Some Effective Methods for Teaching Mathematics Courses in Technological Universities

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Abstract

This article discusses some effective and useful methods for teaching various mathematics topics to the students of undergraduate and post-graduate degree programmes in technological universities. These teaching methods not only equip the students to acquire knowledge and skills for solving real world problems efficiently, but also these methods enhance the teacher’s ability to demonstrate the mathematical concepts effectively along with suitable physical examples. The exposure to mathematical softwares like MATLAB, SCILAB, MATHEMATICA, etc not only increases the students confidential level to solve variety of typical problems which they come across in their respective disciplines of study, but also it enables them to visualize the surfaces of the functions of several variable. Peer learning, seminar based learning and project based learning are other methods of learning environment to the students which makes the students to learn mathematics by themselves. These are higher level learning methods which enhances the students understanding on the mathematical concepts and it enables them to take up research projects. It is noted that the teaching and learning of mathematics with the support of mathematical softwares is believed to be more effective when compared to the effects of other methods of teaching and learning of mathematics.

Keywords: Methods of teaching and learning mathematics; Role of ICT; Impact of mathematical softwares; MATLAB; Self learning methods.
INTRODUCTION

With the advent of ICT tools such as laptop/desktop computers for teaching via power point presentation, e-learning resources such as moodles, hot potatoes etc and also the various mathematical softwares such as MATLAB, SAGEMATH, SCILAB, MATHEMATICA, MAPLE, MATHCAD etc, the teaching and learning activities in mathematics courses have become more effective in technological institutions[1-3]. The introduction of these tools and softwares in the teaching of mathematics enables the students to understand mathematical concepts very clearly [4]. The effective use of these methods, tools and softwares not only achieved a milestone in terms of students performance in mathematics courses, but also it reflects its impact in greater performance in the higher semester branch core subjects [5]. It is evident that the use ICT tools and mathematical softwares change the lecturers’ strategy towards their profession by making them to be more communicative and interactive with students [6]. The various types of ICT tools used in teaching of mathematics and their role in making the teaching and learning activity to be more effective are described section 2. The details on how various mathematical softwares are used for effective teaching and learning of mathematics are discussed in section 3. Section 4 points out effectiveness peer and self leaning methods of teaching and learning mathematics which are mostly applied at post-graduate level. Section 5 summarizes the teaching and learning methods that are presented in this paper and also it highlights the advantageous of using mathematical softwares in teaching and learning of mathematics over the other methods of teaching and learning of mathematics.

ROLE OF ICT IN MATHEMATICS TEACHING AND LEARNING

Computer systems are the basis and essential components of ICT which has grown significantly to exhibit a tremendous success in academic teaching, research and in continuing education. It is well accepted that the use of computer system (preferably laptop) has become essential for the effective classroom teaching, since the power point presentation for explaining many mathematical concepts through different types of pictures/graphs/flow charts makes the subject understanding as easier and clear. To provide the course material to the students as handouts, a computer system with basic office tools is essentially required to every lecturer. The lecturer is expected to be familiar with the use of these basic office tools. Apart from the use of computer by lecturers for teaching, students are also expected to be familiar with the use of basic office tools of computers, as many coursework evaluations are conducted through the use of computers that are connected in a lab either through LAND or they have internet access.

With the advancement of software industry, many user friendly softwares are now available in leading universities for conducting assessment in online. Hot potatoes is one of such software systems which is widely used in several universities to conduct online tests, assignments and quizzes. These kinds of softwares make the conduct of the assessments as an easy and highly secured task for the lecturer. The assessment can be conducted to students in many batches, as different question papers are
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automatically generated for each batch from a large source of question bank, in fact students of same batch get different question papers which prevents any malpractice by students during the assessment time. Though there are some practical difficulties for the lecturers on the usage of the softwares (need training) and preparing the question bank with answers and uploading them in the software, the students assessment evaluation is done by the software instantly and made known to the students on the spot which not only saves the waiting time of the students to know their test performance, but also it reduces the evaluation workload of the instructor significantly.

Moodles is an e-learning software which can be browsed through intranet or internet with valid authentication. It serves as a platform to the faculty members for posting the syllabus, lesson plan, lecture notes, reference books, tutorial, question banks and assignment questions and notices to students. It is a dedicated e-resource centre for the students to download the aforementioned resources that are provided by the course instructor. Since this can be browsed online, students have the flexibility to browse and download the available e-resources anywhere and anytime. The lecturers can edit the resource files to make any updates or corrections in the files and then they can replace the existing files by the newly updated files. This facility gives much flexibility to the course instructor to introduce novel concepts and methods whenever they acquire during the course material preparation.

IMPACT OF MATHEMATICAL SOFTWARES IN TEACHING AND LEARNING

Although many ICT tools are considerably used in the mathematics teaching and learning process, the role of the mathematical softwares such as MATLAB, MATHCAD, SCILAB, SAGEMATH, MATHEMATICA etc is significant not only in the conceptual understanding of many mathematical topics, but also in the geometrical understanding through the visualization. In several reputed higher learning technological institutions, mathematical topics such as Linear Algebra, Trigonometry, Matrices, Analytical Geometry, Differential Calculus, Integral Calculus, Ordinary Differential Equations, Partial Differential Equations, Vector Calculus, Numerical Methods, Operations Research etc are thought with the support of the aforementioned softwares through classroom and lab sessions. The usage of these softwares in the teaching of mathematics not only motivates the students to perceive the subject easily, but also it enhances the students’ depth of learning the mathematical concepts/logics, like continuity of a function at a point, differentiability of a function at a point, directional derivative of vector point functions etc.

It is well accepted that MATLAB is one of the powerful and user friendly software which is not only widely used for learning of mathematics, but also it is effectively used in various branches of science, engineering and technology for problem solving, since it has tool boxes to almost every field of basic and advanced level research studies. To emphasize the effectively use of MATLAB in the understanding of
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mathematical concepts, a sample MATLAB programme code is given below:
clear all
clc
syms x y
z = input('Enter the two dimensional function f(x,y): ');
x1 = input('enter the x value at which the derivative has to be evaluated: ');
y1 = input('enter the y value at which the derivative has to be evaluated: ');
z1 = subs(subs(z,x,x1),y,y1)
ezsurf(z,[x1-2 x1+2])
f1 = diff(z,x)
slopex = subs(subs(f1,x,x1),y,y1);
[x2,z2]=meshgrid(x1-2:.25:x1+2,0:0.5:10);
y2=y1*ones(size(x2));
hold on
h1=surf(x2,y2,z2);
set(h1,'FaceColor',[0.7,0.7,0.7],'EdgeColor','none')
t=linspace(-1,1);
x3=x1+t;
y3=y1*ones(size(t));
z3=z1+slopex*t;
line(x3,y3,z3,'color','yellow','linewidth',2)

For a given function of two variables, this MATLAB programme perform the following tasks:
1. Plots the surface of the given function in three dimensional region of space.
2. Computes partial derivative with respect to x.
3. Plots the partial derivative as the tangent plane passing through the surface at a given point.
4. Plot the tangent line to the surface at a point given point.

For example, the function \( z = x^2 + y^2 \) is considered here to understand how the above MATLAB programme works. The point of interest here is \((1,1,2)\). We have given below the input that we feed in the MATLAB command window after evaluating the programme code in the editor window and the output generated by the MATLAB programme code is also given below:

**Input**
Enter the two dimensional function f(x,y): x^2+y^2
enter the x value at which the derivative has to be evaluated: 1
enter the y value at which the derivative has to be evaluated: 1

**Output**
z1 = 2
f1 = 2*x
We have given below the three dimensional graph generated by MATLAB which is rotated to exhibit the different views of the graph.

**Figure 1(a)**

**Figure 1(b)**
Figure 1: Different views of the function $z = x^2 + y^2$ and its partial derivative as tangent plane and tangent line at the point $(1,1,2)$. 
Through the above example, students can understand easily the three dimensional
gometry of the function $z = x^2 + y^2$, the partial derivative of $z = x^2 + y^2$ with
respect to $x$ as the tangent plane to the surface at $x = 1$ and partial derivative of
$z = x^2 + y^2$ with respect to $x$ as the tangent line to the surface at $x = 1$ and $y = 1$. The
drawing of the surface, tangent plane and tangent line manually is not an easy task for
even to any experienced teacher, but it is instantly plotted by MATLAB which makes
the students to understand easily about geometry of the surface of the function of two
variables, the geometrical meaning of partial derivative as the tangent plane and
tangent line. It is well established that the MATLAB and the other aforesaid
mathematical softwares can be used to explain/demonstrate many mathematical
concepts as shown in the above example for the easy understanding of mathematical
concepts by students.

EFFECTIVENESS OF SELF AND PEER LEARNING METHODS
Apart from the methods of teaching and learning discussed so far, there exists some
more effective methods for learning mathematics, some of them are (i) peer leaning,
(iii) seminar based leaning and (iii) project based learning.
Peer leaning is an easy leaning opportunity to students to get clarification to their
doubts from a small group of their classmates or friends. This method of learning is
very effective as the students do not feel shy to ask their doubts even at the very basic
level as they are just asking their doubts mostly to their friends. The clarifications got
from the friends are easily understandable to the students at their level. Seminar based
leaning is another opportunity to the students to learn on a particular topic in depth
by themselves and get clarification to their doubts during the seminar presentation and
discussion time.

Project based learning is a self learning method, usually under the guidance of a
lecturer, particularly on a recent development in a hot topic. The instructor guides the
students on how to perceive the project problem and how to get innovative ideas to do
the research project. After getting a good exposure to the topic of research and
making significant progress on the project problem, the students are required to
submit a comprehensive report on the progress made. This kind of learning is
considered as a higher level of learning by students in the discovery year of their
degree programme. This project based leaning method gives a vision to the students to
decide on their further studies or career.

CONCLUSION
In this article, some methods of teaching and learning of mathematics in higher level
technological institutions are discussed. The methods discussed are classified under
three categories, such as (i) role of ICT in teaching and learning of mathematics, (ii)
impact of mathematical softwares in teaching and learning and (iii) effectiveness of
self and peer learning methods. Though each method of teaching and learning of
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mathematics has its own advantageous and some practical difficulties to overcome, role of ICT makes the learning of any subject to be much easier. But, the mathematical softwares discussed in this study makes the learning of mathematical concepts to be effective, interactive, deeper and interesting and they pave the way for applying them to execute many research projects at post-graduate level. Hence, it may be concluded that the use of mathematical softwares is more powerful in making the students to understand the mathematical concepts or logics compared to the other methods of teaching and learning discussed in this study.

REFERENCES