles and individual competencies. The SAM process has a greater number of assessment components and different abstraction levels, hence practicing this proposed process for 2 to 3 academic years will give deep insights and benefits along with observable outcomes. Revision of learning outcomes and considering type of Assessment, Competencies, Pedagogical Strategy, Budget and Infrastructure are main challenges of the proposed work.

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