Educating IT-Engineering Theory Courses using BLOOMS Taxonomy (TC-BT) as a Tool and Practical Courses using Magic of Making Mistakes (PC-MoMM): An Innovative Pedagogy.

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Abstract: This paper expounds a novel pedagogical approach used to teach engineering theory courses by using BLOOMS TAXONOMY (TC-BT) as a tool and practical courses using Magic of Making Mistakes (PC-MoMM) in Information Technology programme. The instructions and activities for the theory course being taught are planned in accordance with the cognitive levels of complexity. For each unit being taught, assessment methods are planned to check whether the cognitive levels of BLOOMS Taxonomy are attained or not. The practical course is planned using MoMM pedagogical approach which also integrates collaborative learning activities and peer-to-peer assistance during the laboratory slots. During the implementation of this approach Information and Communication Technology (ICT) tools are used to evaluate students' performance to obtain immediate feedback. Based on the results and feedback, appropriate measures are taken to enhance the learning of students. The results are analyzed and had shown great improvements in the learning of the students. The MoMM approach seemed to be very effective for the programming courses. Designing instructions and assessment as per cognitive levels also directed faculty in the course improvement.

Keywords: Blooms Taxonomy, Pedagogy, ICT.

1. Introduction

Engineering education globally has shifted towards Outcomes Based Education (OBE) paradigm. Kasegaon Education Society's Rajarambapu Institute of Technology (RIT) was established in 1983 in an elfin village Sakharale and was awarded academic and administrative autonomy in 2011-12. RIT is exploring the wings of academic autonomy in the design of curriculum, instruction and evaluation and assessment methods for the courses offered: by considerably incorporating new educational settings with a goal to improve the cognitive ability of students.

Educators have their own pedagogy while delivering education. The common objective of any educator or pedagogy is to give systematic instructions that provides skills and knowledge to the students which can be exhibited to accomplish their jobs. In traditional education systems the pedagogy is Teacher-Centered: where teacher is the only source of information and Teacher-Dominated: where only teacher speaks and students listen. This system neither could help the community to effectively demonstration or apply the learning nor formulated and used any method to measure the outcomes. An outcome is a ending demonstration of learning. The failures of the traditional education system resulted in the paradigm...
shift towards Outcome Based Education (OBE). OBE is a process that involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of high order learning and mastery rather than the accumulation of course credits (Tucker, 2004).

BLOOMS TAXONOMY the well-known model that classifies the forms and levels of learning was created in 1956 by psychologist Dr. Benjamin Bloom to promote higher forms of thinking in education. According to ABET, Bloom's Taxonomy is a multi-tiered model of classifying thinking according to six cognitive levels of complexity. A framework that characterizes complexity and higher-order thinking. Educators use Bloom's taxonomy to guide the development of assessments and evaluations of student learning and instructional methods such as questioning strategies.

This paper discusses a novel engineering instructional pedagogy that is devised and practiced for the course "In-ternetworking Protocols" which is in the curriculum of pre final year students of IT department at RIT. The following sections are reserved for discussing: related work done in design and adoption of pedagogy in to disciplines in second section, motivation behind this work in third section, PC-BT pedagogy used for theory course in fourth section and PC-MoMM pedagogy used for practical course in fifth section and conclusion & future work in sixth section.

2. Related Work

This section discusses the research work done by educators on different pedagogical approaches.

In [1], the authors have identified the Key concepts of differentiated instruction like: qualitative & Quantitative work, assessment to determine the needs of individuals, student centered learning and a blend of whole-class, group and individual instruction. Identified the key concepts, they designed a pedagogy that includes the differentiated instructions through active strategies to address the different learning styles of students.

In [2], the author used Learning through Writing (LtW) pedagogical approach to observe and measure improvement in students’ writing in the discipline, and record student responses to the effects on their learning, by implementing LtW pedagogy in a laboratory course. The learning outcomes required to demonstrate the writing skills are identified and initiatives like workshops and design of action projects are taken to improve the outcomes. The pedagogy is implemented by clearly identifying the grade components, and assessed through RUBRICS. The seven-teen survey questions mentioned provided insights into what communication skills an educator must have. It would of great use if the authors had provided the responses of LtW Student Survey mentioned in appendix 4 of their paper.

In [3], the authors present a project based pedagogy for energy and environment course. The course provided a list of topics the students can choose for the project work. The course pedagogy used the RUBRICS to evaluate the students' project work. The evidences of student evaluation shows that the teaching and learning for that course was enhanced to greater extent.

In [4], the authors presented their efforts taken in the department of IT at RIT, to improve the placement of students. They have identified the most important skills an IT graduate must have and devised strategies that will improve the programming skills, project making skills and professional skills of the students. They have started a Placement Club where the professional skills are practiced by the students on their own without any faculty's supervision to enhance the self-learning amongst the students: by creating a friendly environment to make mistakes and learn from the mistakes. This papers makes use of this "making mistakes" concept and applies this method during the laboratory hours of programming courses for improving the programming skills.

3. Motivation

The second section provided several pedagogical instructions adapted by authors to suite their disciplines with a goal to achieve higher order thinking. With several changes that have taken place in the way students learn and educators teach, the 21st century educators must be sensitive to the needs of individual students. ICT literacy is the basic need and has become a basic tool to meet the learning needs and must adapt to a student centered pedagogy for extending the learning beyond classroom. To promote the higher order thinking among the students, the educators needed a suitable eco system. But the greatest challenge the educators face is with the dynamics of class-room and the factors like:
traditional classroom having large number of students, fixed classroom timings, different learning needs of students with different backgrounds, limited resources and student's attitude expecting the faculty to teach everything. To overcome these challenges and promote higher order learning, we designed a pedagogy that best suits by considering the classroom dynamics, learning goals, assessment methods and teaching-learning activities by identifying the situational factors.

This motivated us to device a customized pedagogy for the IT courses at our department. The pedagogy discussed in this paper is experimented on the course titled "Inter-networking Protocols", which is both theoretical and practical course. The sections below discuss the pedagogies used for theory and practical course. The results of Computer Networks course is used for comparison.

4. Pedagogy for theory courses using Blooms taxonomy (TC-BT) as a tool.

On defining the goals of the curriculum, the subject specific content to be learned by the student is assisted through teaching activities, assessment methods and learning activities. How do students know the pedagogy designed for the course? This is done by distributing a course plan which is designed that consists of the course description, prerequisites for the course, course learning outcomes, ground rules, evaluation schemes, assessment activities and teaching learning activities. Both formative and summative assessment activities are designed and comprised for the course. The pedagogy of the IP course is planned as follows:

A. Course Plan: The course plan consists of course details, description, prerequisites, outcomes and evaluation plan and ground rules.

B. Multiple Choice Questions (MCQ) Tests: MCQ tests are designed for every unit to assess the previously learned information.

C. Definitions: A document containing all the definitions of each unit is provided to the students and a test is conducted and is peer evaluated by the students to assess the comprehension skills of the students.

D. Assignments: List of assignments for each lecture are provided to the students. This is a summative assessment to assess whether the students are able to apply the knowledge to the actual situations.

E. Case Studies: Few case studies are provided to the students to improve the analytical skills.

F. Collaborative Activities: Few activities are planned to promote active learning amongst the students.

Designing the course delivery in this way facilitated the students to learn step by step, get feedback on their learning and enhanced the student's lower levels of learning.

The "Internetworking Protocols" course is about making practical application of knowledge of sciences/subjects like Data Communication, Computer Networks and Internet Technology in the design and implementation of protocols to provide specific services over Network/Internet. The goal of the course is to make students aware about Client server model & socket interface, Next Generation IPv6 and ICMPv6, BOOTP, Dynamic Host Configuration Protocol, Domain name system, TELNET, File Transfer Protocols, Electronic mail protocols and other Internet Protocols. Lab work includes implementing client/Server programs for few services and introduction to packet analyzers and Network Simulator (NS-2) with their installation and configuration. The prerequisites for the Subject are:

- Basic knowledge of data Communication
- Good knowledge over Computer Networks
- Basic knowledge of Socket Programming using Berkely Sockets

The Course Learning Outcomes are given below. After completion of the course the students must be able to:

- Demonstrate the working knowledge of Berkely socket programming for the given requirements.
- Identify the features of next generation addressing and protocols.
- Use protocols like DNS, FTP and TELNET to access/provide the services over the network.
- Explain the concepts of protocols like IP, FTP, TFTP, Remote Login and TELNET services along with their packet formats.
- Practice the HTTP, SMTP protocols, Packet analyzers and Network Simulators (NS-2) and illustrate the same for a given scenario.
The pedagogy used for the course is provided to the students through the course plan. To achieve the higher levels of thinking the students must be good at the lower levels of thinking like knowledge, comprehension and application. Remembering previously learned information and grasping the meaning of information is required to achieve higher order levels of thinking. Hence formative assessments are designed for the first two levels and for application level lecture wise assignments are designed which are of summative type. To check whether the students remembered the previously learned information, Multiple Choice Questions (MCQ) test is conducted during the last ten minutes of lecture after discussing the facts, terminology and concepts of each topic. Though this MCQ test conducted by displaying the question on the screen could provide some feedback, it could not provide all students a chance to respond and was also time consuming. Hence to overcome this online MCQ tests are planned for each portion of lessons. The students are asked to take the tests at their convenient place and time before attending the next class making it a Flipped Formative Assessments (FFA). The average scores of the ten FFA tests which were for 15 marks are shown in the table 1.

| Quiz No | Average Score (15) | Student Remarks                  |
|---------|--------------------|----------------------------------|
| 1       | 9.2                | Not revised after lecture        |
| 2       | 6.0                | Not revised after lecture        |
| 3       | 7.6                | Not revised after lecture        |
| 4       | 6.9                | Not revised after lecture, repeat topics |
| 5       | 7.9                | understood                       |
| 6       | 4.4                | Topics are difficult and needs to repeat |
| 7       | 9.6                | Understood                       |
| 8       | 9.3                | Very well understood             |
| 9       | 7.3                | Understood                       |
| 10      | 6.3                | Should slow down the teaching    |

Table 1: Average scores of each MCQ quiz & remarks.

The average scores of the students had provided an immediate feedback on how much students remembered previous concepts. An informal feedback from the students stated that they are not revising the concepts after the lecture. This shows that the students should be motivated to practice continuous learning skill because they are referring to the concepts only before or during the exams. To partially address this problem and promote continuous learning, Think-Pair-Share activity was performed during the last ten minutes of each lecture. Here an MCQ is asked to the students. Instead of single student answering, he/she can think, discuss with the bench mates and answer the MCQ. During this activity the students felt responsible and were also prepared for the next class to answer the MCQs. Asking any student of a bench to answer the question not only motivated students to think and share the concepts but also addressed the inferiority complex issues of students to stand up and answer. The results of whether this activity motivated the students for continuous and self-learning is shown in Course feedback in figure 11 with scores in third row of table 6.

The MCQ activity in the classroom and using ICT helped to assess the knowledge: remember previously learned information of students. To evaluate the comprehension levels: demonstrate an understanding of the facts of students, peer evaluation activity was designed and practiced. All the resources in the form of power point presentations, videos and text books, question bank and a separate document containing all possible definitions is made available to the students on the MOODLE server available in the IT department. Using the document containing the definitions, peer evaluation activity is conducted after completion of each unit of the IP course. During the peer evaluation activity each student is given a sheet with ten questions and a blank space provided for the students to give their answers as shown in table 2. Later the answer sheet of one student is assessed by the other during the same lecture while the definitions are displayed using compujector. This provided the student with the mistakes she/he made and also the mistakes of others. This is designed to be a formative assessment where it is providing the feedback to students and faculty on the ability of students to demonstrate the understanding of facts and their continuous learning skills.

Table 2: Assessment sheet for comprehension level.

| Sr. No | Question | Answer |
|--------|----------|--------|
| 1      | Client Server Paradigm. |        |
| 2      | Client |        |
| 3      | Server |        |
| 4      | Standard application service |        |

The lecture wise assessments/activities are used for summative assessment and check the ability of students to apply the knowledge to actual situations. As these assessments are evaluated through student presentations, poster designs, mind map charts,
concept map charts, demonstrations etc.; they were also useful to assess the other cognitive skills of students like presentation, thinking, logical and auditory skills. All the assignments are listed and provided to the students. Around fifty six such assignments/activities were designed and made available to the students through MOODLE. Students with a team of two must choose one among the list and apply the knowledge to complete the task. The students can submit their assignments by implementing programs or by poster designs or presentations or by using tools. Table 3 shows a list of few assignments designed. The lecture wise assignments are revised each time to make sure that they are useful to assess the student's ability to apply the knowledge in solving the problems.

Table 3: Assessment sheet for comprehension level.

| Topic: Client Server Paradigm |
|-----------------------------|
| Sr. No | assignment |
| 1. | Which of your local implementations of standard application clients are fully parameterized? Why is fully parameterized needed. |
| 2. | Write a server program using Berkely sockets that will display the clients end point address. |
| 3. | Provide authentication to client at server using the Berkely sockets. |
| 4. | Write parameterized clientserver programs that will read IP address, Port numbers from the command line arguments. |
| 5. | Design the RIT network using CISCO Packet Tracer Virtual Router Configuration tool |

Apart from the above three activities: MCQ, Peer evaluation of definitions and lecture wise assignments, collaborative activities are planned to improve the learning by doing and teaching. One of the activity conducted is JIGSAW. The following instructions give a step-by-step account of how to conduct this activity and are explained to the students.

1. Five protocols are used to implement the Collaborative activity (JIGSAW method with few assumptions).
2. Five groups are chosen from a class with 4 students from each group.
3. Each group is allocated 30 minutes of time during the regular lecture to demonstrate the protocol using role plays and posters.
4. The group members should act as nodes and demonstrate the protocol with the help of chits and cards.
5. The other groups and the student audience are allowed to pose questions for which the group members should answer.

6. The actual demonstration is also allowed with the real setup (if possible; use of tools like NS-2 or computers)

The students are assigned to four-member teams having different levels of Cumulative Performance Index (CPI) scores as shown below.

Member 1: CPI > 8
Member 2 & 3: CPI < 8 & CPI > 7
Member 4: CPI < 7

Table 4 shows the section of the protocol the members work and which are also used to access students. When this activity was for the first time conducted to this class, most of the students were participating as presenters and listeners. But very few students were observed as non-participating. So to motivate the non-participating members, they were informed that they should ask at least two questions at the end of the activity.

Table 4: section of protocol students' work.

| Sr. No | Section of protocol | Description |
|-------|---------------------|-------------|
| 1. | Content development | Here the student should learn and explain the need for the protocol and the types of messages the protocol uses to communicate and explain its format. |
| 2. | Working of Protocol | Here the student should learn and explain the different types of messages the protocol contains, the request and response send and receive messages. |
| 3. | Demonstration | Here the student should learn and demonstrate the protocol with the help of role play or computers |
| 4. | Q & A | The student must be able to answer the questions posed by the other students. |

Figure 1 shows the results of the JIGSAW activity for the Computer Networks (CN) course which is in the third year first semester curriculum of IT program. Also Figure 2 shows the results of the same activity with the same students for the Internetworking Protocols (IP) course which is in the third year first semester curriculum of IT program.

Figure 1. Evaluation of JIGSAW activity for CN course.
From the figures 1 and figure 2 it is observed that the average comprehension skills of the students improved by 7 percent which is calculated from the differences of JIGSAW activity assessment for CN and IP courses (68.75, 75.75) respectively. Figure 3 shows the student team's participation for the JIGSAW activity during the regular class for the CN course as well as IP course. The same students with same teams have given the demonstration of JIGSAW activity for different subjects in different semesters.

The interesting feedback that we received from the students is that they are facing difficulties to demonstrate the given concepts using the JIGSAW activity. The feedback statements of the students are as follows:

"JIGSAW activity is good but it cannot be applied on each topic", "JIGSAW activity is good, but topics like IPV6 couldn't be appropriate way to learn using JIGSAW", Extra activities like JIGSAW is not better way to learn protocols". This feedback from the students helped us to incorporate different activities like: Poster design, Concept map, Mind map, presentation and demonstration using a tool like Wireshark packet analyzer and Network simulator to promote active learning amongst the students. Figures 4, 5&6 provides the snapshots of the mind map, concept map, poster design assignments submitted by the students. The concept map provided the students the entire concepts covered for a specific unit at a glance which can also be used as easy reference before examinations. The mind map helped the students understand well the lengthy and difficult concepts that involved step by step process.

Table 5 illustrates the results for In-Semester Evaluation (ISE), Mid-Semester Evaluation (MSE) with a weightage of 20 and 30 marks respectively. The analysis shows that the results of ISE showed fewer improvement but the progress of MSE is upright. The investigations on the results of ISE showed that the assessment methods for the students graduated in the year 2015 were not appropriately designed and followed traditional methods. The ISE for 2017 graduating students are well defined and RUBRICS were used where the student's demonstration skills were assessed appropriately. Overall with well-designed assessment methods for 2017 graduating students, they outperformed than the 2015 graduated students which can be observed in the total column of table 5.
To continuously update the curriculum of the department, the current requirements of the industry were identified through Faculty Industrial Visits, Industry-Institute Interactions, and Alumni feedback. In view of that, the curriculum is updated and the assessment and evaluation procedures were designed by incorporating the "Outcome-Based Education" (OBE) methods. Programming is the most important skill that any IT graduate must exhibit to be able to work from day one when assigned a project to be developed. This confirms the student's ability to apply basic concepts and principles of IT to solve real-world problems. During the interactions with the industries, it was found that the students are lagging with programming skills. Also, during the campus interviews, the selection process is of Boolean type. That is; given a student to develop a program, the student is qualified only when the program executes without any errors providing the expected output. But the assessment of programming skills of the students for the course during the academics is not based on executed or not executed. Rather it considers partial execution, partial output, and execution with few errors etc. Even after students undergoing several practical sessions for each of several programming courses; the observations on student's programming skills were dis-pleasing. To address this scenario we at IT department teamed up to design a new pedagogy for programming courses. When the Boolean evaluation of programs is introduced in the department for the first time for IP course, it was observed that the learning practices of the students changed involving several malpractices like storing the programs in some directory of all computers before day of exam, getting a pen drive to the exam hall and chits containing the programs written on it. In paper [4], the authors have taken several efforts to improve the programming skills of the students. But the efforts could not provide instant feedback to the students where they are going wrong while practicing the programs during the practical hours. The authors also mentioned that they have started a "Placement Club" that provides students an environment to make mistakes and learn from them to avoid repeating the mistakes during their interviews, professional life, and work place practicing the mantra "Making a mistake is not a mistake but repeating is a mistake". This paper adopts and extends the concept of learning by making mistakes and design the students' programming evaluation using this making mistake therapy titled "Magic of Making Mistakes" that will also improve the learning practices of students. To implement this pedagogy, initially the types of mistakes or errors that occur while executing the programs are categorized, listed, and defined as shown below.

1. Compiler/Syntax errors
2. Runtime/Logical errors
3. Incorrect input
4. Incorrect commands
5. Type mistakes
6. Lack of preparation

The activities during the laboratory slots are very well planned to promote active and collaborative learning among the students. Usually the semester is for 12-14 weeks of duration. Hence the students are supposed to practice and perform 10-12 experiments during the semester for respective courses. The two hours practical slot located for the practical course per week is planned accordingly to provide both formative assessment and consecutive practical slots for summative assessment to the students as follows:

1. The faulty will instruct the students on one experiment only for the first five minutes. These instructions are made available to students at the start of semester itself.
2. Students are given forty five minutes of time to execute/perform the program/experiment.

Table 5: Comparison of average results for CN & IP courses

| COURSE      | ISE (20) | MSE (30) | TOTAL (50) |
|-------------|----------|----------|------------|
| CN-2015 Batch | 17.6     | 13.62    | 32.23      |
| IP-2015 Batch | 14.82    | 15.76    | **30.58**  |
| CN-2017 Batch | 14.95    | 17.58    | 32.54      |
| IP-2017 Batch | 14.3     | 19.64    | **33.94**  |

5. Pedagogy for Practical Courses using Magic of Making Mistakes (PC-MoMM)
3. Immediately after completion of forty five minutes, the faculty will clap to indicate the students to stop execution.

4. All the students in the lab will stand up and the students who have executed the program successfully will assist the students who did not. Students are allowed to take their seats only after all the students show the output to the faculty.

5. The students will record the type of errors they made into their observations report while programming.

6. The steps from 1 to 5 are repeated for the second hour of the lab for the next experiment.

7. In the next practical slot the students will give test on the two experiments they have practiced in the previous practical slots where the students are evaluated based on whether the programs are giving required output or no (Boolean evaluation). The students also record the errors they made during the test into their observations.

During the practical hours which is of two hour duration, the faculty provided necessary instructions for two experiments, students successfully practiced two experiments and recorded their mistakes into the report. All this learning activities in the laboratory was driven to offer formative assessment that provided the students a feedback on the things that went wrong, things that keep going wrong and things that might go wrong in future.

During the immediate next week slot of the lab a programming test is conducted on the experiments that were completed during previous practical slot through peer assistance, collaborative learning and formative assessment. The duration of test for each experiment is one hour and during this test the assessment is of summative where the students are graded. The evaluation is of Boolean and students score maximum marks if the program is executed successfully else zero. The students are again informed to record the errors that occurred during the test into their observations report. This activities were not time consuming because in two practical turns the students could complete two experiments and the faculty could perform both formative and summative assessments. Care should be taken that the experiment planned can be completed in one hour. If any experiment is taking much time, each week slot can be used to conduct only one experiment. The error reports are collected for each experiment from the students using GOOGLE forms. The student reports are formatted, analyzed and displayed to the students to monitor their performance.

Figure 7 shows the error reports of the students. The first row gives the types of errors. The second row shows the total number of errors of that type committed by students. The first column is the experiment number and the next columns show the number of errors made by students of that type. The last column shows the total number of errors committed by the students for that experiment. The graphs for the same were plotted and shown in figure 8. The figure 8 also shows graph for errors experiment wise displayed in green color at the top, graph for errors type wise in brown color at the right top corner and the bottom lines shows the number of errors of each type for each experiment. The graphs are plotted based on the 74 student's responses for 10 experiments resulting in 732 responses in total. Each student is provided with the total number of errors he/she made for each experiment. The total number of errors collected from the class is 2116.

This report provided both students and faculty the performance of each student and their learning process. The more faculty knows about the learning process the more effective faculty can be in designing and delivering appropriate instructions. We have taken this information to modify the instructions differing from experiment to experiment. Each student is individually mentored based on their error reports. When this method was shared among the other faculty associates they were overwhelmed as it is able to get the count of errors of each student and in total and helped to reduce the errors of each student from experiment to experiment.

Figure 7: Error report of each type and for each experiment.
An activity is also planned to identify the different type of learners in the laboratory and address the Active, Sequential and Global learners. Given a problem statement in a lab with 20 students and when instructed to implement a program the following observations are made.

1. Most of the started typing programs on the computer.

2. Few students first had written the steps to solve the problem and then started programming.

3. Some of the students who were unable to implement the programs were asked to pair.

4. Other students browsed the internet and executed the programs successfully but could not explain the program.

![Graph showing analysis of errors of students](image1)

Figure 8: Graphs showing the analysis of errors of students

One of the component in Continuous Assessment of laboratory course is conducting viva. To effectively conduct this assessment component, MCQ tests are designed that contains questions related to each experiment. This type of assessment for viva is done for the first time in the IT department at RIT. This test is conducted online using ICT. This drastically saved the assessment time of faculty. The only requirement was to plan a set of MCQ tests specific for the experiments. All the traditional limitations like unable to pay attention to each student, evaluate properly due to insufficient are well addressed.

![Graph showing result analysis of IP course 2015](image2)

Figure 9: Result analysis of IP course 2015.

Figure 9 and 10 shows the result analysis for the course IP during the year 2015 even semester (JAN-JUNE)for which the above discussed pedagogies were applied. The columns in the figure 9 shows student marks distribution for ISE, MSE, ESE, CAS of IP lab and IP programming test with 20, 30, 50, 30 and 60 as maximum marks respectively. The marks of ESE are not announced during the making of this paper. The bell shaped curves in figure 10 shows that the marks of the students are distributed as per the student's subject skill levels which shows that the evaluation was carried out appropriately.

![Graph showing result analysis of IP course 2015](image3)

Figure 10: Graphs showing result analysis of IP course 2015.

Figure 11 shows the feedback of students for the course CN plotted in blue color and for IP course in brown color-for which the pedagogy mentioned in this paper is applied. This histogram shows that the cognitive skill have improved from course to course.

![Feedback results of CN & IP Courses](image4)

Figure 11: Feedback results of CN & IP Courses.
The same twelve questions mentioned in table 6 were used to collect the feedback from the students for the two different course Computer Networks (CN) which is in the curriculum of second year 2nd semester and Internetworking Protocols (IP) course which is in the curriculum of third year 1st semester. Overall it was observed that there was an exorbitant improvement in the practical skills of the students.

### 6. Conclusion & future work

The paper has provided to the reader an innovative pedagogy used for IT program courses in engineering education at RIT. The results are highly motivating and can be adopted for theory and programming courses offered in Computer Science and Information Technology programs. Educating theory course using TC-BT provided students with in-depth understanding of the course content at ease and inculcated the practice of continuous learning. Educating programming subjects using MoMM made students familiar about their mistakes. The learning of the students gradually improved with reduction in the number of mistakes they made. In future we plan to adapt TC-BT and MoMM pedagogies to all the courses and test the efficacy of these pedagogies.

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### References

[1] Marshall, J., & Blue, C. N. (2014, June), Pedagogy Including Differentiated Instruction That Enables Student Learning Paper presented at 2014 ASEE Annual Conference, Indianapolis, Indiana. https://peer.asee.org/22908

[2] Walk, S. R. (2013, June), Using Learning through Writing Pedagogy to Improve Laboratory Learning Outcomes Paper presented at 2013 ASEE Annual Conference, Atlanta, Georgia. https://peer.asee.org/19023

[3] Pisupati, S., & Yeboah, Y. (2007, June), Project Based Pedagogy To Enhance Teaching And Learning In Energy And The Environment For Honors Students Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. https://peer.asee.org/3066

[4] Rajesh. Dontham, Manoj. Patil, S. A. Thorat (2015, Jan), "IT Student's Placement: Powered by Innovative Practices, Effective Assessment and Evaluation Methods for Improving Programming, Project Making and Professional Skills", 2nd International Conference on Transformations on Engineering Education, Journal of Engineering Education Transformations (JEET) special issue, ISSN 2394-1707, DOI: 10.16920/ijerit/2015/v0i0/59706. http://journaleet.org/index.php/jeet/article/view/59706