

PEDAGOGICAL METHOD USING FLIPPED CLASSROOM, E-LEARNING TOOLS AND TEMPLATED APPROACHES

MANUSCRIPT TRACK: DIGITAL PEDAGOGY

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Abstract:

In this digital era, a successful teaching involves blending different approaches for transferring knowledge to participants. This paper discusses about a teaching method evolved using flipped classroom, e-learning tools and templated approaches. The instructional method followed is that the students are asked to learn the concepts of a specific topic prior to the activities (e.g.: quizzes, problem-solving, etc.) in the classroom. Learning materials are provided in the webpage of the institute or made available through e-mail attachments. In the classroom, quizzes and discussions are conducted which enhances the application, evaluation and assimilation capability of the students in the domain area. Templated approach is useful for complex problems which require logical and sequential understanding. Several interactive e-learning and experiential learning tools are developed and are used for teaching and demonstrating the concepts of the courses handled. To promote the blended teaching method, appropriate teaching/learning materials have to be developed.

Keywords: Flipped classroom, Templated answer form, E-learning tool, Role play, Experiential learning

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I. INTRODUCTION

Teaching is the one profession that creates all other professions. The main objective of education is learning, not teaching. In the educational process, students should be offered a wide variety of ways to learn and a choice to experiment what they learn. Teaching is a powerful tool for learning. Hence the teaching methods used must help to develop and transfer specific skills that serve both the purposes of knowledge development and dissemination, while at the same time preparing graduates for work in a knowledge-based society. Teaching can be conducted in several methods based on the nature of the subject and student. For effective teaching, the teacher has to adopt certain strategies and multiple methods. Understanding the classification of teaching methods, analyzing them and thinking on how to apply the methods based on the situation you face are important.

In this era of digitization and excessive utilization of multimedia tools, there is an immense growth of knowledge society. Therefore, adopting the new technology and methods become easier. In this paper, the pedagogical methods followed for certain courses for a master programme (M.Tech.) in National Institute of Technology Calicut are

discussed. The courses are Inventory and Supply Chain Management, Manufacturing Planning and Control, Group Technology and Flexible Manufacturing System and Lean Production Management, which are basically a blend of theoretical, descriptive and mathematical models. The course on Manufacturing Planning and Control contains procedural methods in addition to mathematical models. A blend of pedagogical methods/approaches is used for teaching these courses. Various approaches used are flipped classroom, templated approach and e-learning tools. The appropriate blend of these approaches is used based on the courses and the exact approach depends on the topic to be covered in each class for a course. These approaches make the learning process effective and are discussed in this paper. This paper mainly discusses the modalities used for conducting the classes in flipped form and the associated tools or methods used.

The organization of the paper is as follows: An overview of the constructivist approach of pedagogy is provided in Section II. Flipped classroom approach followed for certain courses are discussed along with an overview of this approach in Section III. Templated approach followed for theory and laboratory courses are

detailed in Section IV. A discussion on e-learning tools developed and used for certain courses are available in Section V. Some of the difficulties associated with these approaches and a summary of details discussed in this paper are provided in Sections VI and VII, respectively.

II. PEDAGOGICAL METHODS

Pedagogy is the study of teaching methods or the strategies to achieve educational goals and is concerned with how the skills and knowledge are

exchanged in an educational context. Considering the theories of learning, understanding of students and their needs, and the background and interests of individual students, a teacher adopts appropriate actions, judgments and other teaching strategies [1]. Information about different approaches available for transferring knowledge in an educational context helps teachers to equip themselves for transferring knowledge and skills and Figure 1 depicts different approaches.

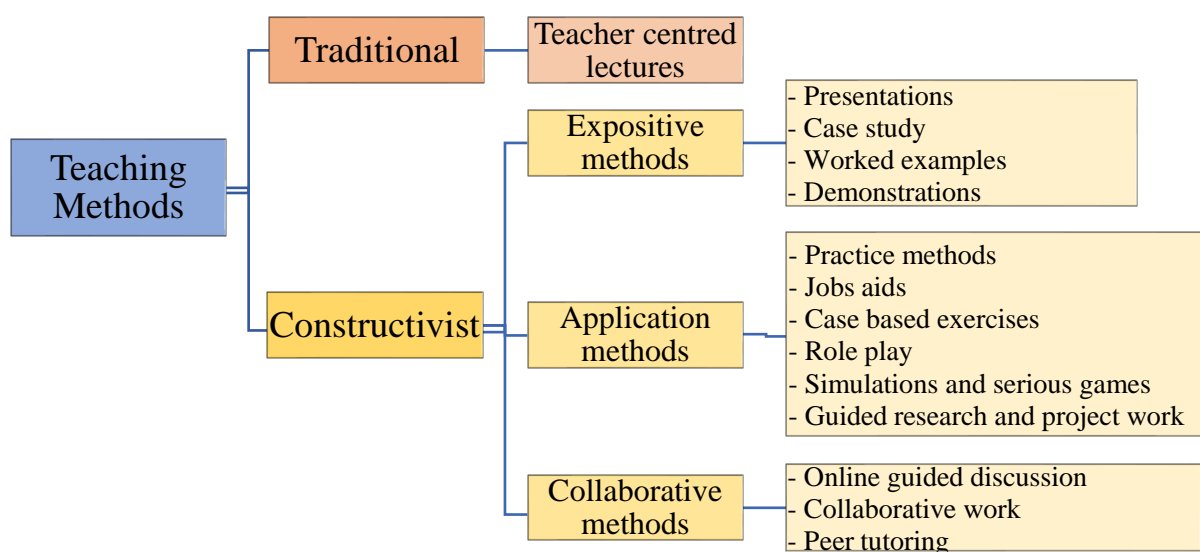


Figure 1: Different pedagogical methods

The traditional method indicated in Figure 1 is a teacher-centered method, where the teacher is the controller and decision-maker of the learning environment. In this case, the teaching method is predominantly lecture based and students listen to the lectures. The mode of delivery is through the chalk and talk method and textbook-based instructions.

Students must do more than listening for learning. They must read, write, discuss, engage in solving problems, relate with the concept and their experience, etc. The constructivist approach given in Figure 1 promotes learning by doing. This approach focuses on how learners think and understand, and it suggests that learners construct knowledge out of their experiences. In this method, the knowledge is essentially subjective in nature, i.e., constructed from our perceptions and mutually agreed upon conventions. Construct new knowledge rather than simply acquire it via memorization or through transmission from those who know to those who don't know.

Constructivists believe that meaning or understanding is achieved by assimilating information, relating it to our existing knowledge, and cognitively processing it. Three such constructivist approaches discussed in the subsequent sections are: (i) flipped classroom, (ii) templated instructional design and (iii) e-learning approach.

III. FLIPPED CLASSROOM APPROACH

“Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter” [2]. In a flipped classroom, reverse of the traditional classroom happens. It is an instructional strategy by which the instructional contents are often delivered online, outside the classroom and what is traditionally been considered as homework happens

in the classroom [3]. It is a blended learning environment where different instructional design approaches are used. The flipped classroom approach is based on the four different elements [2], [4] which are given below.

- (i) F (“F”lexible Environment): Time and place flexibility of learning.
- (ii) L (“L”earning Culture): In flipped classroom approach there is a transition from teacher-centered approach to student-centered approach.
- (iii) I (“I”ntentional Content): Flipped classroom educators think about how education is used to provide fluency and how they can develop a cognitive understanding of students.
- (iv) P (“P”rofessional Educator): Flipped classroom educators continuously observe students during the course, evaluate their studies and make feedbacks.

The most important factor in the flipped classroom approach is the role of the teacher. The teacher has to create a learning condition based on questioning [5], instead of transferring knowledge directly, he/she has to be a guide to make learning easy [6], he/she has to make one to one interaction with students [7], rectify misunderstandings [5], individualize learning for each student [8], use technological equipment suitable for learning condition [9], create interactive discussion conditions [10], increase participation of students [10], share lecture videos as out of class activity [11], and provide feedback by using pedagogical strategies [12]. Unlike in traditional classroom which is teacher-centric, in the flipped classroom student transforms from a passive receiver of knowledge to active promoter of knowledge in flipped classroom approach. In this approach, the role of students is taking their own learning responsibilities [5], watching lecture videos before the course and preparing for the course by using learning materials [13], learning at his own learning speed, making necessary interactions with his teacher and friends, taking and giving feedback [14], participating discussions within class and teamwork. In a flipped classroom:

- (i) before class starts the students watch online lectures, collaborate in online discussions, or carry out research at home

- (ii) engage in concepts in the classroom with the guidance of a mentor.
- (iii) students check their understanding and extend their learning activities after class

On the introduction of flipped classroom approach for certain courses, the evaluation method is also modified. Details of the flipped classroom approach and the evaluation method used to grade the students are discussed in the next section.

A. Flipped classroom approach followed

A detailed course note, generally in bulleted format, is published in the personal site of the website of institute. Else, it is circulated through e-mails among the students of the class. Figure 2 consists of two screenshots. The first one (Figure 2(a)) shows the list of courses in the course offered page of the faculty member’s home page and Figure 2(b) shows the links of various topic in a course page of the website. On clicking the link, the course note on the topic will be displayed in the browser. Screenshots (two screenshots) of the note appeared on the browser is provided in Figure 3. A part of the figure shows the screenshot of a part of two pages (end of a page and beginning of the next page). Each course note page has details like the topic in which the matter belongs, month & year, and bulleted nature. The screenshot also shows the exercise question for practising.

The topic to be discussed in the next class will be informed to students in every class. A thorough preparation on the topic by the students is required before coming to the class. They are free to have the study material with them in the class. Teacher’s roll in a class is like a mentor or a facilitator. In the flipped classroom, given resources for learning by students in their home/room, the teacher has to identify the important points or concepts that have to be formulated through appropriate mode of questions/statements. Some modes of question are (i) open-ended questions, (ii) numerical problems, (iii) multiple choice questions, (iv) fill-in-the-blank questions, (v) templated questions, (vi) small cases, etc. The students have to assimilate or cognitively process the concept based on the discussion evolved through the questions. Intermittently, some classes are used for concept demonstrating discussion. Sometimes the questions or statements are given to the students in advance through e-mail. This will allow collaboration among the peers for the study.

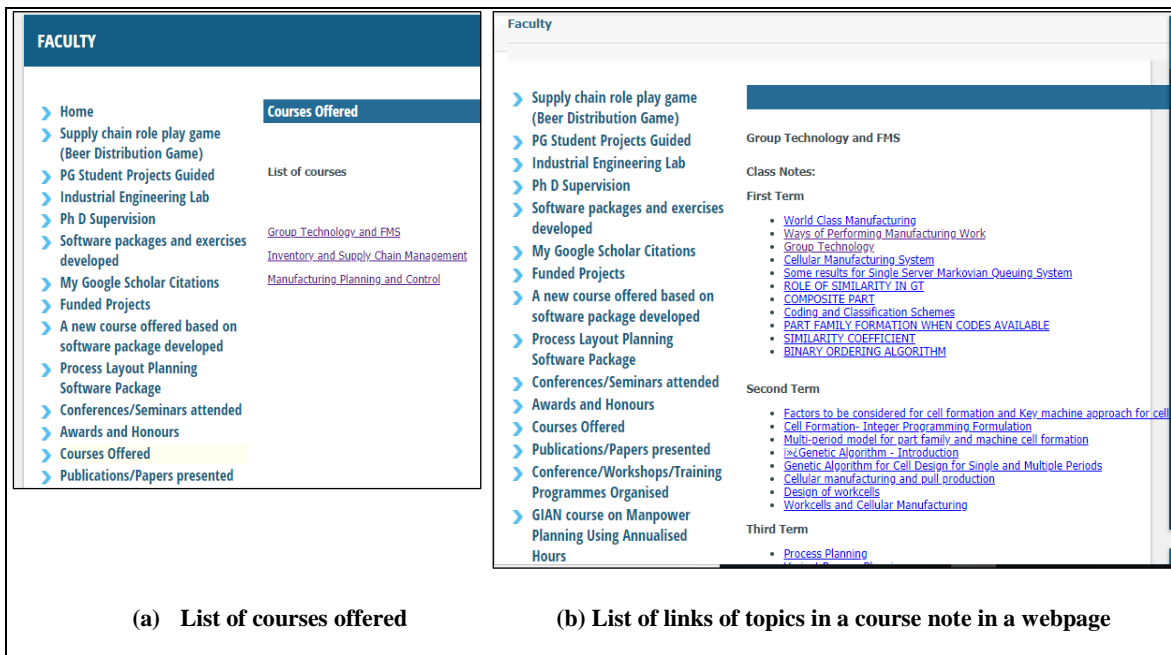


Figure 2: Screenshot showing webpages

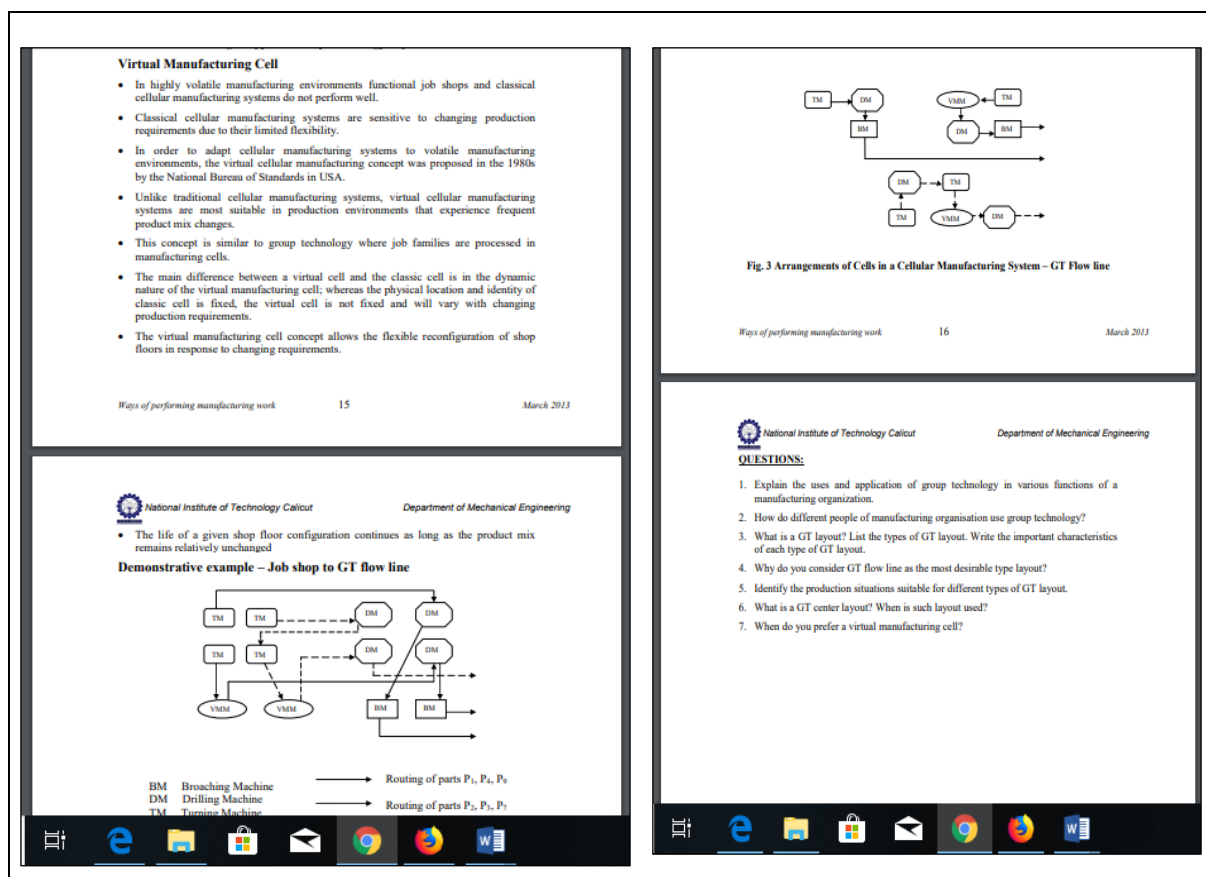


Figure 3: Screenshot showing continuous two pages revealing the characteristics of the course note

In many classes a quiz is conducted and evaluated in the class itself by allowing to exchange the answer sheets among the students for evaluation. The correct answer is displayed in the class or written in the board at the time of evaluation.

One of the evaluation methods for grading the students is quiz. So, the regular quiz marks are tabulated and considered for grading. Absenting from class will affect the performance in the quiz. This will also prompt the student to be regular in classes. Regular deliberations based on the questions on the quiz are also a part of the classes. The study material is given in advance and thus the material discussed in the class is not new to students, and hence the comprehension and assimilation on the topic by the students will be good. Usually, the discussion in classroom helps the teacher to identify slow learner of each topic and provide necessary attention to such students.

All these modes of question are to check whether the student studied and understood the specified topic. Further, discussion based on the questions on the topic enhances the depth of understanding. Numerical type questions are to be developed to reflect the details of the case considered. In the case of numerical type problems, the solutions are prepared and given in advance to discuss in the class. To test the understanding, a quiz on similar type of problem is conducted. For enhancing the understanding and to develop critical thinking and reflection, several questions based on the problem solved are created for discussion in the class. This approach helps the students to come out of the stereo type answering for questions like applying a formula for the numerical data provided and it kindle an interest on the student on the meaning of the problem in a practical environment. This way of discussion of the problem create a big picture of the practical problem environment especially in the Operations Management/Industrial Engineering area. It also helps to link various topics of the course and the thoughts to progress in different direction with respect to the problem environment.

The evaluation of students for grading involves tests (two tests) and end semester exam in addition to the quizzes regularly conducted in the class. Sufficient care should be taken to bring reasonable proportion of questions in the tests and exam to test the critical thinking, just more than

memorising the details discussed in the class and also care should be taken to cover all the topic of the course. During the discussion, the teacher is able to understand the common mistakes made by student in conceptualising a situation and efforts will be made to correct the mistakes. So, questions may be framed in quizzes, tests and exam to test how far the conceptual corrections have happened. A practice followed is that after each exam, the solution of question paper is explained and common mistakes done by students are also discussed.

IV. TEMPLATED APPROACH

The goal of teaching is to encourage higher order thinking in the students by building from lower order cognitive skills [15]. A method that gives directed and focused thoughts to develop higher-order thinking is templated approach of teaching. This approach helps the students to understand and improve the cognition of concepts. In practice, templates are usually used in data collection and application processing for collecting information systematically, sequentially and logically, especially, when different levels of data are to be collected in a single form in one go. The same approach can be used in teaching and assessment, and when it is coupled with flipped classroom, the teaching method will be an effective one. This approach is a useful one for testing the understanding on interconnected topic that are covered through several classes in flipped classroom. Templated approach can be used in theory courses to build a domain knowledge or to test how best the inter-related concepts are captured by students. It also can be used as a teaching/learning approach for laboratory exercises. In the subsequent sections, the templated approach in the context of flipped classroom is discussed first and then the approach applied to the teaching/learning process of a laboratory course is discussed.

B. Theory course based flipped classroom and templated approach

A learning objective to achieve through a course or a module of a course requires course material that is to be delivered through several instructional days and different methods of lesson planning are also required for appropriate delivery of the content. The material and information delivered through

several classes are to be related and interpreted for a big picture or to get an integrated view of the studied material in the practical context. Day-to-day lesson plan-based delivery facilitates understanding of various concepts and thus it helps to progress from lower-level-skills (e.g., memorising factual knowledge) to higher-level skills (e.g., analysis of relationship).

The cognition or higher-level thought building will especially be better in flipped classroom approach of teaching. In this approach, the material to be discussed is given in advance to students and they have to study the material in their home and come prepared for quizzes and discussion. If the quizzes are made of questions that create higher order thinking then they will be useful for improving the understanding of the topic. Moreover, as they studied the material at home and are subjected to quizzes, they are more familiar with topic when it is further discussed in the class. This will help factual knowledge to retain, enhance the understanding and relate various concepts by the students. This also helps the students to build a body of knowledge in their mind on the domain of course module or entire course. Templated approach can be used to test how best the domain knowledge is built in the mind of students. For example, it is possible to develop a templated approach for the solution to be provided by the students for a question which contains sequence of related parts. That is, the prepared material should have a domain specific question and a solution proforma (template). Answer of one part is required as information for working out the answer of the next part of the question. That is, the question links many concepts. For answering the question, a templated material is to be given and the template helps the student to focus their thought and get an integrated view on the topics of the domain. Template helps to answer systematically, logically and sequentially without omitting any intermediate stages. It also helps in directing the thoughts to build in the required direction for the factual knowledge to be in memory and thus have integration of various concepts.

C. Templated approach for the laboratory course

Template oriented approach is a kind of teaching strategy for laboratory courses where a systematic, sequential and logical understanding of the exercise problems/cases is required. The template-oriented

learning material permits the learners to understand, analyze and evaluate the topic of the exercise without much peer assistance. The execution and comparison of traditional approach and template-oriented approach followed in a laboratory class in the Department of Mechanical Engineering, NIT Calicut is given below and also the description given below showcase the effectiveness of the latter over former.

In a traditional approach, students are expected to study the reference material or laboratory manual for the exercise before coming to the class. The manuals and materials are accessible online as downloadable material. In the lab class, first a description of the exercise is provided by a peer, and the tabular columns and observation sheets need to be prepared by the student before starting the exercise. Students have to then conduct experiments and note down the observations, workout the details and write down inference about the exercise. In actual scenario, students do not study the reference material before coming to the class and will do the exercise as per the direction of peers. As a result, students fail to understand the concept and hence not able to analyze the results properly leading to an inference which will be very poor or a copy of somebody else.

Mostly the details provided in a templated handout consist of study/reference material-cum-observation recording sheets. In detail, the templated handout for laboratory exercises includes (i) exercise content (ii) theoretical background and (iii) step by step instruction to perform the exercise. In a step-by-step instruction proforma, instructions to carry out some activities will be provided with space for writing down the details as per instruction. The instruction may be related to preparing an observation sheet or doing necessary computation or preparing results/inference. In the templated approach, a templated handout will be provided to the students for each exercise. Students should bring the handout to the lab class after studying it. Before starting the exercise, an evaluation is conducted by the peer; to test whether the student has read the manual. If the evaluation score is poor, the student has to leave the class. After the evaluation, explanation about the exercise will be provided by the peer. Students have to then conduct the exercise and note down observations in the proforma provided in the handout. This is then followed by calculations, analysis, interpretation of

the results and preparations of inference in the corresponding space provided in the handout. As a result of this procedure with sufficient background material, templated approach allows the learners to cover sequentially and systematically all the basic steps concerned with the exercise and helps to progress systematically from the basic level to advanced level of thinking and analysis.

The above discussions provide a good idea about templated approach for teaching/learning process. The difficult part of this approach is the development of suitable material. Department of Mechanical Engineering, NIT Calicut has developed a few templated materials suitable for the Industrial Engineering and Management domain. In the national level, a learning resource centre, which should be a repository of such type of materials, have to be developed. This repository should be accessible by all who are in need.

V. E-LEARNING APPROACH

E-learning is an approach that utilizes computer and internet technologies to provide a wide-ranging solution to enable learning and improve performance. Application of e-learning tools and technologies in this digital era can be as effective as traditional training at a lower cost. Nowadays, organizations and institutes are demanding increased efficiency and productivity from their personnel. For this, the technology is being turned to a crucial enabler to meet individual learning needs that deliver smart and relevant contents which are easily accessed anytime, anywhere on any internet-enabled device. Hence e-learning tools as an educational offering are transforming academic and corporate training.

The main aim of the e-learning strategy is to develop cognitive skills which involve knowledge and comprehension as well as applying methods in new situations to solve problems (thinking or mental skills). In this regard, it can offer effective instructional methods through activities with the self-paced study, interactive role-playing and using simulation and games. Certain such e-learning tools developed and utilized for teaching/learning at Department of Mechanical Engineering, NIT Calicut in the domain of Industrial Engineering and Management are mentioned below.

- *Supply Chain Role Play Game (SCRPG)*: The SCRPG package is a computerized and web-based role-play package for supply chain

operation simulation. The role play gives an insight into the dynamics of the business operations for the players. This package helps the executives to enact the role of decision maker of business units in a four-stage serial supply chain. This simulator lets the executives experience typical coordination problems in a supply chain. The package has the capability to share information among the supply chain members and thus it is possible to evaluate the effect of information sharing. The simulator can be used to provide participants with a more profound understanding of the reasons why eCollaboration technologies are used in contemporary supply chains to exchange information and to facilitate collaboration.

- *Vendor Managed Inventory-based Supply Chain Role Play Game (VMI-SCRPG)* software package: Online Vendor Managed Inventory (VMI)-based supply chain role play game uses VMI concept between retailer and wholesaler. Information sharing among the entities/stages in a supply chain is essential for their better coordination and for minimizing the system-wide cost. Vendor Managed Inventory (VMI) is one such supply chain coordination system where the responsibility of managing the stock at customer is with the vendor.
- *Google Spreadsheet-based Supply Chain Role Play Game (GS-SCRPG)* online tool: Google spreadsheet-based supply chain role play game for collaboration, and strategy formation in the operation of the supply chain.
- *Four-stage serial supply chain Inventory Policy Analyser (FIPA)* software package: A software package for the performance analysis of a four-stage serial supply chain under different inventory control systems.
- *Supply Chain Inventory Policy Analyser (SCIPA)* software package: Software package for the performance analysis of serial and divergent supply chains under different inventory control systems.
- *Excel-based supply chain simulation for the performance analysis of a four-stage serial supply chain under P-system of inventory control*: Useful for understanding the use of Excel for general application and its use in simulation of supply chains and analysis of inventory control system in a supply chain environment.

- **MED NITC Manufacturing Requirements Planning (MNMRP)** software package: Material planning and scheduling using MRP and generation of material plans by rolling through time.
- **Layout Planning (LP)** software package: Development of best process layout and customizing the layout; simulated annealing based algorithm is the main part of the software package.

The e-learning tools/software packages developed help the students to get better insight and improve the understanding in the production/operations management, industrial engineering, manufacturing system simulation, performance evaluation of production systems, and supply chain management. Figure 4 provides home pages of these software packages and these software packages are designed and developed in the Department of Mechanical Engineering, NIT Calicut.

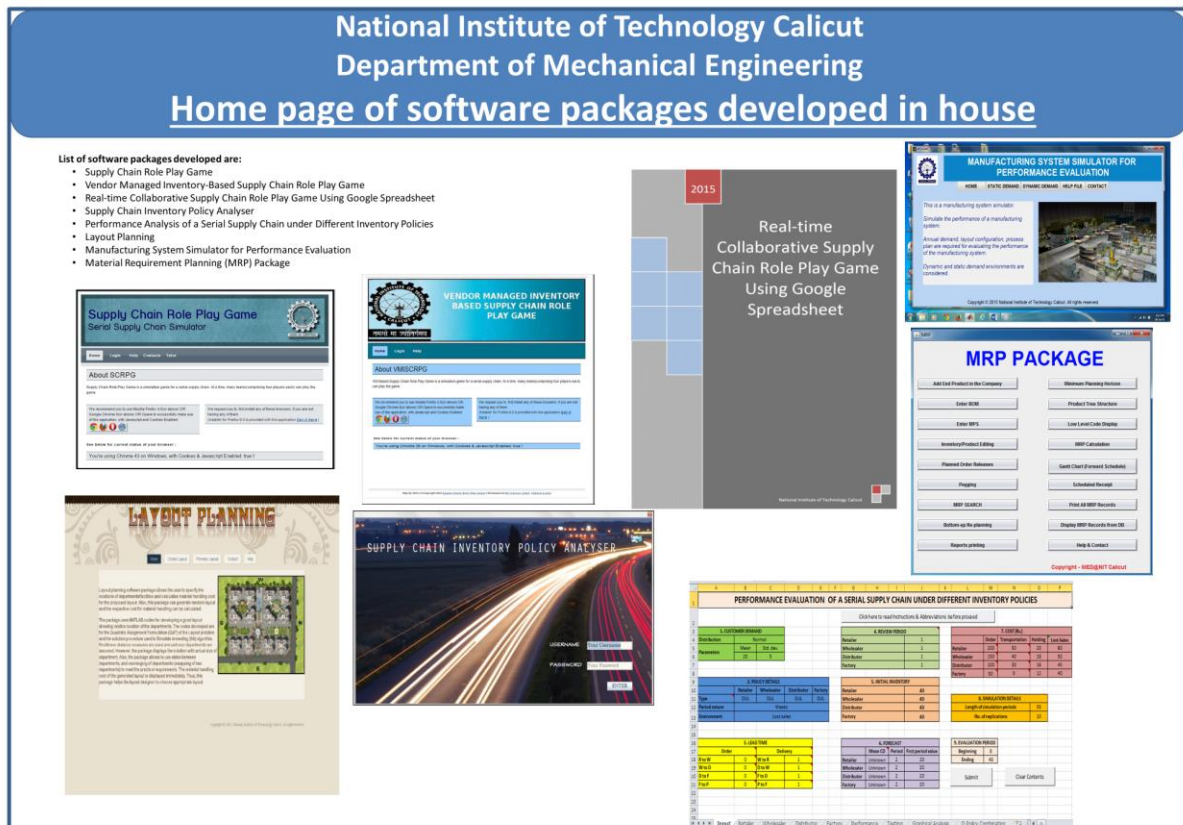


Figure 4 Home page of software packages developed in house

VI. APPROACHES AND DIFFICULTIES

Unlike traditional teaching methods, the constructivist methods face lesser issues. But every method has its own advantages and disadvantages. The flipped classroom has become popular since the advent of the internet. It gives a shift in traditional education from teacher centered to student centered learning. Despite its effectiveness over traditional education, the flipped approach will fail in certain circumstances. The major drawbacks in flipped approach are:

- Necessity of internet-enabled devices to access and download the study materials

- No guarantee that students will cooperate with the flipped model and read lectures at home
- Implementing a flipped approach adds an extra workload on teachers, as there are several elements that must be integrated carefully.
- As learning style of one student may differ from another, the flipped approach needs a lot of self-discipline.

Template based approach also may fail if implemented without proper implementation plan and it is necessary to ensure that the student prepares well and come for the class. And for e-learning approach, development of e-learning tools is more expensive than preparing classroom

materials. Since e-learning is not ideal for all purposes, it is unlikely that it will replace classroom training completely in an organization. This approach will be successful only if:

- learners are from homogeneous background
- learners have at least basic computer and internet skills
- learners are highly motivated to learn
- there is a significant amount of content to be delivered to a large number of learners
- associated debriefing and explanation is given properly

One major requirement for the methods discussed to succeed are the infrastructure facilities required. It may be noted that these methods are practised for a class strength of around 20 students (for the courses of a master programme). Another impediment is the support from the management for the development of suitable materials and the involvement of members of faculty in the development of such materials.

VII. SUMMARY

Great course contents are conveyed effectively by applying the right teaching strategy and methods suitable for that content. In this era of digital technologies, teachers must be trained to use the technology well. On the contrary, the fact that the students ordinarily use smartphones and other tech gadgets does not indicate that they know how to use them for learning purpose. Students likewise must be shown how to use technology to support their learning and another basic requirement is that computer/devices enabled with the internet is a must for implementation.

The paper discusses how digital pedagogy can be utilized for effective teaching. The three methods mentioned are: (i) flipped classroom approach, (ii) templated approach and (iii) e-learning. For every method, the instructor has to develop his/her own strategies and techniques based on the level and performance of students as well as the content that is to be handled. Student and teacher have equal importance unlike in traditional learning which is teacher-centric. The flipped classroom has numerous advantages including one-to-one attention. Templated approach can be used in theory courses to build a domain knowledge or to test how best the inter-related concepts are captured by students.

Templated approach allows the learners to cover sequentially and systematically all the basics steps concerned with the understanding required for the domain area and helps to progress systematically from the basic level to advanced level of thinking and analysis. For a flipped classroom when the strength of the class is lesser it is easy to manage and provide attention to every individual, but when it comes to a classroom of higher strength, then the approach has to be modified. E-learning platforms are of greater importance today when a significant amount of content is to be delivered to a large number of learners. The paper mentions about e-learning tools developed by the author to explain the concepts in the industrial engineering domain. Thus, it explains how every strategy has to be customized based on the needs of the learners. Here, getting it right is critical, and once it is done, employment of technology can transform teaching, build great students, and further change our world.

Various approaches suitable for teaching in this digital era for a few courses is discussed in detail in this paper. A point noted is that for the successful application of the methods discussed in this paper, suitable material should be available and should be developed by the expert of the domain. A national level learning resource centre which can act as a repository of various materials suitable for these approaches may be a solution.

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Author Biographical Statements



V. Madhusudanan Pillai, Professor, Department of Mechanical Engineering, National Institute of Technology Calicut, Kerala, India. With more than 28 years of teaching experience and over 130 publications in international journals and conferences, and editorship of a book, he has developed several laboratory exercises and software packages in the area of manufacturing management and supply chain management. His expertise in the area of developing the logic for e-learning tools on supply chain operation simulation has resulted in the development of several supply chain operation simulators and he owns copyright for three such software packages. He offers courses on Production planning and control, Inventory and supply chain management, Lean production management, and Group technology & FMS. His research interest includes

modelling of problems in supply chain operation simulation, e-learning tools for supply chain operation simulation, sustainable supply chain management, cellular manufacturing systems, material requirements planning, scheduling, facility layout planning, inventory control, lean manufacturing, manpower planning – annualised hours, and ergonomics. He supervised 9 Ph.D. theses, over 80 Master students and he is currently advising 4 Ph.D. scholars and 3 Master students on their research. He is the reviewer for several Science Citation Indexed international journals, and conferences.