Integrated Laboratory Practices in the Question Papers

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Abstract:- Laboratory classes are an essential part of an engineering course. Laboratory sessions are primarily designed to develop proficiency in technical skills, offer an opportunity to place theory in context, develop critical thinking skills and promote investigation-based learning. Laboratory experiences will help to develop as independent learners, researchers, critical thinkers, and generators of knowledge. There are several improvements that need to be implemented to improve student laboratory experiences. The purpose of this research is to integrate with end semester examination in view of requirements of the 21st century.This paper highlight the evaluation system which is robust and dynamic as compared to the traditional evaluation system. This research is based on the feedback collected from industrialists and academicians on the present examination system. The paper has come up with the result that 50 % of academicians are of the opinion that examination paper patterns should include the laboratory-based question. The paper highlights the curriculum design aspect related to the question paper setting. The paper brings some critical points related to the integration of laboratory conduct and evaluation system with end semester examination.

Keywords:- laboratory work, Learner, Knowledge, Integration, Examination, Evaluation

1.Introduction:-

Engineers strive to regulate the content and the material involved with the applications for the benefit of humanity. This task will be accomplished if the engineers, technicians, and others have knowledge and experience in the specific engineering field come together for the objectives. As a result, engineering education at the university or college level helps students lay the groundwork for collecting information and experience that will aid them in engineering practice.

In recent decades, engineering education has undergone a period of fast transformation. While engineering education was predominantly empirical and practical until the 1950s, many hours were spent at drawing boards and in workshop. The rise of scientific analysis began in the 1960s and was bolstered in the 1970s by the advent of digital computers, which made analytical methods more widely available. With the potential exception of hands-on laboratory classes, science, theory, and analysis have nearly totally superseded practical skills from the engineering curriculum.

Along with these changes, there has been an increase of misgivings regarding engineering graduates' practical skills and competencies. These issues prompted the implementation of generic outcome definitions for engineering education in various countries in 2000 [1, 2]. Although these reforms have resulted in some advances, many practicing engineers continue to express worries about graduate competencies. With the advancement of increasingly sophisticated technology, there has been an increasing demand for novel approaches to engineering education [e.g. 3], particularly for global collaboration in engineering projects, activities like project-based learning, research-based learning ,etc [4]. To be competitive in the global educational marketplace, the learning institution tries to expand learning opportunities to its students in the laboratory as well in the virtual platform[5]. Experience in an engineering laboratory is valuable for engineering students [6]. The specifies that students are likely to appreciate are as follows:

1. In the offline mode of conduct of the laboratory, the students are going to be connected if the content is real-time and application-specific.

2. In offline mode, students and stakeholders appreciate the conduct of the content delivered career making and helping them to achieve a higher grade in the final examination.
3. If the conduction happens in virtual mode, then case studies relevant to the curriculum will interest the students towards lab work.
4. In online mode, more the video and simulations related to lab conduct specifics will be appreciated as well it will enhance the students' knowledge base.

Experience in an engineering laboratory is valuable for engineering students [6]. Students are more likely to appreciate specifics about the appearance and operation of the equipment if they attend laboratory classes and handle (operate with) it. Advances in software and communication technology have enabled online laboratory classes [7, 8]. According to evaluations, these laboratory experiences are equally as likely to improve students' knowledge of relevant ideas for which they have received theory as traditional hands-on laboratory sessions [9], albeit there are differences in how students experience online and simulated laboratories.

Students are frequently placed into groups of four or five in typical hands-on laboratory classes that we have witnessed, and they do a single activity together. Not every student has contact with or handles the equipment at all times. A remote-access laboratory, on the other hand, usually allows each student to run the laboratory remotely. The involving examination system should take care of the laboratory content delivered and understood by students , which will test students' knowledge and understanding of technology. Furthermore, our current engineering practice research reveals that there are few specific studies on engineering practice [7]. As a result, determining which laboratory experiences contribute to a basis for engineering practice is difficult. The fact of the matter is students always link laboratory conduct with examination outcomes. The examination system including question paper setting should thereby incorporate the rise of expectation of the students out of laboratory conduct.

High accomplishment at work is associated with "practical know-how," which is crucial to understanding tasks [10, 11-14]. Sternberg and his colleague believe that practical intelligence is related to tacit knowledge, a concept established by Michael Polanyi that describes know-how that is not explicitly communicated and is generally not taught directly

Our study of engineering practise underlines the significance of unwritten know-how. Extensive technical knowledge is required, according to careful investigations of engineering practise [e.g. 7]. The majority of this information is obtained after finishing university courses, and much of it is very elementary. Engineers, for example, must be familiar with the components and materials used in their profession as practised inside a certain business, at least to the point where they can identify components and comprehend what they are used for. Much of this information is so simple on the one hand, and so specialised to a certain business or industrial area on the other, that it would be inappropriate to try to teach it in university engineering courses. Students, on the other hand, must recognise the importance of this 'implicit' knowledge or 'practical intelligence' in engineering practise.

However, because engineering courses set an emphasis on explicit information (students must write or talk to transmit their knowledge), students' perceptions of the relative worth of practical intelligence and tacit knowledge may be reduced. The availability of information is so huge nowadays, the examination pattern should also be involved with the changes around.

We anticipate that students will gain practical intelligence as a result of their laboratory experience. They will probably learn enough for troubleshooting: detecting and resolving difficulties or diagnosing defects in the equipment. This experience can occur either intentionally or unintentionally, and we believe that unintentional learning is a vital element of laboratory work [16]. While laboratory classes have previously been evaluated by examining explicit knowledge (in reports and test response scripts) and student perception of the laboratory class experience [9], no metrics of inadvertent learning, such as 'practical intelligence,' has been found. The topic is whether students who gain experience in laboratory classes have a high level of implicit and tacit knowledge gained through inadvertent learning that may help them to achieve good credit in the final examination. As a result, in this study, we look at the learning through laboratory evaluation and integrate it with the final examination.

2. Traditional Evaluation system :

Examinations are tests that aim to determine the ability of a student. Academically, an examination is an official test of knowledge. Different types of Examinations are conducted all over the world for evaluating a person's skills and intelligence. Examinations are usually written tests, although some may be practical or have practical components, and vary greatly in structure, content, and difficulty depending on the subject.

Mainly comprises of evaluation of students in two aspects viz. laboratory examination and end semester examination. The following were the key points associated with examinations;

2.1 Laboratory examination:

i) There used to end semester oral /practical examination normally focussing on an experiment performed by the students

ii) Examination used to happen most of the time on one or two important topics. It use to be so because of coverage of experiments or sometimes driven by the expertise of faculty.

2.1 End semester examination:

i) The traditionally ESE used to be on curriculum and considering weightage /hours assigned to a particular module

ii) Question paper setting use to be most of the time driven by faculty members' understanding of the subject.

iii) Question Paper S used to be most bounded by the pattern provided and so there used to be less weightage given to lab experiments.

iv) In an olden era of the education system there were only basic experiments were incorporated in the curriculum and they were not correlated with all modules

2.3 Mismatch and Coherence factor:

a) Traditional examination system lacks in assessing the students' knowledge in totality as there was a mismatch in question paper system.

b) Students use to treat TES in a discrete manner i.e examination of Lab and ESE.

c) Question paper setting used to be on the theoretical concept and less importance had been given on experimental-based questions.

d) Traditional examination system is not capable of testing students on real-world problems, skill development, cognitive learning capabilities, etc.

3. Why there is a need to integrate the question paper setting with the Learning outcome of the laboratory?

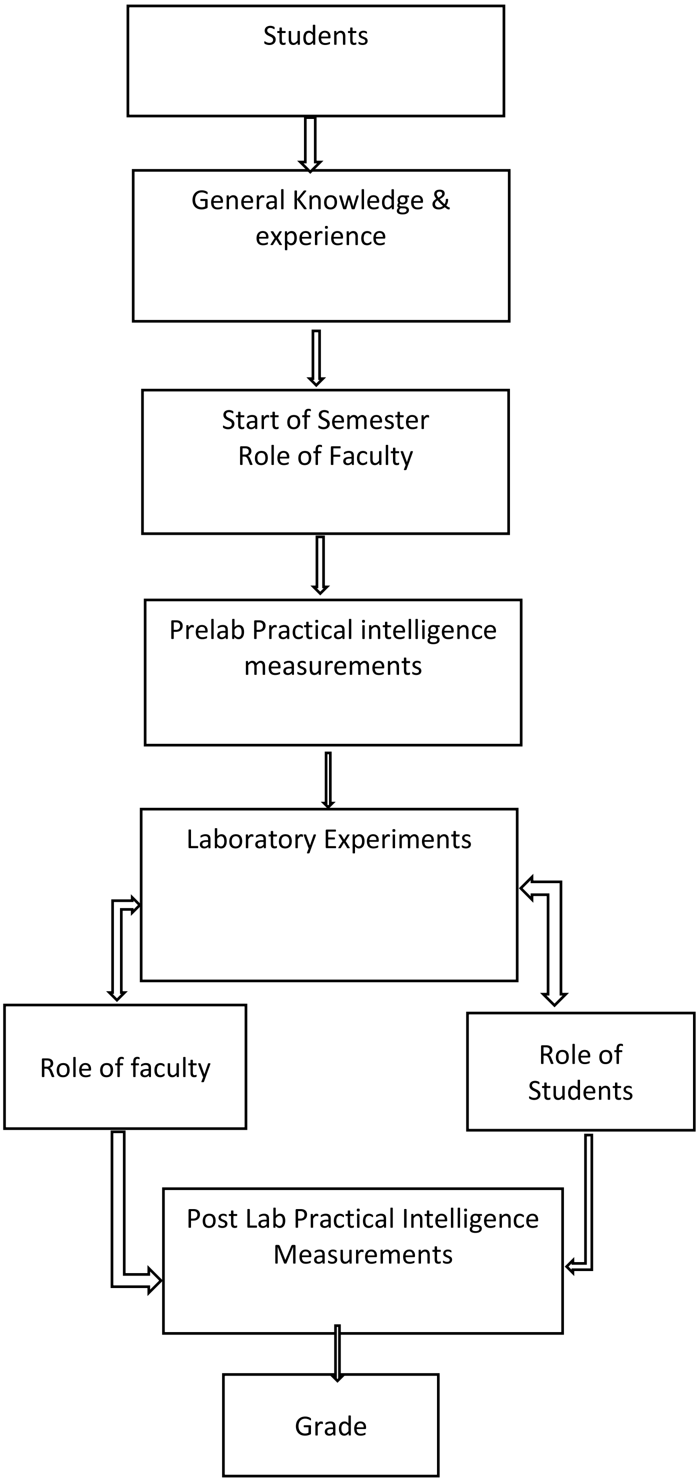
The practical component of the engineering curriculum is one of the most essential components in developing engineering graduate characteristics [6]. Laboratory sessions are great learning experiences that may be utilised to successfully explain the relationship between practical skills and theory. Working in an engineering laboratory setting allows students to test conceptual knowledge, collaborate, interact with equipment, learn by trial and error, do analysis on experimental data, and learn how to handle tools and equipment safely. According to Webb [16], the underlying rationale for the benefit of laboratory sessions is that they provide students with a fundamentally distinct setting for learning. The setting in a laboratory class differs from that of other learning styles such as lectures or tutorials**.** Real hardware, components, and materials are used by students. They integrate their learning in a different environment and, as a result, generate new knowledge.

4. Proposed Model: Integrating Laboratory Learning and End semester examination

The expectation of stakeholders from engineering institutes at TCET was addressed in various ways by incorporating changes required as per industry needs, making laboratory manual and conduct more inclusive and effective. The focus was to address the shortcoming out of TES and integrate aspects covered in the laboratory with the main examination. This has become possible by making changes in laboratory conduct and question paper setting. In TCET lab experiments were categorized into three parts a) Basic Experiments b) Advance experiments and c) Mini or Major Projects. It helps students with technical, analytical skills and knowledge. The lab manual has been prepared by involving all the parameters like , Aim, Objective, Basic Materials, procedure, Result, conclusion. The standard of evaluation of students is set based on the difficulty level of the subjects at lab and ESE.

5. Methodology for conduction of Laboratory:-

The sample way of conducting laboratory in Figure 1



Students:- Civil Engineering Subjects

Having experimental knowledge or documented knowledge from previous experience or learning outcome
For ex:- stress, strain, Modulus of Elasticity

As Faculty:- Faculty has to orient them about the subject
It's practical as well as industrial importance.
Circulate the printed Manual of the same

As Students: - Whether they read the experiments?
Whether they know the materials used for experiments?

As Faculty: - Explain the parts of equipment,
Connection and procedure of performance
As Students: - They follow the sequence mentioned in manual or Instruction is given to them by faculty

As Faculty: - Validate the results
Test their post knowledge of learning
Can they able to solve the quiz question of it?

Figure 1:Flow Chart of Methodology of Conduction of Lab

The survey was carried out to establish correlation or importance of practical knowledge to assess unintentional learning classic implicit knowledge in engineering laboratory classes. In other words, we wish to develop ways to measure the experiential and "hands-on" component of the learning a laboratory that can help to attempt the question asked in End semester examination.

5.1 Present Examination System: -

Figure 2. shows the present examination system, the paper pattern for End Sem Examination has based on the module and divided the question the based

on allocated time hours mentioned in the module. In this pattern, we have tested only the routed type of knowledge. we are not able to test practical knowledge which is required for industries

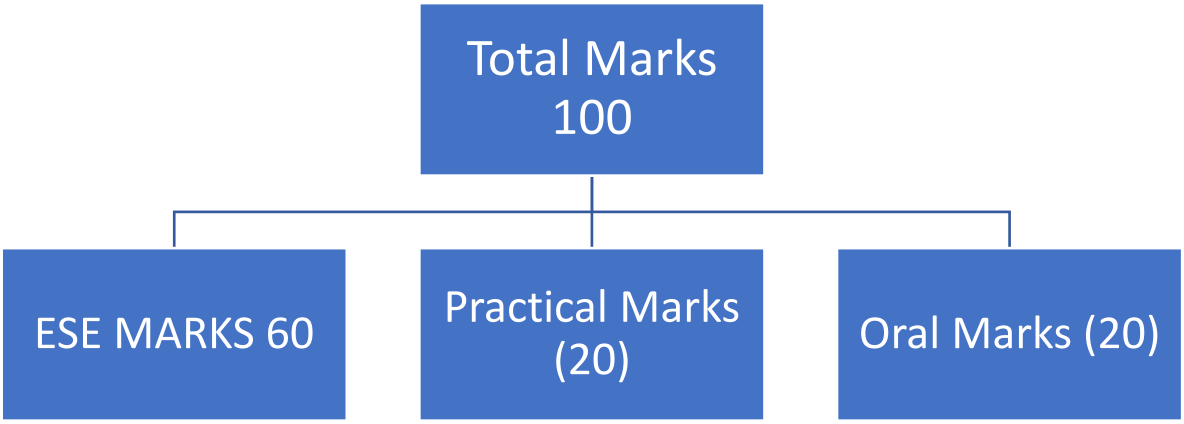


Figure 2: Traditional Paper Patterns

5.2 Proposed Examination system:-

To incorporate effective utilization of laboratory works and their importance as per the industrial needs as well as to test a practical knowledge of a student's. The survey was conducted by floating questionaries to industrial people and teaching fraternities. It was observed that the test of subject knowledge of students can be categorized according to subject needs and its industrial importance. It can be categorized into three parts

1) Importance of Theoretical subject
2) Analytical /Numerical base subject
3) Practical oriented / Industrial oriented subject

The present university pattern is implemented for all subjects and is bound to some parameters. It also found that teachers cannot test the knowledge of students based on their practical skill set. Even though it is helpful for future points of view but still students are not much focusing while performing the practical.

Proposed examination system shown in Figure 3. It can be eliminated in Autonomous colleges by conducting the end-semester exam in such a blended or hybrid pattern. By considering the above parameter. We have been categories the few subjects of civil engineering into the above three parameters

5.3 Categories for Civil engineering subjects:-

Civil Engineering

Theoretical base	**Analytical**	**Practical /Industry**
Engineering Geology	Mathematics	Geotechnical Engineering
Risk Value Management	Theory of Structure	Building Materials and Construction Technology
	Design and Drawing of Steel structure	Transportation Engineering
	Design and Drawing of Reinforced structure	Environmental Engineering
	Strength of Materials	Solid Waste Management

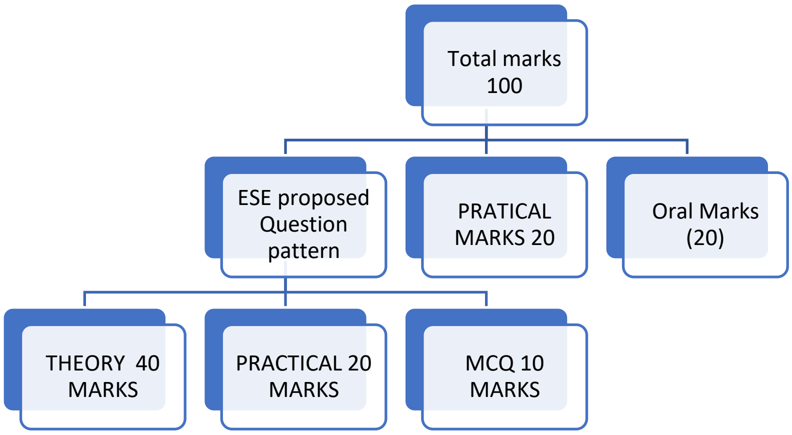


Figure 3: Integrated Question Paper Pattern

5.4 ESE Paper Pattern for Practical and Industrial requirements

Qu No	Pattern of Question	Marks
Qu 1	Objective question	10
Qu 2	Subjective Base question	30
Qu 3	Practical Base question	20
	Total Marks	60

5.5 Sample Question papers of Geotechnical subject:

Practical- Sieve Analysis

Q. A coarse soil sample of 1000gm is passed through different sieves and the observed values of soil retained on each sieve are mentioned in the below Table 1. Based on the observation classify the soil and justify your answer

Sieve Size (mm)	Soil retained (gm)
4.75	466
2.36	218
1.18	160
0.6	80
0.3	30
0.15	18
0.075	08
PAN	20

Table 1:- Sieve size and soil retained

Practical- Liquid Limit

Q. Soil passed from 425 microns is collected and performed for liquid limit using Casagrande apparatus, after performing the test no of blows and water content values are noted which are mentioned below. Draw the flow curve and calculate the flow index.

No of Blows	52	44	38	27	22
Water Content (%)	12	14	16	18	20

Table 2: shows the variation in soil

6. Results and Discussion:

Here, this section of a paper highlights the responses of students on aspects of learning, directly and indirectly of correlating the outcome

6.1 Response of students to the category of questions:

The Figure 4 shows that more number students are inclined to attempt or have correctly solved questions on experiments carried out in the lab. The theoretical questions solved by students are less in number as compared to experiment base questions. It also makes it clear that students would like to attempt questions if they are covered in the laboratory.

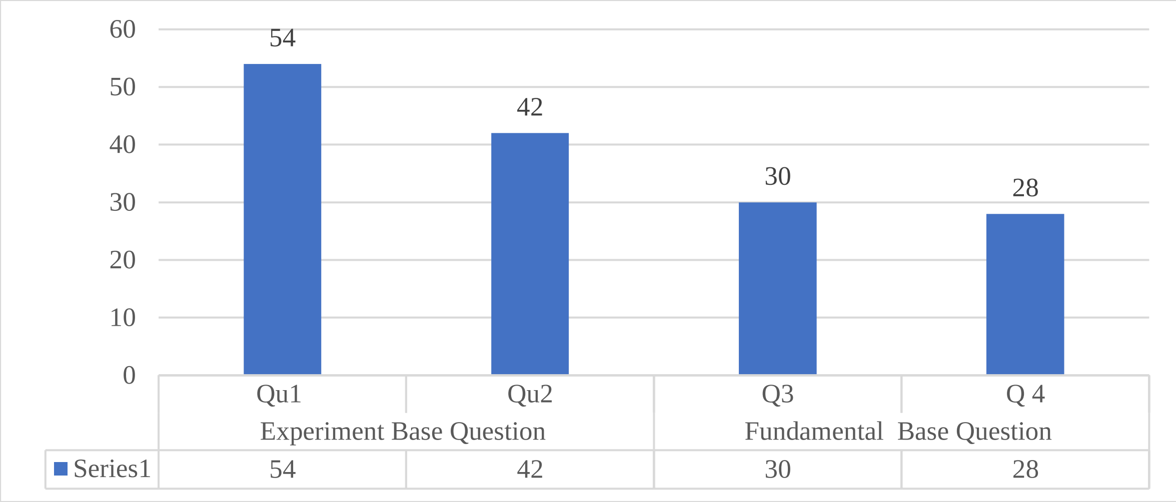


Figure 4: Response of students to the category of question

6.2. Learning Validation and Proposed model

TCET Model of Question paper setting coherence with lab conduct is tested now for almost more than 2 years. The satisfactory performance of the students in the end semester examination is studied and the survey has been pointing towards the same. The lab work and end semester examination were very well addressed as TCET Model and survey carried also validate the same. Responses of students were shown in Figure 5.

The keyword was identified by the faculty in charge before setting up question paper for ESE keeping in mind to test and validate the students' performance with the integration of lab work. The keyword identified are as follows (partial list) :

a. equipment/Tools
b. Lab -Prerequisite
c. Tutorials, discussion questions
d lab conduct/experiments are correlated with curriculum module
e. Conduct and analysis

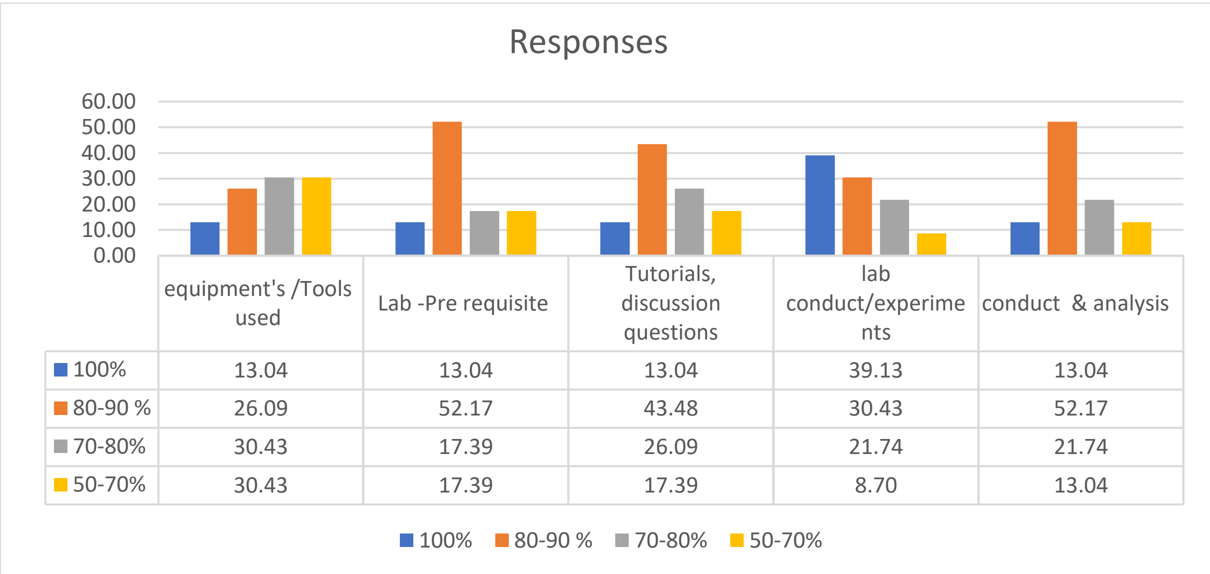


Figure 5: Responses of Students to validate TCET Model

6.3. Impact on ESE results due to integrated practical question in ESE exam: -

I have surveyed 50 students based on classroom teaching. I have floated the question paper as per the above format to those students. The basic aim was to draw the correlation ship between the impact of classroom teaching and hands-on experience while solving the end semester exam. The result shows that 15 % of students have attempted the practical base question and it is also not up to the marks. whereas subjective and objective base questions were attempted by 80 % and 100% students respectively.

After the performance of a practical same set of question papers were circulated among the students. This time it was found that 75 % of students has attempted the practical base question and almost all were given correct answers. Overall results of the subject were improved. On that basis, we concluded that, if we set the syllabus and pattern of question paper based on subject requirements. Students give the importance of practice

6.4. Responses of students to various category question paper settings.

The lab manual and conduct were found to be useful for students in attempting multiple choice questions as well subjective questions. The students found very useful the lab work during ESE in attempting even analytical and design-based questions.

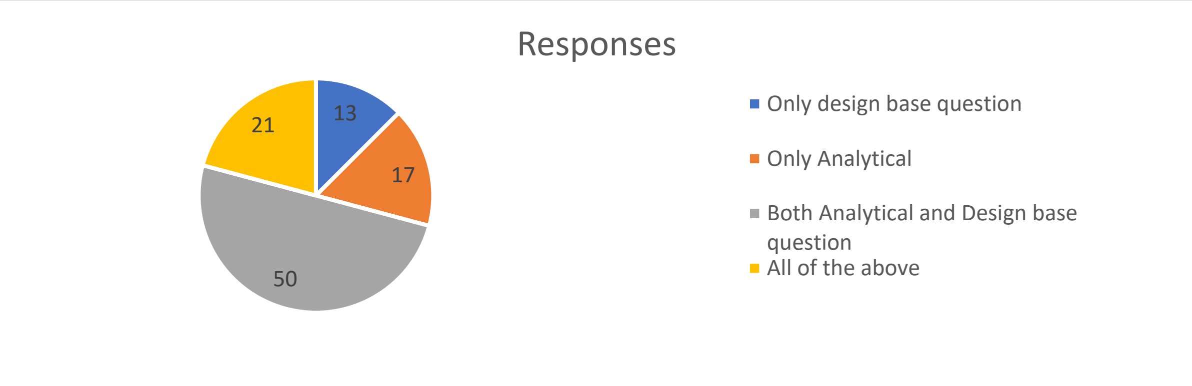


Figure 6: Responses of students to various categories of question paper

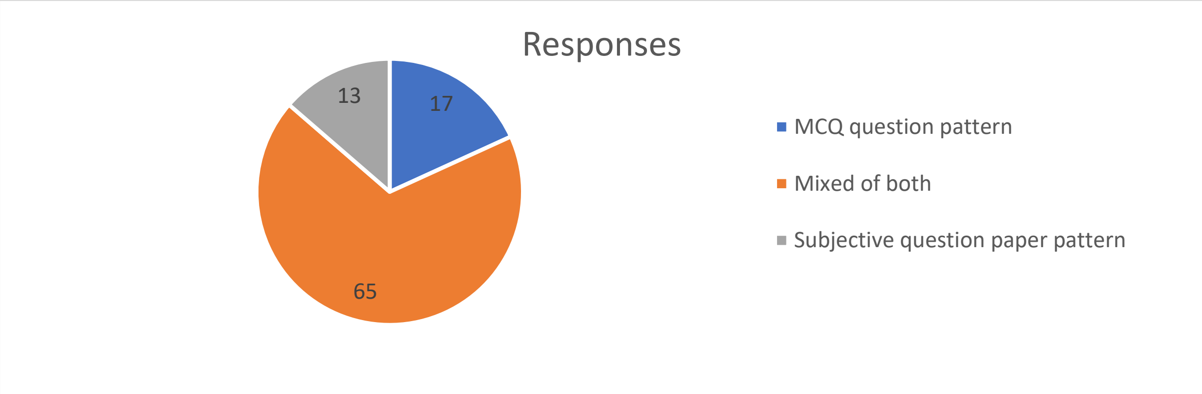


Figure 7 : Responses of students to various category question paper settings.

The Figure 7 shows above validate the TCET model of setting question paper integrated with laboratory work. The TCET Model of lab manual has been useful for end-semester examination. It also found that more than 50 % of responses have stated that the lab prerequisite, conduct, and analysis of experiments has cleared their understanding and helped them to solve ESE

From the graph, it can be concluded that more students agreed that laboratory work help them to attempt both MCQ and Subjective question.

7. Conclusion:-

This research will help learners, academicians to understand the importance of laboratory work and integration with end semester examination . The based on a survey conducted,inputs from various stack holders ,It is imperative on academician to integrate laboratory work with end semester examination . It helps students to strengthen their knowledge and improve the overall academic developments. Further paper conclude the following ,

1. As per the result of the survey 54 % of students have solved the experimental-related question rather than a theory-based question.
2. Paper highlights Integration of laboratory worked with end semester examination paper setting will help to comply RBT level.
3. It found that more than 50 % of responses have stated that the lab prerequisite, conduct, and analysis of experiments has cleared their understanding and helped them to solve ESE.
4. The Paper also highlights the marking scheme should be varied as per the requirements of the subject .

8. Future Scope:-

As per as the examination system is concerned, the model has proved its importance in offline mode as well as in online mode by introducing little changes in the previous system, But still, there is the scope of improvement for reframing the subjective type of question pattern in online mode to avoid the flat evaluation and to achieve the bell shape curve. The model can be made robust by integrating the questions-based RBT level. The module-wise questions and RBT level will help them at the time of examination. The integrating of industrial inputs should be considered by faculty in charges and paper setters to make the proposed model more dynamic .

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