Provoking the Education of Mathematics By Creative Teaching & Active Learning

S.Giri Babu
Asst.Prof
Dadi Institute of Engineering And Technology
(Affiliated to JNTUK), Anakapalle, India

B.Venkat Rao
Asst.Prof
Adtiya Institute of Technology And Management
(Affiliated to JNTUK), Tekkali, India

Abstract:

The influence of the learning environment to power and endorse learning is significant. The learning culture and resources endow with significant opportunities for students to discover new ideas and facts, collaborate, and unravel problems. The successful implementation of the creative teaching techniques requires the use of a variety of resources that enable the student to learn through a rich and varied selection of instructional materials, may be reading books, writing programs, eLearning, game designing and other technological resources with the suitable student learning outcomes. In the implementation of the techniques provide students with an invitation to explore, investigate, learn and collaborate. The learning culture presented in this article provides ample chance for intended student interactions and engagement.

Keyword : Engineering mathematics, Creative Teaching, active Learning techniques, Teaching methodology.

I. INTRODUCTION

Active learning of Engineering Mathematics can occur with the implementation of in a wide variety of thought-stimulating activities, ranging from direct learning to learning by doing and other kinds of problem solving where the learning cannot be defined as either direct or discovery. All of these thought-stimulating activities can produce *active learning,* because educationally productive *mental activity* can occur with or without *physical activity* in which you "do" something — during a wide variety of mentally-active experiences.

The first objective of any act of learning, over and beyond the pleasure it may give, is that it should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more easily –quote by (Jerome Bruner)

Active learning motivates the students to thinking critically, interact with the other peers in a group, present their views orally and through writing, explore hidden talent/skills of their own or of their group, present or receive open analysis of theirs or others presentations and overall reflect upon the learning process. It is vital for the faculty members to present well-crafted and captivating lecture presentation especially time efficient way to cover course content and promote deep and lasting student learning. The proportion of students taking notes in a class is often small. Further, the ubiquitous use PowerPoint slides during presentations has led students to anticipate routinely that they will have ready access to these slides.

In 2002, Steven etal.[1], focused on the transformed method of integrating the different lively learning strategies into a conventional lecture. The explanation of the growth of energetic learning is proposed to highlight the inspiration and incentives necessary for bringing about the transform.

In 2006, Michael etal.[2], presented alternative teaching approaches by using explicit remarks, problems, reviewed different effective teaching learning methods. The author defined each method, presented concepts of interest and disinterest.

In 2010, Charles etal.[3], presented a technique to maintain efficient knowledge gaining and imparting the concepts of engineering mathematics by unfolding a organized way for developing a component, which promotes deeper learning.

Charles etal.[4], in 2011, conformed several standard methods and seek to develop personal, interpersonal and professional skills through an active and interactive learning paradigm. Also discussed the content, pedagogy and efficacy of the module in relation to student motivation, engagement and attainment over a three year period. It is shown that such an approach is successful in this regard.

In 2013, John etal.[5]**,** discussed sufficient number of knowledge gaining methods elaborately. They chose the method which was easy to use and hence could be implemented. Also, learning methods like rereading, etc. was chosen because learners result depend heavily on them.

Marisa and Edmund [6], in 2014, constructed a project and analyzed its usage as a part of latest knowledge gaining process. The proposal was intended to supply vigorous support to 1st B.Tech students. This process provides an atmosphere of accomplishment and possession that allows students of all levels to take pleasure in the knowledge gaining process.

In 2015, Natanael [7] discussed the practice of imparting knowledge of Calculus for the 1st B.Tech students, the knowledge gaining and imparting process is a stabile combination between the teacher and learner. Vasanti and Vinod [8], promoted technical education students in learning engineering mathematics through special modules designed for the purpose. Designed the module by dividing the curriculum into various stages and correspondingly graphical user interfaces were developed. Efforts were made to attract the students as per their interests developing four methods of accessing the modules emphasizing the effective mathematics learning through information technology.

The implementation of different active learning methods and the results are readily available in internet. With necessities, at the first year B.Tech level, in mathematics teaching and learning, a good amount of success is achieved and further more is required for different level of students. The main aim of this article is to develop typical **Creative Teaching & Active Learning techniques** for B.Tech students with regard to Engineering Mathematics. The move towards developing some critical teaching techniques and step to implement them, is based on the experience of the authors in this area.

II. METHODOLOGY

In this article we discuss some of the typical **Creative Teaching & Active Learning techniques** for B.Tech students with regard to Engineering Mathematics. The importance of this article is to develop the following:

i) Active Learning.
ii) Conceptual learning
iii) Self learning.
iv) Communication skills
v) Time management.

To develop the concepts of engineering Mathematics with sufficient basics and problem solving skills, **Creative Teaching & Active Learning techniques was designed** after verifying the standards of students. Then to achieve the course outcomes some of techniques were

implemented based on learning conditions of the first year student. The analysis and benefits of each technique can be easily assessed.

Different activities are presented with suitable examples and pictures:

A. *Activity -I:Rapid Round*

To revise the basic Mathematical formulas, each and every student is made to attempt a set of oral questions normally mathematical formulae posted by the teacher to every student during the 1st 10 minutes in the class daily. This particular technique may help the mentor/teacher in ensuring the knowledge gain of each and every student as in Fig:1, 2, 3. One after the other every student has to answer a series of oral questions without any support of other students. Here the score of a member is credited to his/her account as an individual based on their performance. Thus motivating the students to prepare and present in a better manner.



Fig.1 Fig.2 Fig.3

Fig., 2, 3: shows Student of I B.Tech, DIET College, participating in Rapid round.

B. *Activity –II: Enhancing Basic Knowledge*

In this activity, to enhance the basic Mathematical knowledge, active involvement of each and every student is highlighted by making groups in a class. The group member must be ready for presenting/answering a series of short questions posted by other group members as shown in Fig:4,5.


Fig.4 Fig.5

Fig.4, 5: Students of I B.Tech, DIET College, participating in group activity of Enhance Basic Knowledge.

One after the other every group member has to present/answer a series of questions with the support of other group members. Here the score of a member is credited to the account of the group score, whose score is the score of the entire group and may be the internal marks of their course. Thus inspiring the students to be proactive in preparing and presenting the short questions.

C. *Activity –III: Questions Relay*

An activity is implemented where an answer to a question can be put in the form of 5 blank boxes named as step 1 to 5. Then a member of 1st group has to attempt to answer the requirement in the 1st box, a member from 2nd group has to answer the requirement in the 2nd box after verifying the data in the 1st box. Similarly, a member from 3rd group has to answer the requirement in the 3rd box after verifying the data in the 1st and 2nd box. The score for every correct entry in the provided box can be 5marks and every correction done for the previous entries can be 3 marks. Thus developing the problem solving skill of a student in an interesting way as in Fig. 6, 7.

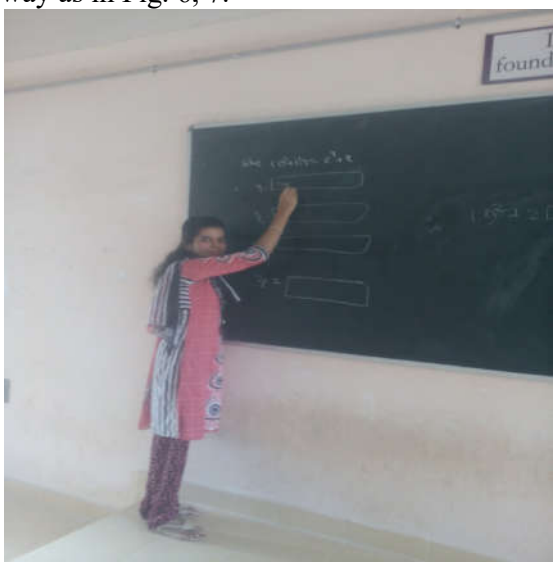

Fig.6

Fig.7

Fig.8

Fig.9

Fig.6, 7, 8, 9: Students of I B.Tech, DIET College, participating in group activity of *Questions Relay*.

D. *Activity –IV: Identification of Suitable answer*

The mentor prepares 4 sets of 4 transitional results on different chart papers for a question which can be solved in 4 steps say. In the class, he sticks the 4 charts on the wall and the question can be presented on the board. A student representing a group has to solve the problem identifying the correct result from one of the 4 sets of transitional results available in the charts. A correct selection of the first step in the first attempt helps a student score 4 marks, in case of wrong selection in the 1st attempt, the student has to perform 2nd, 3rd and 4th attempt with a score of 3, 2, 1 marks respectively. The instructor should have the promptness in identification of the correct options while preparing the 4 charts. This method develops the analysis strategy of a student. This style of problem solving motivates the student for self learning and self confidence as shown in Fig;10, 11.

Fig.10 Students of I B.Tech, DIET College, participating in an active learning process to identify suitable solution from 4 different charts.

Fig.11: 4 sets of charts supporting the students in identifying suitable result.

E. *Activity –V: Rule Framing*

Students generally fail to identify and remember the correct method of solving a problem because of availability of varied number of techniques and of course because of lack of practice. Some times to understand and apply a process of solving by a particular method say solving a

double integral or a triple integral can be a difficult target for a student. To resolve this and support student learning, formula framing can be a creative teaching methodology. Here the rule is explained for "**Evaluation of Double Integrals In Cartesian Form":**

Rule: For a double Integral problem, if the limits are not given and the limits are to be written from the diagram of region of integration, we introduce Aguru's Formula. If we are to integrate w.r.t x axix, then draw lines or strips PQ parallel to x-axis to cover the entire region of integration as shown in the figure: 10 and the new limits can be written using Aguru's formula:

	Lower limit	Upper limit
Limits of x	Equation of the curve where P moves when PQ moves from left to right.	Equation of the curve where Q moves when PQ moves from left to right.
Limits of y	minimum value of y for R	maximum value of y for R.

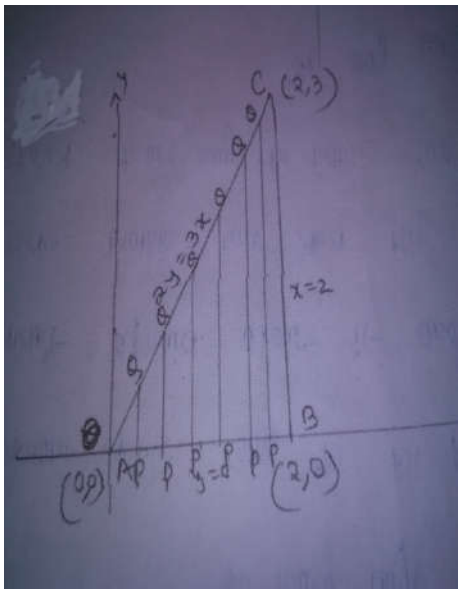

Fig.12

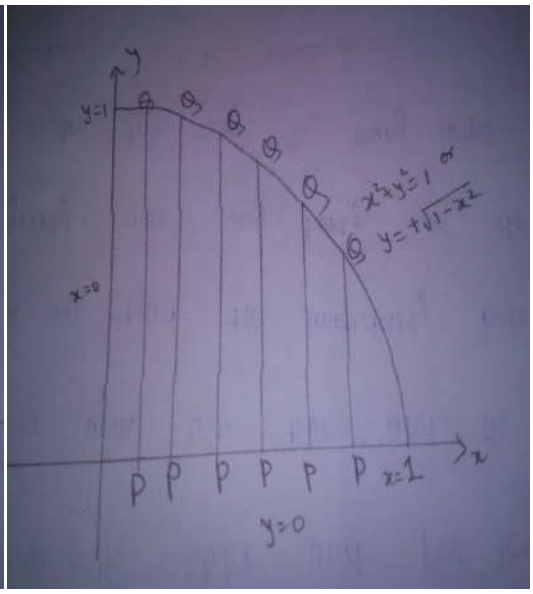

Fig.13

Fig.12,13: lines or strips PQ parallel to X-axis and Y-axis to cover the entire region of integration.

Similarly, the limits can be written for the case of PQ's drawn parallel to y-axis. Some the points to be noted are:-

(i) Integrate w.r.t that variable whose limits are functions of other variable.

(ii) Consider the strip PQ parallel to that axis with which we integrate first.

(iii) If all the four limits of integration are constants, then the double integral can be evaluated in either way i.e., we first integrate with respect to 'x' and then w.r.t.'y' or vice – versa and the region related to this case is a square or a rectangle.

Example-1 If R is the triangular region with vertices (0, 0), (2, 0), (2, 3), evaluate $\iint_R x^2 y^2 \, dxdy$.

Solution: For the triangular region bounded by the vertices A, B, C, we decide to integrate w.r.t. y first then x. So, order of integration: first w.r.t. y then x (take PQ parallel to y-axis) as shown in fig.14.

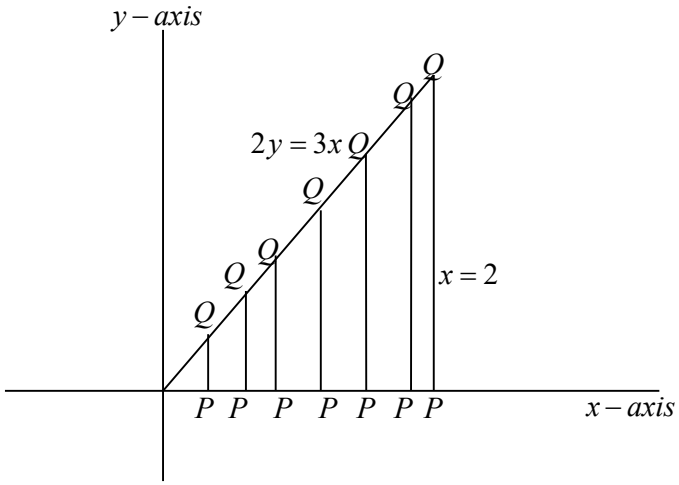

Fig:14

By, Aguru's formula

	Lower limit	Upper limit
Limits of y	y = 0 (Equation of the curve where P moves when PQ moves from left to right).	$y = 3/2\, x.$ (Equation of the curve where Q moves when PQ moves from left to right 2y = 3x).
Limits of x	x = 0 (Minimum value of x for R).	x = 2 (Maximum value of x for R).

[Note: Equation of line AC is $y - 0 = \frac{3-0}{2-0}(x-0) \Rightarrow y = 3/2\, x.$]

Hence, $\iint_R x^2 y^2 dxdy. = \int_0^2 \int_0^{\frac{3x}{2}} x^2 y^2 dydx = 12.$

Fig.15: One of the Author explaining example -1.

Example-2 Evaluate $\iint_R ydxdy$ where R is the region bounded by the parabola's $y^2 = 4ax$ and $x^2 = 4ay$.

Solution: The region of integration is shown is the fig.16. So, order of integration: first w.r.t. y then x (take PQ parallel to y –axis).

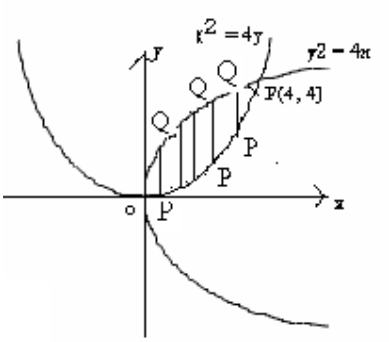

Fig:16

By, Aguru's formula

	Lower limit	Upper limit
Limits of y	$y = \frac{x^2}{4a}$ (Equation of the curve where P moves when PQ moves from left to right).	$y = \sqrt{4ax}$ (Equation of the curve where Q moves when PQ moves from left to right).
Limits of x	x = 0 (Minimum value of x for R).	x = 4a (Maximum value of x for R).

$$\iint_R ydxdy = \int_{x=0}^{4A} \left[\frac{y^2}{2} \right]_{y=\frac{x^2}{4a}}^{\sqrt{4ax}} .dx = \frac{48}{5}a^3$$

Here rule is explained for "**Evaluation of Double Integrals In "Polar Form"**

Example-1: Solve $\iint_R r^3 drd\theta$ over the region R bounded between the circles $r = 2a\sin\theta$ and $r = 2b\sin\theta$, b >a > 0.

Solution: The region R is as shown in the figure, is the region between the two circles $r = 2a\sin\theta$ and $r = 2b\sin\theta$ with centers at (0, a) & (0, b). Consider an element PQ, by drawing radial lines from pole to cut the region of integration R as shown in fig.17.

By, Aguru's formula,

	Lower limit	Upper limit
Limits of r	$r = 2a\sin\theta$ (Equation of the curve where P moves).	$r = 2b\sin\theta$ (Equation of the curve where Q moves).
Limits of θ	$\theta = 0$ (Minimum value of θ for R).	$\theta = \pi$ (Maximum value of θ for R).

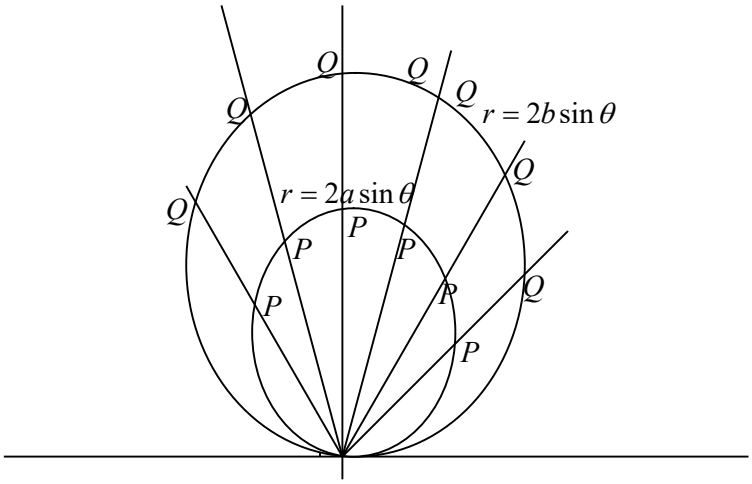

Fig:17

$$\therefore I = \iint_R r^3 dr d\theta = \int_{\theta=0}^{\pi} \int_{r=2a\sin\theta}^{2b\sin\theta} r^3 dr d\theta = \int_{\theta=0}^{\pi} \left(\frac{r^4}{4} \right)_{r=2a\sin\theta}^{2b\sin\theta} .d\theta = \frac{3(b^4 - a^4)\pi}{2}.$$

Here rule is extended **Triple Integrals, as follows:**
By Aguru's formula, the limits of x, y, z are as follows:

	Lower limit	Upper limit
Limits of z	Equation of the surface S where P moves	Equation of the surface S where Q moves

For writing the limits of y and x, the projection of the surface S onto xy plane is considered as region R and the limits are for R is as follows:

	Lower limit	Upper limit
Limits of y	Equation of the curve where P moves	Equation of the curve where Q moves
Limits of x	minimum value of x for R	maximum value of x for R

III. CONCLUSION

The Creative Teaching & Active Learning techniques for engineering Mathematic education were found to be facilitating and provided sufficient support to develop conceptual understanding and constructive learning. The active and interactive learning approach, combined with the entertainment strategy, provided sufficient environment for the development of the individual student.

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