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A circumstantial approach towards formative assessment in mechanical engineering courses

Mohammed Abu Basim Nazer Ali [1], Velammal Institute of Technology, India

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Abstract

Universities are entrusted with nurturing a nation's brightest minds through different assessment and evaluation strategies. However, assessment became difficult during the COVID-19 pandemic era, hence, raising concerns about alternative assessment methods. This study focuses on the importance of formative assessments in higher education and how they can be designed to assess students' performance using online web tools on mechanical engineering. The study was conducted by considering 60 students who undertook various assessment methodologies for 6 different courses. The result obtained helps the instructors to understand their learning efficacy and how it helps the individual to what extent the learning outcomes have been attained. Also, there was a huge gap between what instructors thought and how the students understood the context.

Keywords: Attainment; Examinations; Formative Assessment; Learning Outcomes; Students' Performance

* ADDRESS FOR CORRESPONDENCE: Mohammed Abu Basim Nazer Ali, Velammal Institute of Technology, India.
E-mail address: basim89@gmail.com

1. Introduction

The COVID-19 outbreak continues to pose a significant concern around the globe. Both rural and urban communities remain to see a surge in the prevalence of cases. The education ecosystem has been greatly exacerbated by the crisis (Leal Filho et al., 2020). Several nations were obliged to migrate from their regular classroom teaching to online teaching due to the closure of colleges. Most nations are simultaneously grappling with the pandemic's second or third wave. Although vaccination programs have been initiated, the pace at which the vaccination is done is slower than the spread of COVID-19. The consequence of the pandemic in 2020, results in exam disruptions and suspensions are persisting this year in some countries. Around the globe, the perception of university examinations being postponed or canceled differs. The suspension of board and university exams has hindered students' effort and morality towards passing their exams.

Students in higher education institutions have been promoted to higher semesters without attending their current semester courses and their backlogs (Magana, Seah & Thomas, 2018). This situation will result in a major impact on students' mindset towards assessments and evaluation techniques. The central and state governments forced all the universities to cancel the exams due to no alternative to conducting them considering the inevitable danger to the students' community.

Due to the cancellation of exams, the government has decided to select the most feasible method of conducting them through online platforms to assess the individual's attainment. Among the most demanding components of administering online examinations is verifying that students are not influenced by the internet facilities. When students undertake exams in the absence of an examiner, they may find it convenient to look up alternatives or review the approach with the others (Kunutsor et al., 2022). All modes of exams will have different sets of regulations and each course can't be conducted in the same pattern. For instance, some courses need data books, diagrammatic approaches, and other additional sources to solve problems.

1.1. Conceptual Background

Many universities hired professional third parties and sometimes universities have designed their own AI-enabled online proctored platforms to conduct online exams. These technologies are essential to identify the unauthorized behavior of students during exams. Nevertheless, many students have highlighted the potential ramifications and privacy concerns of test software designed to combat misconduct. Perhaps, some felt uneasy following the platform in which they were required to illustrate the entire workplace via camera, disclose personal information, and be informed about every activity, which will be captured, examined, and archived in the database.

Academicians must be aware of the implications of adapted assessment methods, which could try to address the following question. Does the mode of assessment help students learn inside the classroom and enhance their test scores on external accountability tests? The current education system could use formative assessment to clutch more enthusiastically for "research-proven" solutions. Many educators think that formative assessment would help instructors teach more effectively. Some firmly believe in "Black and Wiliam research synthesis" (Black & Wiliam, 2009) that formative assessment could concentrate more on classroom implications and it provides little consideration in improving external test results.

1.2. Literature review

In India, the importance placed on grades reinforces the belief that memorizing and passing exams is far more rewarding. Unfortunately, this type of learning results in little to no accumulation of the skills required for creativity and breakthroughs. Factor into this the societal shame associated with lower

grades and with pursuing specific fields such as the humanities rather than highly regarded programs like engineering, and students in India struggle to cope with academic demands. Recent research discovered that Russian and Chinese undergrads outperformed their Indian counterparts (ET Online, 2018). Indian students make significant improvements in mathematics and critical thinking through their first two years of education when compared to their fellow students in China and Russia, and besides their overarching higher thinking abilities are significantly lower, as indicated by a report on Indian Express based on the initial findings of an assessment on undergraduate engineering learning outcomes. The research demonstrates that Indian students are capable of thinking critically. Their intellectual development is stifled by inaccessibility to a high-quality education.

Almost every university student has a personal approach to learning. Some students acquired an interest and focus toward STEM-oriented courses, for them classroom cultures, interactions with teachers, projected relevance of the curriculum, and instructional techniques may all play a significant role in their education (Carlone, & Johnson, 2007; Chang et al., 2011). Consequently, each course requires its evaluation procedure. Engineering students from top private schools have different qualities, privileges, and liabilities compared to those who study four-year in affiliated institutions to occupy a certain economic niche. Admissions criteria at Tier I institutions are tougher than those at Tier II and III institutions. While these huge differences in socioeconomic conditions and individual features all determine academic success, most college students face similar challenges. Even when enrolling in a freshman semester class, students bring with them a certain level of competencies necessary for the course, which reflects part of their educational and life experiences. These talents answer a key question many students ponder even before college: What other qualities do I need to succeed academically? Capabilities might include broad propositional talents like sustaining academic work in monotony or mobilizing a certain attitude while avoiding or diverting human ideas in difficult situations. Throughout the undergraduate years, the student may depend on situational talents to overcome numerous educational and behavioral challenges faced in the classroom and in academics.

1.2.1. Development of Assessment Standards

It is necessary to start the assessment modernization and development phase with a well-articulated declaration of the abstractions to be evaluated with the set of objectives to be met without jeopardizing its quality. A restatement of these aims provides an overall framework for assessment development. (Dweck, 2006) proposes in chapter 2 that the perspective involved in students' intelligence emerges via learning and cognitive process. Thus, a sampling technique would indicate how these pieces would be sampled from a content perception of the developmental frame of mind conceptual framework. The assessment building process also includes test objectives and ramifications. The assessment's structure and psychometric properties are affected by the goals and results interpretations. Examples of this might include an evaluation aimed to discover and analyze a student's developing attitude in particular mathematical models connected to applied mechanics. Rather, an examination of an intervention's influence on the trait's creation should examine growing mentally across time, potentially at the micro-level. There are also various assessment requirements with a thorough strategy for who should be tested and how. (American Educational Research Association, et al., 2014, P-85) outlined specific items which include the a)test's purpose(s), b)the constructor domain being measured, c)the expected examinee population, d)viewpoints for intended uses, e)the test's content, f)the proposed test length, the item configurations, g)the preferred psychometric attributes of the test items and the test, h)and the expected sampling of items and sections.

Written examinations are very important in assessing student learning and grading in Indian engineering education. Exam results are skewed heavily in university and college grades. The examination/test paper questions directly contribute to assessing the student's degree and the effect of learning in the courses

and hence in the program. Because assessment promotes learning, test questions must go beyond simple memory recall. They must also evaluate higher-order skills and abilities. End-of-semester written tests assess limited implications on outcomes and cognitive ability. This alone would not be sufficient to make educated predictions about student learning, especially in courses with larger course outcomes (COs). MCQs, reflective practice assignment questions related to concrete experience, abstract conceptualization, short answer type, practical work based on open-ended, structured enquiry, essay type, interpretation questions, etc. (Soeiro et al., 2015) must be used to ensure assessment techniques align with learning objectives. It is advisable to design academic assessment procedures for each course that are transparent about the following: a) Assessment aligned with specific course learning goals; b) Cognitive level of learning expected of students across all courses; c) Assessment method adaptation. Considering the foregoing, it is apparent that formative assessment is widely esteemed. Since it is a continuous evaluation, immediate qualitative feedback is offered to ensure the student understands the core curriculum and meets the course goals. Providing timely feedback on student performance helps them achieve the course's learning goals and grow as self-regulated learners.

1.2.2. How Formative Assessment differs from Summative Assessment?

Summative assessment has conventionally been used to accumulate relevant data about student learning—a test, sometimes teaching and learning process, occasionally shared centrally, and but often regulated, supervised at the final result of an instruction to determine attainment. Educators, typically assign grades based on the results of the exams conducted and then proceed on to a different unit of teaching. As policymakers, we often utilize standardized assessment results to evaluate the performance of institutions which are considered important metrics for university ranking. They inform us about how the students finish in the race, providing a snapshot for comparison reasons. However, at this moment, the race is finished. By contrast, formative assessment provides instructors with data that they may use to enhance their teaching and improve students' learning while the race is still ongoing and the result is still debatable. The formative assessment utilizes several methods to ascertain students' comprehension, enabling instructors to identify and remove any barriers to a student's development (Greenstein, 2010).

The method is analogous to that of a coach designing brief workouts to evaluate a runner's posture, and pace, and then making the necessary changes to help the runner develop. Classroom teaching formative data to evaluate the concentration and kind of learning, assistance, and practice that a student intends to achieve a goal. When instructors and students use formative evaluation before, during, and after teaching, all stakeholders have a sense of progress. Accomplishment is often seen as verifiable and tangible progress over time, not as a benchmark score. In this sense, competence refers to individuals who are actively engaged in the process of expanding their knowledge and abilities. Different students may approach this differently—some may take fewer measures than others—but progress will be achieved. To return to our race analogy, runners measure their success not just in terms of final positions, but also in how their performance is improved. Both lecturers and learners may use formative assessment to quantify learning and may assist teachers and students in making choices on what to do next.

1.2.3. How does a small entity make a huge difference?

Finding and articulating criteria for identifying new and impactful assessment strategies is considered as a significant role in adaptive formative assessment in classroom settings. Rather than categorizing many techniques, the emphasis has been put on factors that influence what's been effectively evaluated, how it is been assessed, and rejecting the old and traditional practices in which the essential elements are considered. A step to step from evaluating the fragmented, meaningful contexts encompassing the components of knowledge and ability toward assessing broader comprehensive, complex processes and

activities which require knowledge updation and skills involved in solving complex problems in real-time scenarios (Heritage, 2010).

A transition from standardized and regulated evaluation strategies that produce quantifiable scores and establish greater isolation between assessment and teaching-learning methods toward a diversified array of possible assessment methods that produce qualitative, contextual as well as empirical characterizations or judgments to maintain a strong connection between assessment and teaching-learning process. Considering these changes, it is essential to focus more on a comprehensive approach with more emphasis on assessment type. In simple terms, ranking the students based on their scores must be eschewed, instead of assessing the students based on their performance throughout the course and how the learning outcomes are met, and most importantly to what extent. It is better to monitor their learning curve through proper portfolio management which includes their learning analytics. Performance-based judgment must be the governing criteria to assess the students' competencies in any course.

1.3. Purpose of study

The study present here strongly believes that formative assessment could be an alternative for end-semester examinations. It also helps in solving some unanswered questions like- Is it possible to utilize the impacts and influence of formative assessment in higher education institutions to evaluate individual competencies? Is it possible to utilize it to increase individual course graduation rates following the course's objectives? Can students' gained experiences throughout the evaluation process be used to assess their professional skills during the employability process?

2. Materials and Methods

2.1. Participants

Let's begin with an example. Consider a sophomore class in mechanical engineering that encompasses 60 students. This year, students will concentrate on courses in applied mechanics, fluid mechanics, thermal sciences, material science, and mathematics. During the course, it was found that some students were not able to demonstrate certain competencies related to mathematical knowledge by applying certain numerical methods and statistical techniques in the course on Statistics and Numerical Methods. They were unable to comprehend the fundamental operations of certain models, such as quick return motion, mechanisms, and so on. Most of them were not familiar with drawing velocity and acceleration diagrams, Coriolis components of acceleration, instantaneous center methods, etc about the course Kinematics of Machinery. Even some students are not able to perceive the concept of bending and torsion in beams, failing to assess the slope and deflection of a simple beam. They could not differentiate between direct stresses and indirect stresses, which pertain to the strength of the materials. The problem continues to prevail in various courses in the third and final years of engineering.

2.2. Data collection

All of these courses are evaluated and taught by experts in their respective fields, such as design engineering, manufacturing, and so on. Students were given assignments at the end of each unit by the course instructors. Even these students tend to solve minimum problems. It was difficult to monitor individual students in all aspects in a class of 60 in 50 minutes. The duration allocated for each course by the university is 45 hours. This is the reason that course instructors are not able to assess the individual course competencies which are reported by many faculties in the department. Despite these issues, the majority of the students we discussed earlier received higher grades in their end-of-semester exams. This leads to questioning the education system and its assessment methodologies. The majority of knowledge is lost after the semester tests. Nonetheless, Indian students concentrate on memorizing

knowledge year after year. The system recognizes and rewards the top students. These are some of our educational system's basic problems. The emphasis should be more on skill-based learning beyond actual memorization and stimulating students' creative ideas as a solution.

2.3. Procedure

A model study was conducted using the Time to Assess Learning Outcomes in E-Learning (TALOE)(European Commission's Lifelong Learning Programme, 2015). Assessment platform which helps to make decisions to select the best feasible assessment methods for courses. TALOE is a web tool that leads you through 2 phases which will assist the course instructor in effectively defining learning outcomes and selecting appropriate assessment methods for each outcome. We have used the TALOE web tool to decide the assessment strategies to be implemented for the courses like Kinematics of Machinery, Fluid Mechanics and Finite Element Analysis. Learning outcomes were designed by the instructors, and correlated with the university curriculum. Then, based on the learning outcomes assessment methods were decided using the TALOE tool.

3. Results

The web tool is used to define e-assessment methods, we used this to bring out the best methodologies to implement in both online and offline assessments. The following section will be focusing on the assessment methods for the Kinematics of Machinery course and how the attainment is calculated. Learning outcomes for the KoM course are listed in Table 1.

Table 1

Learning outcomes of the Kinematics of Machinery course with suggested Assessment Methods

Learning Outcomes	Assessment methods using TALOE Web-tool
LO1: Understand the principles of kinematic pairs of planar mechanisms using various criteria for different applications	MCQ-Understand Reflective practice – concrete experience MCQ Remember
LO2: Apply the principles of the Coriolis component, Instantaneous center method, and various graphical approaches to find velocity and acceleration	Problem-solving – interpretation Short answer – describe the limitation of data Practical work – open-ended enquiry
LO3: Develop a cam profile using various displacement diagrams and calculate angular velocity and acceleration.	MCQ Apply Reflective practice – abstract conceptualization Problem-solving – routines
LO4: Analyze the working of various gear trains using the principles of gear design by understanding gear tooth geometry and nomenclature	Practical work – structured enquiry Problem-solving – interpretation Essay – write on
LO5: Apply the principles of "frictional forces" in various power transmission systems.	MCQ Apply Reflective practice – abstract conceptualization Problem-solving – diagnosis
LO6: Analyze various simple kinematic mechanisms using Multi-body Dynamics Approach	Essay – Discuss MCQ Analyze Practical work – structured enquiry

Regarding the course Kinematics of Machinery, LO1 emphasizes more on the basics of kinematics which is confined to the basic mechanisms, criterion involved in calculating the number of joints, its mobility and configurations, various inversions of 4 bar chain mechanisms, single slider crank chain mechanisms, double slider crank chain mechanisms, approximate and exact straight-line motion mechanisms and steering mechanisms.

LO1 contributes more on the understanding level. TALOE recommends *MCQ-type assessments related to remembering and understanding levels*. Students were asked to enter their responses which necessitate the retrieval of several accurate pieces of knowledge and may include many unrelated items, sometimes related to remembrance or identification of one piece of accurate information. Assignment questions are provided as a *reflection cycle* that includes a 'doing' element. The student is required to remember and choose pertinent learning experiences from the course/module, which are often correlated to the LOs. Occasionally, the student may remark on learning incidents that unfolded beyond the course module but are significant to the LO. *For example, Students were asked to submit the models on mechanisms in wooden, steel plates, etc.*

LO2 insists more on a graphical approach to find velocity and acceleration using relative velocity, instantaneous center, and Coriolis component methods. TALOE recommends *Problem-solving – interpretation* in which the learner is provided with a real-world scenario and is required to understand and translate it into a recognizable representation of the issue to solve it. Additionally, the learner will be required to understand and apply the answer in the physical realm. Secondly, *Short answer – describe limitations of data type* in which the students were given results with an experiment and asked to identify its limits. He will be required to understand and analyze the facts provided, as well as to evaluate and defend his conclusions. Lastly, the *Practical work – open-ended enquiry* in which students were presented with a challenge and limitations in this kind of practice. They will be responsible for formulating it, selecting and designing experimental methods, as well as interpreting the findings and consequences. *For example, Students were asked to use different methodologies to find the velocity and acceleration of the Da-Vinci Xi robotic arm, chair swing ride, etc.,*

LO3 emphasizes more on the fundamentals of cam mechanism by studying its types, nomenclature, and displacement diagrams and based on which cam profile is developed by the learner for various types of followers like a knife-edge, roller type, flat-faced or mushroom-shaped and oscillating followers. Apart from this, LO3 also focuses more on determining the velocity and acceleration of cams including tangential and contours cams. TALOE recommends *MCQ-type assessments related to applying level*. Secondly, the assignments are given as *Reflective practice – abstract conceptualization* in which the student will make inferences about his or her learning experience by evaluating their accomplishment to that of the LO3, making inferences, and explaining his/her findings. Finally, the assessment is of *problem solving-routines* which are those that can be solved without having to make any choices. The learner is given a common issue and asked to answer it in this kind of problem exercise in which the learner will need to remember and follow the method they used in previous comparable situations. To get the unique answer, the learner needs simply to follow the process properly. In certain instances, the student is instructed on the appropriate process to follow. *For example, Students were instructed to graphically plot the follower displacement diagram for an automated transfer mechanism using rise, dwell and fall angles with the type of motion like cycloidal, simple harmonic, uniform velocity, and uniform acceleration-deceleration motion.*

LO4 drew attention to the fundamentals of gears in which the learners were moved towards nomenclature of gears, the law of gearing, methods to avoid interference, etc, With this, the learners were instructed to analyze various mechanisms of gear trains like simple and compound, reverted, epi-cyclic, planetary gear trains to determine its motion and teeth. TALOE recommends *Practical work – a*

*structured enquir*y which is a less organized and more open kind of practical. The student is informed of the activity's objective and may be provided with some of the tools and techniques to utilize. Students are required to choose resources and strategies for achieving their objectives. Secondly, *Problem-solving– is an interpretation* type in which the learner is provided with a real-world scenario and is required to understand and translate it into a recognizable representation of the issue to solve it. Additionally, the learner will be required to understand and apply the answer in the actual world. Finally, *Essay – write on* in which the students are assigned a topic and are required to choose and arrange information according to a framework they must create. This kind of essay will determine if the student has a thorough understanding of the subject, not only in terms of comprehensiveness but also in the terms of how things are connected. *For example, Students were instructed to analyze some complex gear train mechanisms like overdrive for a vehicle, Humpage's reduction gear, differential gear of an automobile, etc.*

LO5 gives more prominence to friction on mechanical elements. Students were taught about the basics of friction in Engineering Mechanics. Based on this, they were given problems on clutches, bearings, belt drives, brakes, etc mainly confined to friction and factors influencing it. TALOE suggests *MCQ-type assessments related to application-level* in which the students discuss the knowledge and its implications. Secondly, assignments are given as *Reflective practice – abstract conceptualization* in which the student will make inferences about his or her learning experience by evaluating their accomplishment to that of the LO5, making inferences, and explaining his/her findings. The final type of assessment is based on *Problem-solving – diagnosis* in which the learner is given a question and is tasked with selecting the appropriate procedure or method of executing a procedure. While this seems to be a prevalent question, it is a more challenging one because the learner is presented with limited information. The learner must first identify the kind of problem, then choose and execute the proper procedure. *For example, Students were instructed to determine the loss in kinetic energy in automotive clutches and it can be based on a single plate, multiple disc clutches, etc.,*

LO6 makes much more emphasis on the introduction to Multi-Body Dynamic Systems. The learners were instructed to simulate basic mechanisms (*covered in earlier chapters of the course*) which were influenced by the external forces. LO6 also discusses the differences between the forward and inverse dynamics. TALOE recommends an *Essay-Discuss* type of assessment in which the student is tasked with defending a specific fact or assertion. This kind of essay may include a description of the context, an explanation of the statement, a comparison to different points of view, an analysis of the statement, and an evaluation of the viewpoint. Secondly, *MCQ- Analyze* the type of assessment in which the student correlates and distinguishes, demonstrating an ability to discern between alternatives. The test item requires you to make distinctions, infer, outline, and separate. Lastly, *Practical work – a structured enquiry* which is a less organized and more open kind of practical. The student is informed of the activity's objective and may be provided with methods and materials to utilize. Students are required to choose resources and strategies for achieving their objectives. *For example, Students were instructed to simulate the basic Quick Return Motion mechanisms like Whitworth, Crank and Slotted Lever mechanism, Ackermann Steering Systems, etc. They were also instructed to submit a report on any interesting mechanisms which involve Multi-body dynamic systems*

The following table 2 shows the method in which the attainment was calculated for 60 students for the Kinematics of Machinery course with 6 learning outcomes.

Table 2

The process to calculate the attainment for the Kinematics of Machinery Course

	LO1					LO2					LO3						LO4					LO5						LO6				
Name of the Student	MCQ-Understand	Reflective practice – concrete experience	MCQ Remember	**Total**	**Attainment**	Problem-solving – interpretation	Short answer – describe the limitation of data	Practical work – open-ended enquiry	**Total**	**Attainment**	MCQ Apply	Reflective practice – abstract conceptualization	Problem-solving – routines	**Total**	**Attainment**	Practical work – structured enquiry	Problem-solving – interpretation	Essay – write on	**Total**	**Attainment**	MCQ Apply	Reflective practice – abstract conceptualization	Problem-solving – diagnosis	**Total**	**Attainment**	Essay – Discuss	MCQ Analyze	Practical work – structured enquiry	**Total**	**Attainment**
###	6	7	6	**19**	**2**	9	9	4	**22**	**3**	5	6	5	**16**	**2**	6	4	5	15	**2**	5	8	10	**23**	**3**	7	7	4	**18**	**2**
###	5	7	8	**20**	**2**	4	7	7	**18**	**2**	7	4	7	**18**	**2**	10	4	4	18	**2**	10	5	7	**22**	**3**	9	9	8	**26**	**3**
###	8	6	8	**22**	**3**	7	10	4	**21**	**3**	8	7	5	**20**	**2**	6	5	7	18	**2**	9	6	5	**20**	**3**	10	5	7	**22**	**3**
-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
###	5	8	8	**21**	**3**	4	7	6	**17**	**2**	9	6	10	**25**	**3**	5	8	4	17	**2**	6	8	8	**22**	**3**	7	6	8	**21**	**2**
###	5	5	6	**16**	**2**	6	10	5	**21**	**3**	9	7	10	**26**	**3**	8	7	8	23	**3**	10	4	8	**22**	**3**	9	7	5	**21**	**3**
###	6	8	8	**22**	**3**	10	6	4	**20**	**2**	5	5	9	**19**	**2**	8	8	6	22	**3**	9	5	10	**24**	**3**	5	7	8	**20**	**2**

If a student secures a total of 1-10 out of 30, it is considered Weak Attainment, if it is 11-20, then it is Medium or Average Attainment and finally, if the student secures a total of 21-30, it is highly attained. Through this, the performance of individual students can also be analyzed through the selected assessment process correlated with individual learning outcomes. The overall attainment achieved by the students for the KoM course is listed in table 3.

Table 3

Attainment achieved by the students through the above table (2) in correlation with individual learning outcomes

Total	Attainment Level	No of the students attained individual Learning Outcomes					
		LO1	LO2	LO3	LO4	LO5	LO6
1-10	1	9	11	8	10	8	10
11-20	2	30	26	35	24	27	32
21-30	3	21	23	17	26	25	18

We have listed 6 courses like Engineering Mechanics (E.Mech), Fluid Mechanics and Hydraulic Machinery (FMM), Kinematics of Machinery (KoM), Strength of Materials (SoM), Finite Element Analysis (FEA), and Mechatronics (MCT) (as a sample) in table 4 with their learning outcomes associated with 3 assessment methods recommended by TALOE.

Table 4

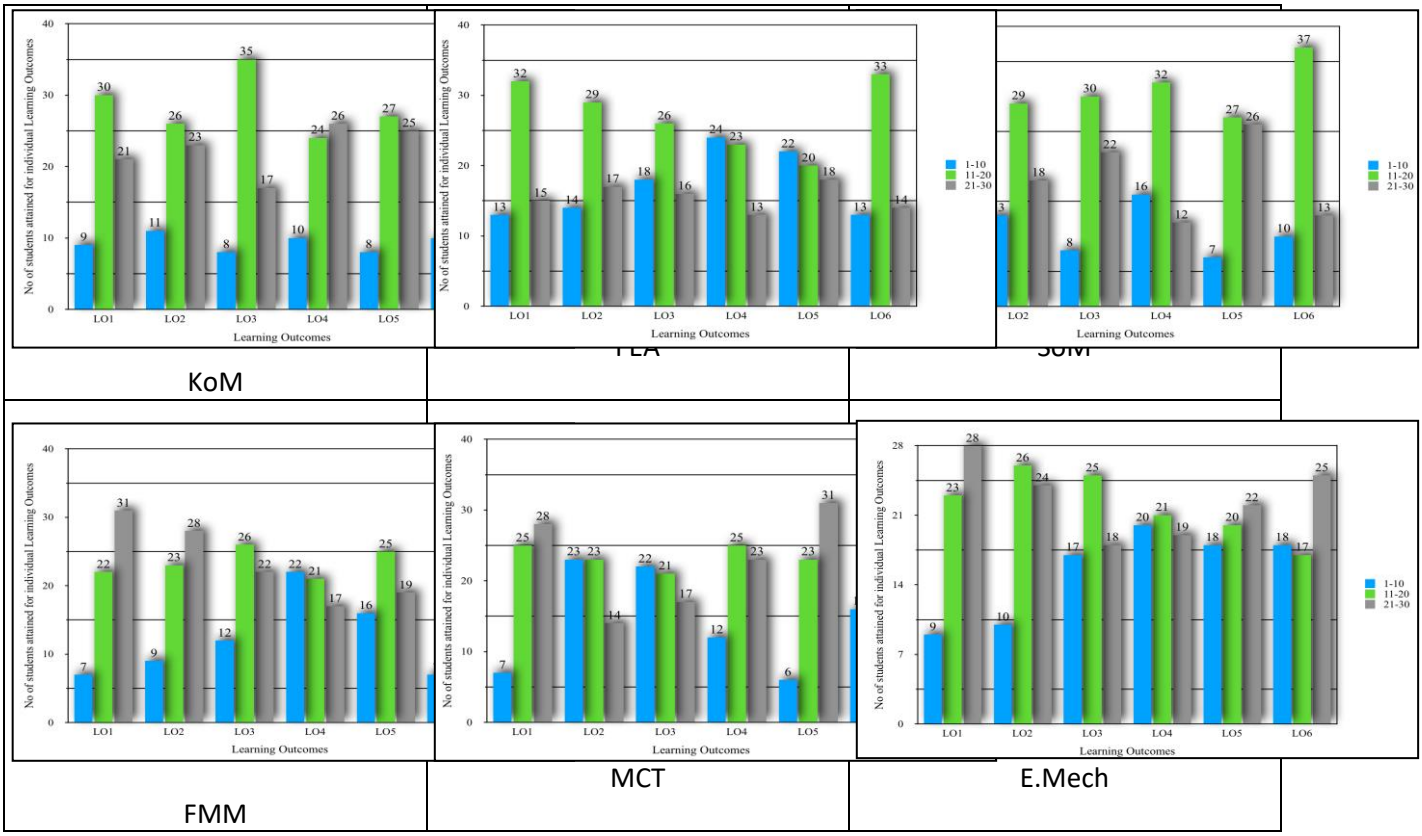
Correlation of listed courses with their learning outcomes and assessment methods recommended by TALOE Web-tool.

Assessment Methods		MCQ Understand	MCQ-Remember	Problem-solving –Diagnosis	Problem-solving interpretation	Practical work – open-ended enquiry	Reflective practice – reflective observation	Essay- Write on	MCQ-Analyze	Essay Discuss	Reflective practice – concrete experience	Short Answer-Explain methods, procedures, and Relationships	Short Answer-Formulate valid conclusions	Short Answer- Describe the limitations of the Data	Practical work-structured enquiry	Practical Work-exercise	Essay Speculative	Essay Compare	MCQ Apply	Reflective practice – Abstract Conceptualisation	Problem Solving Generation	Problem Solving-Routines	Problem Solving-Strategy	Problem Solving-Interpretations
E.Mech		1, 2, 3, 4			1	1	2,4			2, 4	3				3,5, 6	5,6	5	6						
FMM				1		3		4, 5	6	6		2		3	1,2, 4,5	1							2	3,4 ,5, 6
KoM.	**LEARNING OUTCOMES**	1	1	5		2		4	6	6	1			2	4,6				3, 5	3,5		3		2,4
SoM		6				4					6								1, 3, 4, 5	1,2,3 ,5		1, 3 5	2	2 4,6
FEA					5, 6	3, 5		6							6				1, 2, 3, 4, 5	1,4		1, 4	2	2,3
MCT		4		2		6			5	5			4						1, 2, 3	1,2,3 ,6	6	1, 3		4,5

Each learning outcome encompasses 3 different types of assessment methods which includes MCQ type, reflective practice type of assignments, practical work type of assessment, problem-solving type, short answer type, and essay type of questions. It is hard to implement all types of assessment methods for all learning outcomes, so as per TALOE, only 3 assessments will be considered for each learning outcome of individual courses which were described above. Figure 1 shown below describes the number of students with their attainment levels about individual learning outcomes for 6 different courses.

Figure 1

No of the students attained individual learning outcomes for 6 courses (From Top-Left to Right KoM, FEA, SoM, and Bottom-Left to Right FMM, MCT, and E.Mech)



4. Discussion

Usually, the instructors implement various assessment strategies and activities inside the classroom to get a holistic understanding of to what extent the learning process has been progressed through formative assessment (Ferreira, Martinsone & Talić, 2020). Since, the process involves the feedback mechanism which is provided to the students it helps in examining and reacting according to the data, utilizing it for further improvement in the teaching and learning process. In this way, the efficacy of formative assessment is determined. At the same time, it motivates them to systemize their ideology toward learning and enhancing it for further levels. This helps in validating and assessing their work and learning curve. Students are considered proactive knowledge providers and major assets during the formative assessment process. Their participation not only affects the teaching-learning process but is also a major contributor to setting up the objectives and level of attainment for a particular course. This simultaneously affects their competency level in their academics and career. Emphasis should be given to training the course instructors to provide feedback on individual students' learning process and their professional development.

The assessment methods suggested by TALOE for different courses were carefully selected by the designated course instructors. The questions provided during the assessment were crafted critically to include the necessary competencies listed in the (AICTE, 2018) new examination reforms policy. These competencies are correlated with individual performance indicators. Some of the major competencies include mathematical modeling, engineering fundamentals, how they approach a problem in a real-time

scenario, formulating a solution plan, applying a specific methodology from various alternatives which must be optimal, and familiarizing with various design experiments to solve complex and open-ended problems, utilizing modern tools and resources which are essentially required for solving any type of engineering problems.

A single tool cannot help to solve all cases; it is their ability to select the best and most relevant tool from the available resources provided by the institutions and open source. Additionally, students must also be able to demonstrate their ability in environmental safety, health, public welfare, and regulatory standards while manufacturing the products with proper ethical standards to achieve sustainable goals. The education that they learned must also help in developing their leadership and communication skills, teamwork, and the ability to solve conflict situations. They must also possess the necessary competencies in reviewing the financial viability of current market scenarios to discuss the expenditures involved in the product design and manufacture. As professional engineers, they must possess the ability to identify the knowledge gaps in the recent Industrial 4.0 era and update themselves through lifelong learning (Ecclestone et al., 2010). All these aspects are critically reviewed by the course experts in framing the learning outcomes and assessment methods.

The negative aspect of the current summative assessment is it lags in peer-to-peer review and assessment which is one of the major components of formative assessment (Figa, Tarekegne & Kebede, 2020). This helps the student to think and go through in-depth to assess their abilities (out-of-the-box scenario). *For example: if student 1 thinks about purchasing a piece of new machinery for his research, student 2 handles this situation by modernizing the existing machine with automation technology which results in cost reduction and he understands the concept of utilization of available resources*. Peer assessment, also known as peer review, is an effective teaching-learning strategy in which readers evaluate and give comments on one another's efforts. It helps students to learn about life skills in reviewing and providing instructions to others, as well as self-assessment and understanding of the progress of their performance. Reflective practice assignments are assessed using peer review methods. Instructors designed the rubrics to ensure the peer-reviewers effectively use them.

It is found that most of the students in higher education institutions spend significantly less time in their courses for their assessment preparation; previously it was not the case (Chung, Subramaniam & Dass, 2020). They used to learn harder since no proper pedagogies were introduced to teaching them. Now the scenario has changed. Students used to learn from textbooks to online resources, as well as the instructors were using many innovative pedagogical techniques to make them understand the concept by deep diving through different approaches. Even now, it is common to know that employers often complain about graduates who lack essential skills like writing, problem-solving abilities, and critical thinking. They were those who graduated with exceptional grades during their end-semester examinations. The majority of the graduates failed to meet the attainment levels in various competencies. The transition from summative to formative assessment will help to maintain the consistencies in their competency development and significantly raise their attainment levels. The results which were discussed in the earlier section indicate the number of students whose attainment level for a particular course varies from weak (1) to strong (3). The assessments conducted at the end of the semester have shown a significant increase in their pass percentage. Almost 95 percent of students have passed with significant grades. One of the major drawbacks of implementing formative assessment is the time limitation. So, it is advisable to conduct formative assessments based on the priorities for core courses. We have done it for only a few courses and some were listed in earlier sections with their assessment methods. Through this, it is evident that individual students' performance can be deeply analyzed and feedback can be given based on their outcomes.

5. Conclusion

In most of the cases, there was a huge gap between what instructors thought and how the students understood the context. The significant barriers to introducing effective assessment practices for learning implementation include the instructors' mischaracterization of the assessment regulation (policy), excessive time spent on paperwork, and incompatibility between assessment strategies and learning outcomes. Additionally, inadequacy in instructors' knowledge towards the formative assessment process, conflicts in students' learning and their learning strategies, classroom practices and their size (Strength of the class), and a heavy workload for the instructors. Formative assessment provides great promise in transforming the teaching-learning experience, but the instructors must get convinced about this process, if not the system fails. Since the instructors are the key players in molding the students' behavior towards learning experience and their employability prospects.

Formative assessment is the fundamental step in transforming the learning process into problem-based learning and project-based learning approaches. This transition leads to creating an open landscape for both instructors and students, in which both the players tend to make mistakes. The interaction between them helps to engage in all the activities required for the formative assessment process. The most significant part of conducting formative assessment helps the students to showcase extensive expertise in a form of a "portfolio" through constructive and sensible activities, rather than displaying limited productivity in a fixed period. This is done by integrating different assessment methods both online and offline, instead of a single assessment process. Since it is a continual process in which assessments are conducted on a frequent period, they can exhibit their learning curve in all aspects. This helps them to understand their strengths and weaknesses.

Maintaining a portfolio throughout the assessment process encourages more genuineness and can provide a positive correlation to students' success. It is a complete perspective of student's professional skills and accomplishments in classroom settings with the valuable feedback from the course instructors, which helps them to grow as conscious and independent learners which would be much easier for the employers to assess them during the recruitment process.

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