Journal of Engineering Education Transformations ,
Volume 30 , No. 2, October 2016, ISSN 2349-2473, eISSN 2394-1707

Streamlined Integration ofict Tools and active Learning Strategies For Effective Content delivery in Engineering Education– An Experimental Study

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Abstract : In the current era of education,quality of the content delivery is considered as important as the Course Contents to attain the objectives of the course. Quality Content delivery methods leverage technology and place more emphasis on active learning. This paper highlights few of the active learning strategies and ICT tools. Also, this paper presents a streamlined approach to choose a Active learning(AL) method and ICT toolto from among the rich set of available tools and strategies to deliver a content effectively.The proposed approach decides the suitability of the AL method and ICT tool chosen to deliver a particular content based on the nature of the content structure and expected cognitive level of learning the content. An attempt to identify the prominent learning style of the students in a class and chart an efficient content delivery plan by matching an appropriate AL strategy with suitable ICT tool is presented in this paper. The proposed approach was practised in fourth semester B.Tech (Information Technology) class of 72 studentsfor Computer Networks Course. The effectiveness of the implemented approach is measured using standard tools and presented.

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Keywords: ICT tools, Active learning(AL) strategies, Content delivery methods, Course objectives attainment.

1. Introduction

Teaching and learning has takena new dimension in recent days. Modern Teaching-learning processlays a lot of emphasis on active learning in class, opposite to the passive learning of conservative teaching-learning process. To support this, number of ICT tools are being used. Some of the widely used ICT toolsare such as educational videos, video lectures, Animations that provide visualization of the concepts, Simulations and other tools like wikis, blogs and forums. Instructors may leverage the above said tools to make the Content delivery effective. Usage of ICT tools helps the learners to understand the concepts better and excel.

It is an excellent practice to integrate the usage of ICT tools with active learning strategies. In fact, employing active learning strategies becomes easier with the use of ICT tools.A wide range of ICT tools and AL strategies are available, but it is the responsibility of the teacher to find a tool/strategy that best suits the nature of the content. This work aims to bring out a set of standard guidelines to choose and integrate a specific ICT tool and AL strategy suitable for delivering course content.

2. Motivation:

Many a times, it is at the discretion of the instructor to pick up an ICT tool or an active learning method suitable for a given course content. The idea proposed in this paperpresents a set of guidelines to select anICT tool/active learning strategy specific to teach a course content considering the nature of the content and the expected level of perception of the content.

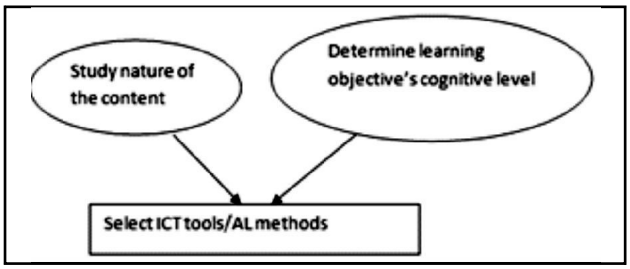


Figure 1

2. Related Work

Students in a classroomcan be classified into different types of learners based on how they observe and process information. Traditional lecture doesn't support or address all students. Teaching the studentsbased on their Individual Learning Styles results in effective learning. If the learning style and teaching style mismatches, it may lead to poor learning. This phenomenon is strongly recommended in [1] and it also recommendsclassifying the students in a classroom based on their learning styles and addressing them with suitable teaching methods.Improvement in learning capability has also been indicated. [1]

A paradigm shift is required for the educators to switch from teaching centric methods to learner centric methods. Active learning can be as simple as integrating in-class activities alongside traditional lecture to address all types of learners in the classroom and also it helps students to reach higher cognitive levels of learning. Active learning strategies such as Flipped Classroom, Think Pair share, Muddy Point, Quiz may be practiced in order to make the students highly interactive in the classroom and make the learning two-way. Active learning strategies when implemented properly yields powerful learning outcomes, retention of knowledge, increased depth of knowledge and promises an optimistic future for education. Implementation of one such active learning strategyand its effects arestudied in [2]. When the teacher practices active learning strategies in the classroom, students have the freedom to interact with the content according to their own learning style.

The adoption of active learning techniques in engineering education requires careful planning and implementation to ensure success. Planning the class is very important which includes listing out the learning objectives of the topic; categorizing its bloom's level, then finding out the best suited active learning strategy accordingly. This course of action is implemented in [3]

ICT tools and active learning techniques influence the way students learn and makesTeaching-learning process more learner centric. This, in turn helps learners to achieve real, deep and effective learning. The use of ICT tools in education develops higher order thinking among students.Some of the ICT tools used in education widely are Computer-based presentation tools such as power points, video, audio, files, images,photos, computer-generated art, Spreadsheets and related tools (displaying data/findings effectively with graphs),Online collaboration and sharing of teaching and learning resources, Microphones and recording software such as Audacity, Blogs, Wikis, Podcasts and Vodcasts, Learning Management Systems, Online forums, Online communication tools (e.g. Skype). The impact of ICT in education is widely researched in [4].When the instructor includesICT tools in their content delivery,the efficiency and effectiveness of learning improves.

The following section explains the proposed method to integrate ICT tools and Active learning methodsbased on the learning styles of the learners in the class room, nature of the course contents and cognitive levels of learning objectives.

3. Proposed System

The proposed system chartsguidelines for choosing a combination of active learning strategy and ICT tool from the rich set available, taking multiple considerations into account. The scheme of the proposed idea is show in the Figure 2 below

To begin with, the class of students taken for study are made to take Felder's survey to identify their learning style viz auditory, Visual or kinesthetic learners. This classification helps to choose

appropriate active learning strategies and ICT tools, so that learners with different styles could be kept engaged.

At the next level, the course content is analyzed. Objectives of the course and the cognitive level at which each objective is expected to be perceived by the learners is decided.

In addition to the inputs mentioned above, suitable AL (Active Learning) strategies and ICT tools are integrated into the course content delivery Plan using standard guidelines which are elaborated in the following sections.

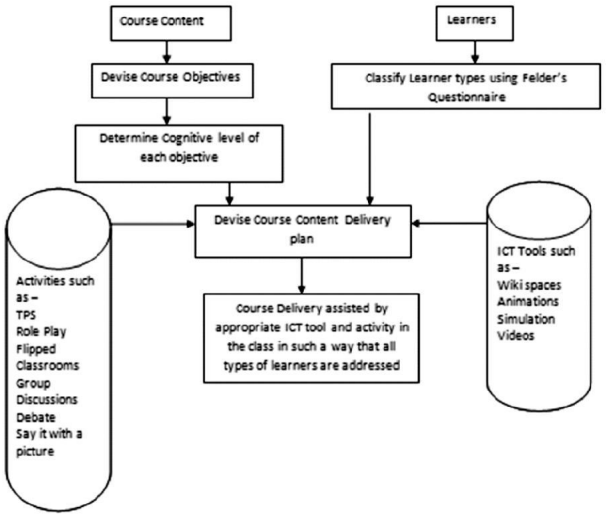


Figure 2

3. Mapping Al Strategies With Course Contents

The ICT tools and active learning strategies involved in the content delivery should be chosen in such a way that they complement the content. Only then employment of ICT tools and AL methods would improve the attainment of course objectives. To ensure this, it is highly important to carefully study the nature of the course contents to select appropriate ICT tools and AL methods.

[5] Provides guidelines on identifying the content structures. An educational content may contain

i. Facts
ii. Concepts
iii. Rules and Principles
iv. Procedures
v. Interpersonal skills
vi. Attitudes

Considering the above categories, content of various Computer Science Engineering coursescould be categorized as given below:

a. Facts
b. Concepts
c. Principles (which may include design principles)
d. Procedures (which may include algorithms)
e. Derivations
f. Problem solving (Numerical/ Analytical)

Any computer science engineering course content would fall under one or more of the above six categories.Once the nature of the course contents isanalyzed and fitted into a content structure mentioned above, it is a good practice to lay out the learning objectives. Every objective is linked to a cognitive level. Associating the learning objectives to an expected cognitive level of learning provides an idea on the width and depth of contents to be delivered which in turn would help choosing an appropriate delivery method. Bloom's Taxonomy [8] provides a guideline to fix the cognitive level of learning objectives.'Recall','Understand','Apply',Analyze','Create', and 'Evaluate' are the knowledge levels given in [8].Rest of this section explores number of active learning methods andICT tools. Also suitability of their usage for a given content type is explored

Facts, Concepts and principlescan be delivered with the help of aids like labeled images, charts, flash cards. Further, the students may be encouraged to inquire into the facts using multiple ICT tools available such as blogs, wiki spaces, and e-learning opportunities such as moocs[6]. ICT tools can be used together with active learning strategiesto deliver the course contents. ICT tools and AL methods are chosen based on the cognitive level at which the course contents are expected to be learnt. To teach facts/concepts and principles at “Recall” level, an activity called “Fact or Not” – a technique where students are given a set of statements based on the particular fact/concept and asked to judge the correctness of the statement- may be used. This helps the students to remember the content taught.“Focused Listing” is another activity that could be employed while teaching facts/concepts and principles at Recall level in which the students could be asked to absorb the vital information presented during lecture session and have a discussion on the same. Preparing the list

of vital information and discussing the same would help the learners to recall and understand the concepts learnt. While teaching the facts/concepts and principles at apply level,activities such as brainstorming and "Think-pair-share"may be used. These activities help the students to learn how a concept/idea learnt can be applied to solve real world problem.Think-pair-Share activity can be used in such a way that the participants work on the given problem individually and then in pairs. Think-pair-share activity should be based on pre-planned questions that would test if the students are able to application of the concepts learnt.To teach Facts/concepts and Principles at analyze level, Case studies/Scenarios can be used. Participants discuss and analyze the given scenario/Case, study based on the concept/Principle and Facts. In this way, flow and nature of the activities/ICT tools chosen should match the inherent nature of the contents taught.

Usage of animations for teaching contents if the inherent movement of the animation and the content matches in terms of speed, physical nature and subject matter is recommended in [5] .Hence usage of animation would be apt for delivering course contents that are sequential in nature such as Procedures and Problem solving. But the instructor should ensure that the speed and physical nature of the animation matches that of the content. In the same lines, Simulations would be apt to teach problem solving topics."Two-Column method" would be a suitable activity for teaching problem solving at various cognitive levels. In this activity students are given a problem and present various solution approaches in separate columns.While performing the activity, students are expected to fill up each column with the details, principles advantages and disadvantages of the corresponding solution approaches. This helps the students to recall the various facts related to the topic, understand the concept better and look at the considerations to apply the ideas and analyze them totally.

Group based problem solving is another activity that could be used to teach problem solving in a class. The inherent nature of the activities chosen match that of the contents taught.

The blend of ICT tools and AL strategies chosen contains visual, auditory and kinesthetic components. Hence the content delivery mode supports all the three learning styles addressing the learners of all styles. For example, consider the activity 'Focused listing". While presenting the contents using slides, visual learner would be benefitted. As contents in the list prepared by the learners are discussed, auditory listeners would be benefitted. Since learners will not be passive and asked to perform some kind of activity, woes of kinesthetic learners would also be addressed in the delivery plan.

Various active learning techniques and ICT tools used to teach contents at a given cognitive level are given in Table 1[7].

4. Implementation

In this work, Computer Networks is taken as sample course and 72 students of fourth semester of B.Tech IT are involved

In order to test the effectiveness of the proposed idea, some of the topics were taught using the proposed methodology while remaining topics were taught using traditional teaching methodology. Major topics covered in the course are given below

OSI Network Model, TCP/IP Network Model
DLL Functions – Framing, Error Control, Flow Control,Access Control
IP Addressing, Routing
Transport Layer Functions – Reliable Delivery, Flow Control, Congestion Control.

Initially, to identify the learner types, Felder question naireis used to survey the learning style of the learners. Almost 40% of the Students were found to have moderate to strong orientation to a particular

Nature of Course Contents	Cognitive Levels	ICT Tools	AL Technique
Facts/ Concepts/ Principles	Remember	Labeled Images	Fact or Not, Focused Listing
	Understand	Video	
	Apply	Excel	TPS, Brainstorming
	Analyze	Simulation Games	Case Studies/Scenarios
	Evaluate	Ms-word	NA
	Create	Wiki	NA
Procedures / Problem Solving	Remember	Animation / Simulation	Two-Column Method / Group Based problem solving
	Understand		
	Apply		
	Analyze		
	Evaluate		Group Discussion
	Create		Mini-Projects

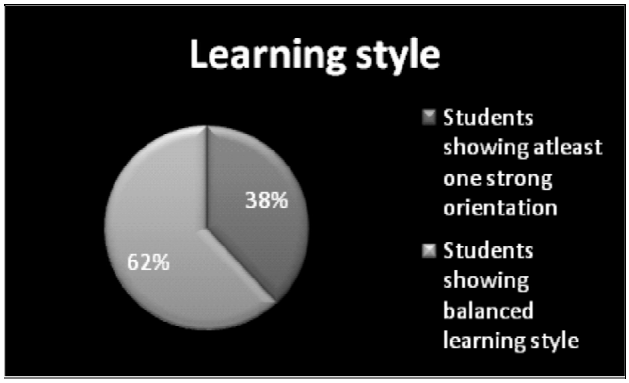
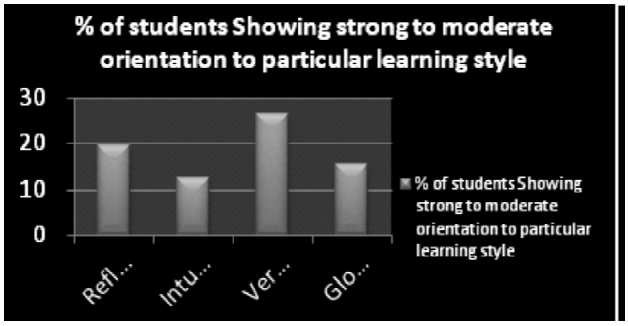


Figure 3



style of learning(Reflective, Intuitive, Verbal and Global) as shown in the Figure 3.

Figure 4 shows the percentage of students with a specific orientation as per Felder's scheme of evaluating learner's style

This orientation of a considerable percentage of students in a class towards a particular learning style should be considered while charting the delivery plan. For example, it should be noted that over 25% of the students in the class have strong verbal orientation and considerable percentage of them show strong orientation to global style of learning. Hence it is better to chart a delivery plan with activities that majorly include discussions and information sharing that allows students to process information in bits and pieces.

OSI Network Model, Network Topology
Error Control, Access Control
Routing
Congestion Control

At the next step, Learning objectives and expected cognitive level of learning for each topic were identified. The following topics were chosen to be taught using the proposed methodology.

Nature of the contents under these topic is analyzed and accordingly an ICT tool has been chosen.Table 1 given above was refered to choose the appropriate ICT tool and AL method. For example, for the contents under Congestion Control, animation is chosen as an ICT tool, since congestion control is inherently sequential in nature. Group discussions and Two column method activities were carried out to teach the various aspects of congestion control techniques at the cognitive level of analyzing. Similarly, Role play was chosen to teach OSI network model. Problem solving followed by discussion was used to teach Routing, assisted by ICT tools like AV shows on the related topic.

4. Performance Evaluation

Performance evaluation of the proposed approach is majorly through the periodic tests conducted throughout the semester (Continuous Assessment Tests – CATs). Three CAT exams were conducted in a semester, each at an equal and regular time interval. As the course under concern, has been taught using the mix of both hybrid and regular approach, pattern of students' performance in the topics taught using hybrid approach and topics taught using regular approach were studied carefully.

Marks scored by students in each question were taken into account. For each assessment, aggregate of marks scored in the topics taught with hybrid approach and aggregate of marks scored in the topics taught with usual approach were calculated and normalized to be on the same scale. Aggregates of these two categories were compared. Sample data of the evaluation carried out is given below in the table 2

Table 2

Samples	CAT I			CAT II		
	AL Average	Non-AL Average	Difference	AL Average	Non-AL Average	Difference
Student 1	37.33	43.67	**6.33**	40.00	8.00	**32.00**
Student 2	37.33	48.83	**11.50**	40.00	15.00	**25.00**
Student 3	37.33	45.00	**7.67**	31.11	17.00	**14.11**

Though in the first Assessment there wasn't much difference in terms of students' performance, usage of proposed hybrid teaching methodology appeared to have brought in major difference in the further assessment tests. The complete results are shown in the Figure 5.

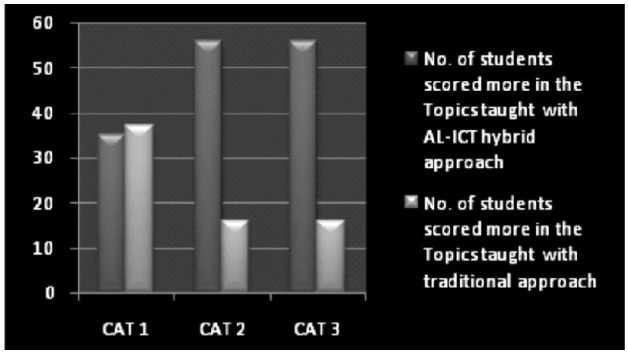


Figure 5

The not-so-impressive results in the first assessment might be due to the initial hiccups of adapting to new active learning environment. In order to further analyze the results, marks scored by the students in the questions that test their higher order thinking (Apply and Analyze levels as suggested by Bloom's taxonomy) is focused. Since first assessment test did not have any relevant question under this criterion, the other two tests were considered. Figure 6 shows the students performance in the area of higher order thinking tests.

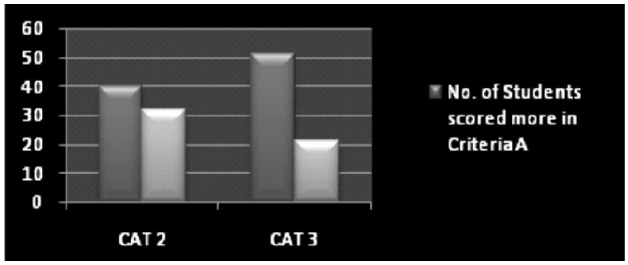


Figure 6

The graph clearly shows that the hybrid approach of teaching actually helps the students in the higher order thinking domain.

Further, in order to analyze the effect of the proposed approach of teaching on individual students a sample set of 24 students were chosen by random sampling method. The aggregate they scored under each criterion of topics and the percentage by which one excel other are shown below in figure 7

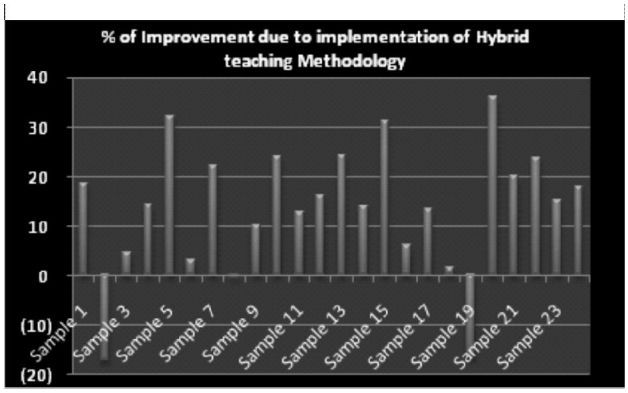


Figure 7

From the graph it is inferred that except negligible number of samples, all the other have showed improvement due to the application of proposed method. Maximum of 35% improvement is shown in a sample whereas an average of 15% improvement has been shown. Though 15 might sound average numerically, 15% improvement in the marks means a student scoring 75 has scored 90 and a student scoring 45 has scored 60 which can be considered as decent improvement.

6. Conclusion

Our proposedhybrid approach on content delivery gives learners an engaging role in the learning process. IntegratingICT tools and Active learning strategiesbased on the nature of content structures appropriately eliminates teacher-centered, lecture oriented learning environment and creates a learner - centered, interactive and constructive learningenvironment.It also improveshigher order thinking skills in the learners, since it is adaptive to individual learning styles.

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