Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210

IMPLEMENTATION AND STUDY ON INNOVATIVE NEW TEACHING METHODS TO ENHANCE LEARNING OF MECHANICAL PRINCIPLES MODULE AT UNDERGRADUATE LEVEL

Dinesh Keloth Kaithari[1], Abubacker K.M.[2], Suresh Babu V[3]
[1,2,3] Caledonian College of Engineering, Department of Mechanical and Industrial Engineering, Seeb, Muscat, Sultanate of Oman.
Email: dineshkk36@yahoo.co.in

Article History: Received on 17th August, Revised on 20th October, Published on 25th October 2017

ABSTRACT

This paper is an outcome of the motivation and need to address wide spectrum of teaching and learning styles that are recognized by the students. It is the order of the day that the student's are encouraged in self-learning, engaged learning, peer to peer learning etc., for providing better exposure and ambience for easy understanding of the basic concepts. In this context, Mechanical Principles module that is taught at undergraduate level at the Department of Mechanical engineering at Caledonian College of Engineering, Oman is considered for implementing new teaching tools. This is a core module in mechanical engineering where the teaching involves a large group of students which require addressing pedagogical teaching and resource challenges. Various strategies are developed in order to enhance the teaching and learning experience of students such as change in layout of their seating arrangements inside the class room, use of soft tools for wider learning, open ended lab to improve the practical skills, use of CCE learn for online access of course documents, online quizzes for more interactive learning as well as access for students to video lectures & EBrary sources in addition to the traditional teaching. Survey conducted towards the level of satisfaction of students indicates that a majority of students appreciate different teaching and learning methods other than the traditional ones. The present work that is carried out for Mechanical principles module can be extended to other related modules. Definitely any useful teaching learning tools used in addition to the conventional methods of teaching creates attention to student community and enhances their theoretical and practical exposure.

Keywords: *Innovative; Mechanical Principles; e Learning; Open ended lab*

INTRODUCTION

The Mechanical Principles course is with 20 Credits having 4 hours of lecture session and two hours of laboratory. In these course students from other engineering programs in addition to various streams of mechanical engineering are also admitted and a typical class size is around 50. Author has experience in teaching mechanics module for level 1 student in various countries that include multi linguistic and multicultural societies such as Ethiopia, Libya, India and Oman. Engineering mechanics is divided into Statics and Dynamics and taught as two separate modules in Ethiopia, India and Libya whereas in Oman both statics and Dynamics as well as part of mechanics of solids is taught as one module by name 'Mechanical principles'. One common aspect irrespective of the country and nature of the students is that the student find difficulty in realizing the basic concepts of the module as well as to establish a correlation between what taught in the class and what available in real life applications. This results in more failure rate in this particular module irrespective of the background of the students. Students without proper learning the contents of the module are unable to retain their knowledge gained with respect to time that result in failure to learn advanced related modules in the future. Integrating the ideal concepts with the real practical situations is very important to motivate the student towards learning the contents of the module.

LITERATURE REVIEW

Common problems faced by the students (Karim, 2011) in learning modules such as statics, mechanics of solids and properties of materials to understand the basics of these subjects is discussed and introduced innovative teaching methods and strategies for better understanding of the concepts to the students. Demonstration models were prepared and presented to students for better grasping of the ideas. Handout with less description and more blank spaces where students can write on the diagrams was found to be more effective. Some practice problems were taken in and around the class for better understanding of the topic.

Computer aided instruction package (Saravana kumar, 2008) was developed using Matlab software. This provided an interactive help between students and staff where student staff ratio is high. In addition to interactively solve the problems with students, theory topics learned in the classroom can be reinforced. Computer aided instruction package is prepared for the Engineering statics subject that cover varieties of topics such as shear force and bending moment diagrams, trusses, equilibrium of rigid bodies, friction, virtual work and moment of inertia of areas and masses.

Reflective learning for core courses in mechanical engineering to improve met cognitive skills (Srikantha Phani, 2012) of the student can make the student life - long learning. Sample questionnaire was prepared for both lecture and coursework

Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210

where the student can make a decision on his/her own learning style. Online survey tools such as Felder – Solomon's ILS and Myers – Brigg's MBTI was used.

Engineering subject centre report (Robinson et al., 2005) studied the response of change in the teaching learning of mechanics in schools in England. Mechanics was a part of A- level mathematics traditionally. Some schools were unable to include mechanics modules in A- level mathematics whereas others advise students to study statistics in order to obtain a higher grade. Report contains the information about monitoring changes in A-level mathematics, awareness among academics about the prior knowledge of mechanics of their students and the assumption of academics with respect to their student's knowledge in mechanics while they teach this subject.

Each assignment shapes the learning (Maryellen weimer, 2015) that results. Many options such as blogs, posts, journals etc. were discussed. Each assignment has its own characteristic that results in different learning outcome. The learning outcomes associated with private journals and public blogs were compared. The blog posts were read by the classmates and the journal entries were read by the instructors.

Most of the students are either unaware (Maryellen weimer, 2015) or misunderstood what really plagiarism is. Plagiarism is nothing but cheating which is an addictive behavior that does not stop with one assignment or one course and it can continue after graduation also. Preventing cheating and promoting academic integrity can be done by the following ways 1. Teachers can do thing that promote academic integrity such as returning of course works after finishing corrections as promised, email queries are answered within a specified time period and office hours for consultation with students are posted 2. Make students to discover about academic integrity by discovering themselves through an activity.

Learning fundamental concepts (Julie Schrock, 2015) to answer essential questions are very important for a student undergoing any course. The students should be able critical think so that they can connect the fundamental concept learned in their course with other courses as well as their future professional lives. Students should be able to use fundamental concepts of a course to reason essential questions of the course. The essential questions are the one that provoke deep thought which inquire into the core content of the course. The essential questions require students to consider alternatives and justify their answers. Through essential questions students can make connections with what they have learnt and their personal experiences.

METHODOLOGY

Learning Outcomes

Different innovative methods have been adopted for teaching learning practices in Caledonian college of engineering, Oman for core modules at level 1 such as mechanical Principles and engineering mechanics. Following details will lead to the author towards those practices that are introduced and proven to improve the effectiveness of teaching learning for these modules.

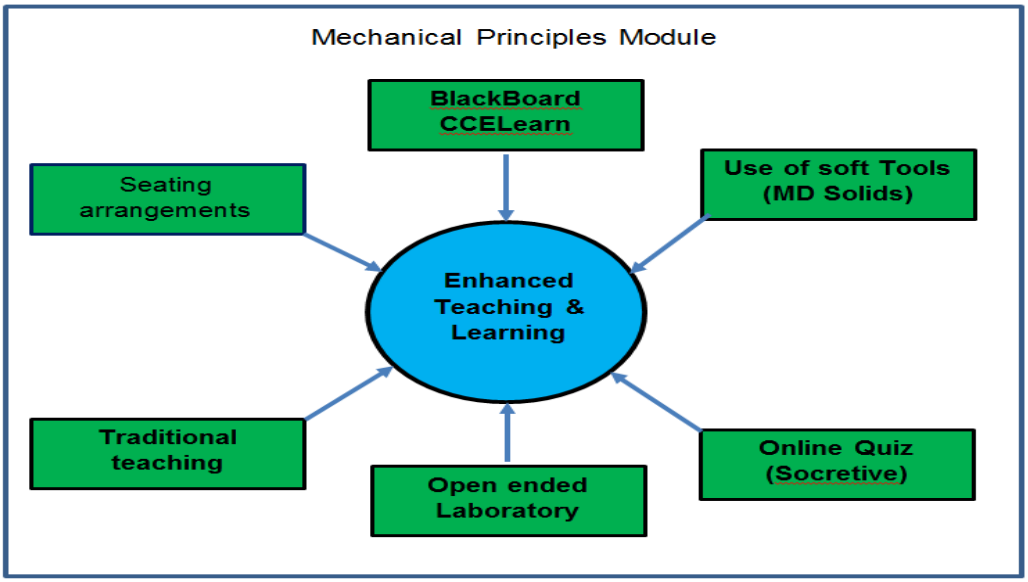


Figure 1 Different strategies adopted

Layout of classroom

Traditional practice followed for student sitting posture is line by line from front to back facing the teacher. Main disadvantage of this seating arrangement is lower interaction among teacher and students as well as amongst the students themselves. From this year onwards, student seating layout is modified in which students are allowed to sit in groups that comprises of 8 students belong to each group. After demonstration of a topic, students are given group task in the form of a tutorial that enables each group of students to have a group discussion to achieve towards the solution. Interaction amongst the students got improved as a result of this. Moreover teacher goes around each table and closely monitors the student activities. This is found to improve the student teacher interaction also. This type of seating arrangement has the advantage of close interaction between weak students and the teacher.

EBrary and video lectures

College has introduced EBrary resources of different authors for these fundamental core courses and the links to these sources are provided in the module handbook. This helped the students to go through additional learning materials apart from what is provided in the class room teaching. Ebrary sources are carefully selected so that the student can get the required information easily with the contents explained in simple English so that the ideas can be grasped easily. In addition to this video capturing of the topics are done with the IT support and inbuilt infrastructure of the college. These video lectures will be made available in college portal so that each student can separately access and watch those video lectures. Video lectures will be extremely useful to the category of special part time students. This category of students do work in companies often far away from college and attend the college intermittently by managing their job and classes here in our college.

E-learning week

Fifth week of a semester is set apart for extra learning in which student is given an introduction to the MD SOLIDS software to have a hands on experience. Students are given practice problems in the area for construction of shear force and bending moment diagrams instantaneously as per the nature and magnitude of forces as well as the type of beams. This will help the student to visually observe how change in parameters such as the load applied, location of the load, length of the beam etc. effect the shear force and bending moment diagram. Such practices can be extended to other topics as well. MDSOLIDS software is chosen as training aid as mechanical principles module is the core module which is a pre requisite for the advanced design modules. Online quiz on variety of topics are also available for the students to practice. In addition to this, online quiz can be conducted through the CCE learn software. There is a good level of responses from the students with a positive feedback.

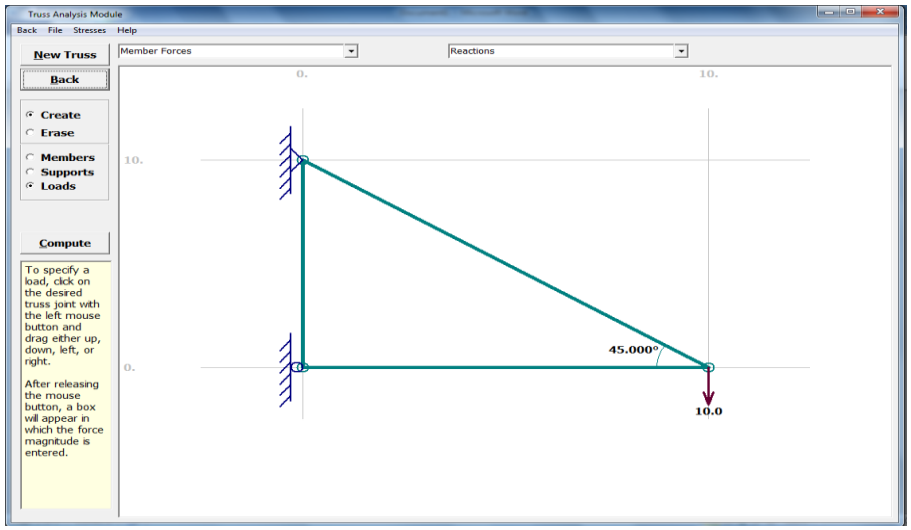
Integration between theory and practical

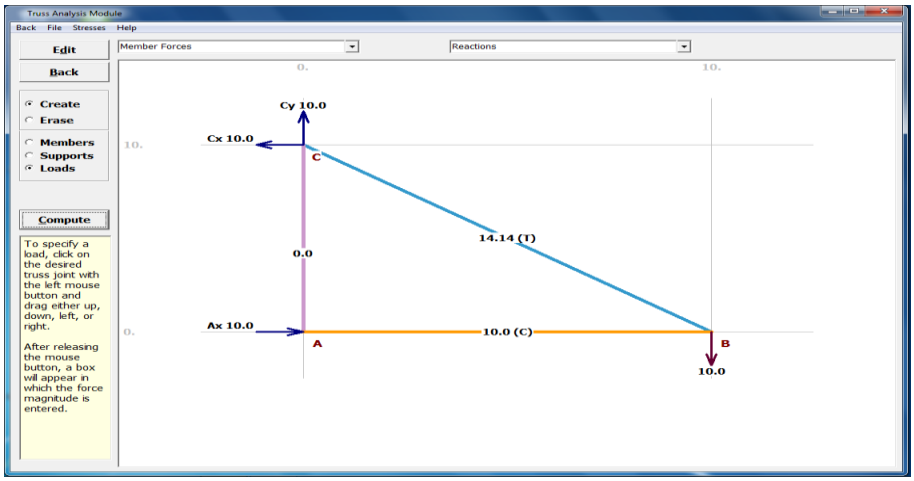
One of the coursework designed for the mechanical principles module is the lab work in which students get hands on experience where the basic theory learned is verified through experiments. This practice integrates theory learned in the classroom with the real practical application. Students are given feedback at the end of each experiment that enables them to identify mistakes and do corrective measures.

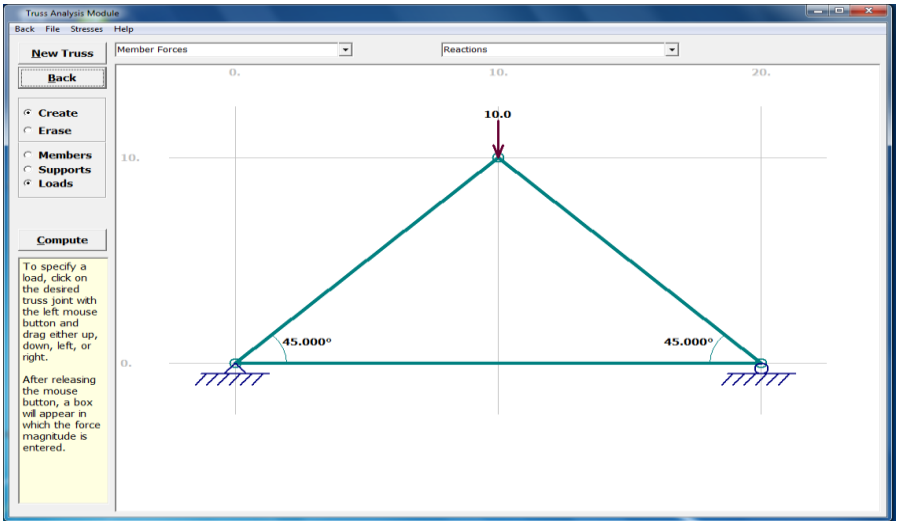
Open ended lab

At the end of regular experiments, an open ended lab is introduced where the students can decide experiment by themselves instead of following a set of guidelines prescribed in the manual. Students have to develop aim, theory behind the experiment, procedure and result supported with their own conclusions. This activity forces student to have a deeper thinking for themselves and work hard to achieve their goals.

Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210







Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210

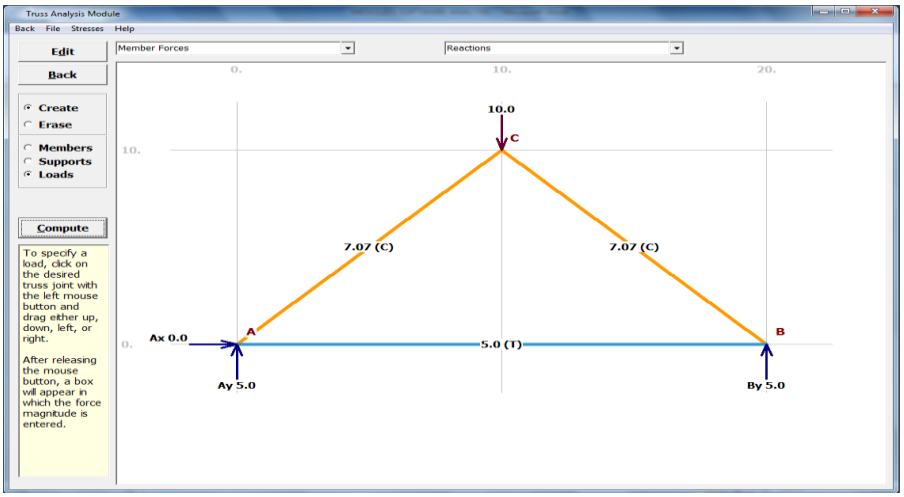
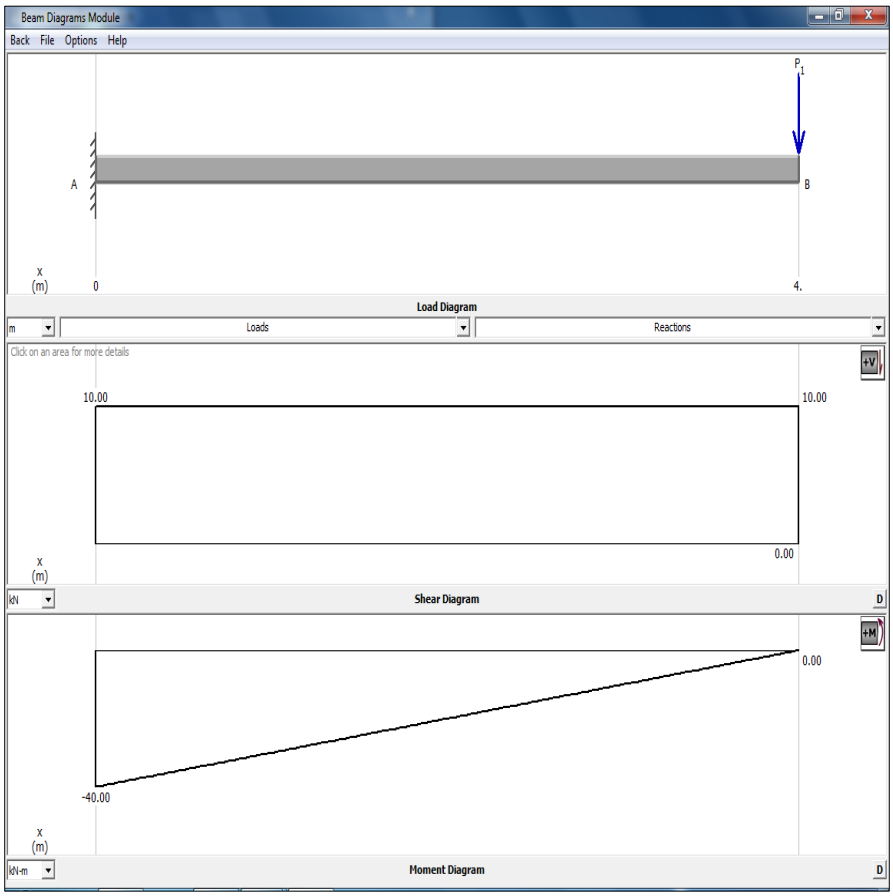


Figure 2 Practice problem on truss



Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210

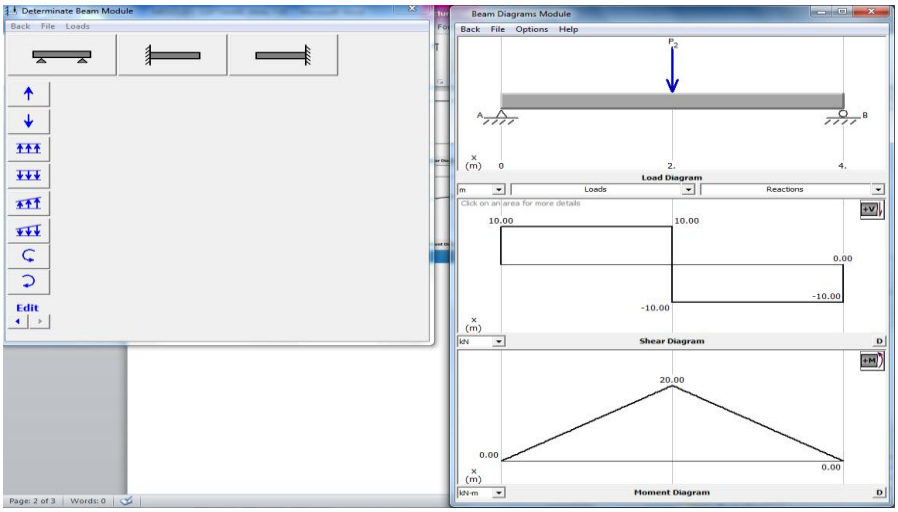


Figure3 Practice Problem on shear force and bending moment diagram

RESULTS AND DISCUSSION

Modification of class room layout has improved more student staff interaction and gave students an opportunity to have a group discussion for better understanding of the topic covered in the class room. EBrary sources helped the students to have a wider reading on the topic to broaden their knowledge. Additional teaching and assessment tools are used in the e learning week such as MD SOLIDS software for learning and students feel they had hand on experience on additional tools employed. Open ended lab made the students to gain knowledge in designing an experiment, conducting it and come out with the required results. Students came out with important conclusions derived from their experiment.

Student survey was conducted amongst three different programmes namely Electronics, Electrical power, Computer aided mechanical engineering, Mechatronics and process operation and maintenance to get their feedback on the innovative practices followed. Details of the questionnaire are shown in table 1.

Table 1: Survey on eLearning activities for level 1 Engineering Students

Who study Mechanical Principles (M1H321458) module

Mechanical and Industrial engineering Department, Caledonian College of Engineering

Name of the student:	Student number:
Program:	Signature of the student:

When completing this survey, please use the following scale:

1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree

Class room seating arrangement useful for performing group tasks	1	2	3	4	5
Comments:					
MD SOLIDS software helped in additional learning	1	2	3	4	5
Com Comments:					
Online quiz helped to test the knowledge learned inside the classroom	1	2	3	4	5
Comments:					
Open ended lab helped in improving skill to write lab report independently without the support of lab manual	1	2	3	4	5
Comments:					
Video lecture helped to improve the skill to learn a new topic by watching video lectures	1	2	3	4	5
Comments:					

Humanities & Social Science Reviews
eISSN: 2395-6518, 5 (2), 2017, pp 141-148
https://doi.org/10.18510/hssr.2017.5210

Table 2 Outcome of the student satisfaction survey

1- Strongly Disagree 2- Disagree 3-Neither Agree nor Disagree 4- Agree 5- Strongly Agree

MECHANICAL PRINCIPLES MODULE - TEACHING AND LEARNING ENHANCEMENT					
Attributes Considered	1	2	3	4	5
Class room seating arrangement	1	7	19	18	18
Enhanced learning through soft tools MD Solids	2	4	7	20	30
Online quiz to asses level of understanding	3	4	12	17	27
Open ended lab to write lab report independently	4	6	11	24	18
Video based learning	6	4	7	25	21

The outcome of the student satisfaction survey is presented in Table 2 with the attributes considered and the response of the students against each one of them that ranges from strong disagreement (point 1) to strong agreement (point 5).

It is clearly evident from the above table that for each attribute positive response is more than the negative one that strongly indicates the acceptance of innovative methods by the students of level 1 that spreads across different programmes such as Electrical power & Electronics engineering as well as various modes of study such as Full time, part time and Special part time categories. The total marks awarded is 100 out of which 50% is awarded for coursework and the remaining 50% is awarded for the final examination.The coursework comprises of three components namely midterm test, assignment and the lab report.

The midterm examination is conducted at the 7^{th} week after commencement of the semester which is a closed book examination. The midterm examination carries 10% weightage. The assignment that carries 20% weightage comprises task to be completed by students individually at the end of the 5^{th} week. The lab report comprises the total marks for the report of 8 experiments that carries a weightage of 20% which has to be submitted at the end of 10^{th} week.

The final examination is a closed book examination of 2 hours duration in which questions are asked from all the topics covered during the semester. For the current semster the regular students are belonging to Electronic engineering as well as Electric power engineering. The performance of these students in two consecutive years are presented in Table 3 below. It is evident from the table that the pass percentage in this module is high irrespective of the program of study. Table 4 presents the results of Computer aided mechanical engineering, Mechatronics as well Process operation and maintenance students for two consecutive years.

Table 3 Comparison of pass percentage of students in mechanical principles module (Semester B 2014 and Semester B 2015) belonging to the same programs

Program	Pass percentage of students for Sem B of 2014	Pass percentage of students for Sem B of 2015
Electronic engineering	85	86
Electrical power engineering	82	84

Table 4 Comparison of pass percentage of students in mechanical principles module (Semester A 2015 and Semester A 2016) belonging to the same programs

Program	Pass percentage of students for Sem A of 2015	Pass percentage of students for Sem A of 2016
Computer aided mechanical engineering	78	73
Mechatronics	71	61
Process operation and maintenance	69	80

It is clearly evident that there is a positive trend in the pass percentage of students for Electronic engineering, Electrical power engineering and process operation and maintanence programs compared to the last year.There is a decline in pass percentage for computer aided mechanical engineering and mechatronics engineering programs as the result also depends on the nature of the cohorts involved.

CONCLUSIONS

Innovative methods adopted for teaching and learning of this core module has improved the student staff interaction, provides additional tools for learning the contents of the module motivate the students for initiating designing of their own experiments and also got introduced to new software which they can use in advanced future design modules. The student satisfaction survey supports the e-learning activities with a high pass percentage of students in both the coursework and final exams belonging to the various programs as evident from the tables 3 and 4 above. The e-learning activities in addition to the class room teaching has broadened the learning spectrum of the students. The additional e learning tools can be brought in for the future for the enhanced learning.

REFERENCES

1. Karim, R., 2011. Teaching and learning of fundamentals of mechanics in an innovative way to maximize student's understanding, 2nd WIETE Annual Conference on Engineering and Technology Education. Pattaya, Thailand, 25-28 January 2011. pp. 29-34.
2. Saravana Kumar, G., 2008.*Computer aided instruction package on computer problems for engineering mechanics*, Department of Mechanical Engineering, Indian institute of Technology, Guwahati, India.
3. Srikantha Phani, A., 2012. Reflective learning in a large core course in mechanical engineering. Department of mechanical engineering, The University of British Columbia, Vancouver, Canada. pp.1-14.
4. Carol L. Robinson, Martin C.Harrison and Stephen Lee, 2005, Responding to the changes in the Teaching and Learning of Mechanics in Schools. Engineering Subject Centre Report. Loughborough university: The Higher Education Academy.
5. Maryellen Weimer, 2015. How Assignment Design Shapes Student Learning. [online] 8th April 2015. Available from: http://www.facultyfocus.com/articles/teaching-professor-blog/how-assignment-design-shapes-student-learning/#sthash.hTA89QOh.dpuf [Accessed9th July 2015].
6. Maryellen Weimer, 2015. Promoting Academic Integrity: Are We Doing Enough. [online] 22nd April 2015. Available from: http://www.facultyfocus.com/articles/teaching-professor-blog/promoting-academic-integrity-are-we-doing-enough/ [Accessed 8th July 2015].
7. Julie Schrock, 2015. Using Fundamental Concepts and Essential Questions to Promote Critical Thinking. [online] 12th January 2015. Available from: http://www.facultyfocus.com/articles/instructional-design/using-fundamental-concepts-essential-questions-promote-critical-thinking/[Accessed 9th July 2015].

