An Illustrative Study on Methods of Improving Student Engagement

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Abstract - Globalization and the accelerating pace of change in technology have placed new demands on higher education. Graduates are expected to acquire knowledge, technical skills, critical thinking, problem solving, teamwork, adaptability to multidisciplinary domains and communication. Student engagement is the key to effective learning and sustainability. This paper presents various collaborative learning methods that can be used to increase student engagement based on the practical experiences of the authors in teaching courses in Electronics and Communication Engineering.

Keywords: Student Engagement, role-play, concept maps, think pair share, Jigsaw

Introduction

Modern pedagogy has shifted the focus from transmission of knowledge from the faculty to the learner to interactive teaching and outcome based education. In interactive teaching, students will become partners in the teaching – learning process. Interactive and innovative teaching methods make teaching interesting, engaging, challenging, reliable and rewarding and also lead to better retention of knowledge. Student engagement is the level of interest, attention, and curiosity that a faculty is able to create in students, who are learning or being taught.

Studies suggest that 25% to 60% of students are chronically bored and disengaged in the classroom [1], [2]. Effective student engagement in higher education will lead to student satisfaction, persistence in education, academic achievements and social engagement. After analyzing 44 studies, Fredricks et al. in [3] proposed three different types of engagement, i.e behavioral, emotional, and cognitive. Anderson et al. [4] organized engagement into behavioral, academic, cognitive, and psychological dimensions. Behavioral engagement refers to the student's willingness to participate in the learning process by attending class, listening attentively, finishing homework and assignments, writing test / exam etc. Emotional engagement refers to the student's emotional mind-set towards learning. Behavioral engagement does not guarantee Emotional engagement. Cognitive engagement is connected with the way of thinking or conscious mental processes. It refers to learning that maximizes a person's attention, memory, and creative thinking [4]

In [5] Bloom *et al.* classify learning into cognitive, affective and psychomotor domains. The cognitive domain refers to the development of knowledge / skills and the ability to use that knowledge. Affective domain refers to the student's emotions and judgment of the cognitive aspects. The psychomotor domain refers to physical activity that occurs with or due to the cognitive learning [5]. In engineering education much focus is given to the cognitive domain and the attainment of learning outcomes. This results in excellent behavioral engagement but very poor emotional engagement. The need for affective learning through emotional engagement is discussed in [6]-[12].

Effective learning is possible only when there is learning in all the three domains. Student engagement can be ensured by employing modern pedagogy like role-play, concept maps, think pair share, zigzag etc.

In Section II we discuss five methodologies, role-play, concept maps, think pair share, Jigsaw that can be used to improve student engagement. In section III, we discuss the results of the using above methods to enhance student engagement in subjects like Digital Electronics, Signal and Systems, Embedded and Real Time Systems course of Electronics and Communication Engineering program.

II. Overview of some pedagogical methods that can be used to improve student engagement:

i. Role-play

Role-play is a method in which learning happens in cognitive, psychomotor and affective domains. In role-play the instructor / teacher gives the topic or prompt to a group of students who act out roles. Role-play is usually done by Role-Switch in which the concept is understood from the actions of either people or things who take up the role of the component/system/concept [13]. Role-play is an effective active learning strategy which encourages participation of passive learners, increases retention of concept and adds enthusiasm to the classroom environment [14].

ii. Concept maps

A concept map uses visualization technique to organize knowledge based on the relationships between the concepts. It is basically a pictorial representation in which the concepts are written inside circles / shapes and connected by arrows with linking phrases. Concept maps can be used as a teaching methodology, learning strategy, assessment tool, and planning curriculum. It helps learners to synthesize information, organize concepts and assimilate information [15]. The major advantage of the concept maps is that it supports visual presentation, focuses on concepts and makes learning easy [16]. Concept maps are usually top-down hierarchical and do not use graphics and symbols and is different from mind maps. Concept maps as a teaching methodology can be implemented by selecting a topic, brainstorming to obtain key concepts, finding & labeling the relationships between concepts and finalizing the layout by hierarchical structuring.

iii. Think Pair Share

Think-Pair-Share (TPS) is a team learning activity in which instructor poses a question, students first think to themselves before being prompted to discuss their ideas with the person sitting near to them (**P**air) and finally **S**hare what they discussed to the entire class. This method provides an opportunity to work in small groups and a safe environment in which they are not scared to mistakes during the learning process [17]. The advantages of this method are students learn to communicate [18], improve problem solving skills, requires no or less preparation. For the faculty it increases student engagement and improves student learning outcomes. Generally, TPS is done when higher order thinking skills are required. It is done as a few minute activity or more. The faculty must ensure that the question is challenging and aligns with the learning objective of the day/week [19].

iv. **Jigsaw**

Jigsaw is group activity in which the contribution of each participant impacts the solution. The activity is divided into two phases. In the first phase students are divided into small groups and each group is given a different modules/part of a problem statement as shown in table 1. Each group discusses the problem and creates a group response. In the second phase new groups are formed, comprised of students from different groups. Each student of the intermixed group should justify his group response and contribute in finding a collective solution. The grouping of students may be self-selected or intentionally chosen based on abilities & interests or randomly assigned by the faculty. This method engages all the students and allows every student to participate. Jigsaw improves the knowledge and its retention [21]. This strategy encourages students to actively listen, communicate with others and prompts students to improve and practice skills. It also improves critical thinking and teamwork [20, 21].

Table 1: Phases of Jigsaw Activity

Phase I- Expert groups	Module 1	Module 2	Module 3	Module 4
Phase II – Intermixed project groups	Project 1	Project 2	Project 3	Project 4

III. Results of Case study

A sample set of 60 students from the 2014 -18 batch was taken, to analyze the effect of role-play, concept maps, think pair share, zigzag on the teaching –learning process. The subjects were carefully selected to demonstrate the chosen methodology and understand how student engagement influences learning.

a. Role Play

The course, "Digital Electronics", focuses on the theoretical background of Digital System Design. The course is selected as it links the theoretical aspects with the professional practice. It provides scope for learning in the cognitive, affective and psychomotor domains. For this reason Role play was selected to discuss the shift register concepts. There are four types of shift registers Serial In Serial out (SISO), Serial In Parallel out (SIPO), Parallel In Serial Out (PISO), Parallel In Parallel Out (PIPO). Learning material on basic concept, procedures, etc. was provided to the students in advance.

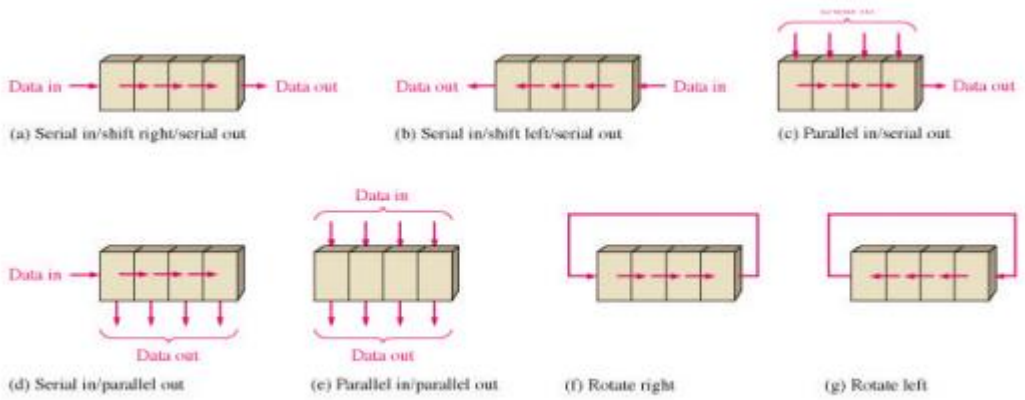
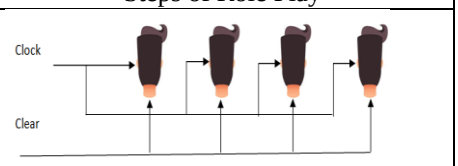
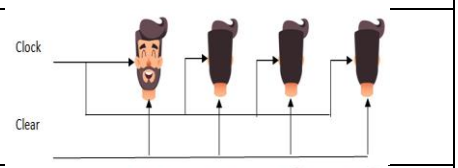
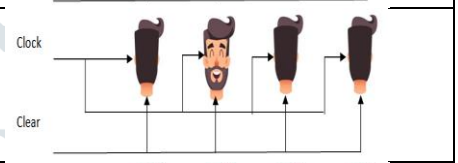
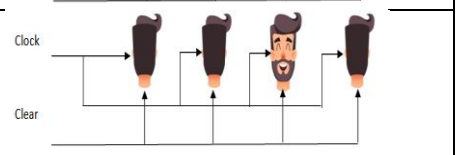
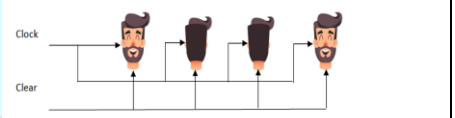


Fig.1 Types of Shift Register

As a sample, the concept of Serial in Serial out (SISO) shift register using role play methodology is shown in table 2. A basic 4-bit Serial in Shift right Serial out can be constructed by D-flip-flop. The input data is then applied sequentially to the D input of the first flip-flop. During each clock pulse, one bit is transmitted from left to right. The operation of the circuit was enacted as follows. Four students were used to do the role-play. Assume that the data word to be stored is 1001. Bit "1" is represented in the table 2 as a face and bit "0" as the backside of head.

Table 2: SISO operation using Role Play

Shift Register Operation	Steps of Role Play
All FF are cleared & Data =0000	
After first clock Data =1000	
After second clock Data = 0100	
After third clock Data =0010	
After fourth clock Data =1001	

b. Concept maps

The course, "Signals and Systems", focuses on the theoretical background of basics of Signal Processing. The concept map was used as a knowledge organizing tool to help students in the understanding and follow-up of the subject. The students are in the third semester and usually find it difficult to correlate the signal, system and transforms applied. The instructor can draw a concept map based on key concepts, finding & labeling the relationships between concepts by brainstorming and finalizing the layout by hierarchical structuring. As a sample, the concept linked to linear time invariant system as a concept map is shown in fig2.

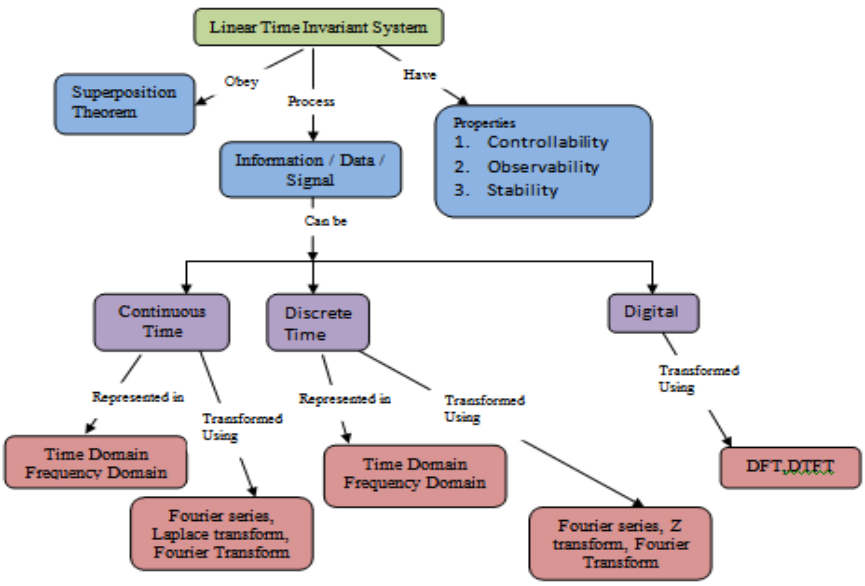


Fig.2 Example of Concept Map

c. Think Pair Share

The course, "Embedded and Real Time Systems", focuses on the design of embedded systems. Think Pair and Share method was used as an active learning method, in which the students were given a chance to think, discuss their answers with their peers and then share the answer with the class. Two samples of the questions asked is given below in table 3 & 4.

Table 3: Sample 1 for Think Pair Share

1.	No. of Students in Class	30
2.	No of Groups	10
3.	Question	Which microcontroller is suitable for temperature measurement?
4.	Parameters	ADC, No of data Bits, Cost, Power consumption, Speed, Size
5.	Probable/Expected Answers	PIC16F877A, ATMEGA32 Microcontroller

Table 4: Sample 2 for Think Pair Share

1.	No. of Students in Class	30
2.	No of Groups	10
3.	Question	Name the electric actuator that can be used for movement of Robot arm
4.	Parameters	Speed, Weight, Degree of freedom, Power requirement.
5.	Probable/Expected Answers	Stepper Motor, Servo Motor

d. Jigsaw

Jigsaw learning methodology was used to improve the students interest in finding solutions to real time problems. Students were given the option to choose their area of interest and provide solutions to real time problems. Two samples are given below. The process and sample results of example 1 are shown in table 5 & 6.

Example 1: PEGA tool based Food order / Insurance Policy / Movie Ticket booking / Students leave
Module1: Specification
Module2: Life Cycle Design
Module 3: Process Design
Module 4: User interface design

Example 2: Design an IOT based System for Home appliances/Industry boiler/Printers/UAVs.
Module1: Sensors
Module2: Acquisition and Processing Unit
Module 3: Interfacing with cloud
Module 4: Retrieval from the cloud

Table 5: Example 1 for Jigsaw

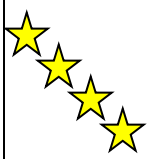
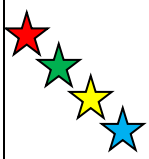
Phase I- Expert groups	Module 1- Specification	Module 2 - Life Cycle Design	Module 3- Process Design	Module 4- User interface design
				
Phase II – Intermixed project groups	Food order	Insurance Policy	Movie Ticket booking	Students leave
				

Table 6: Results of example 1 for Jigsaw

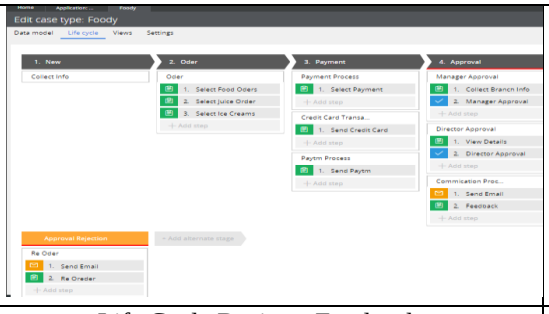
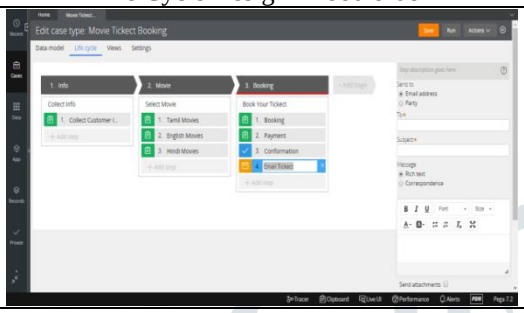
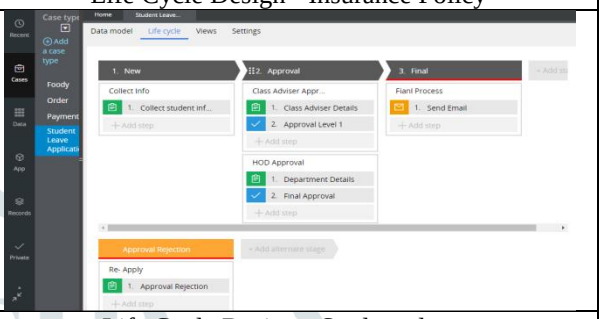
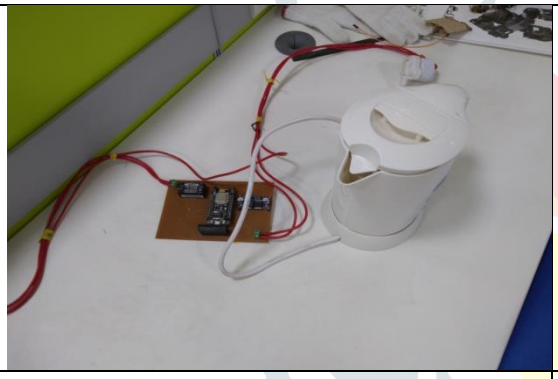
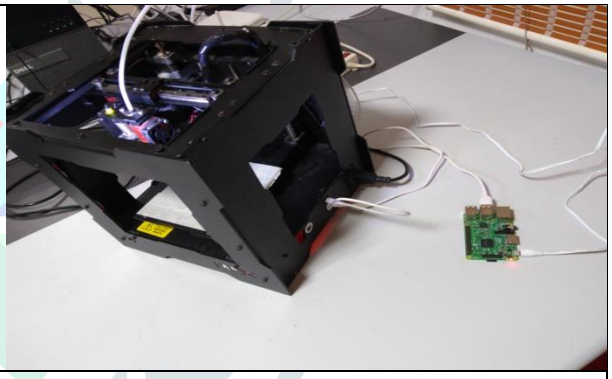
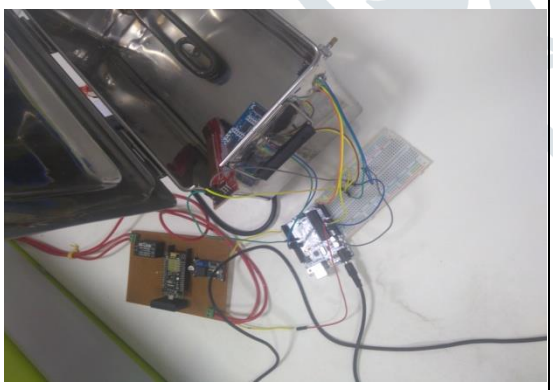
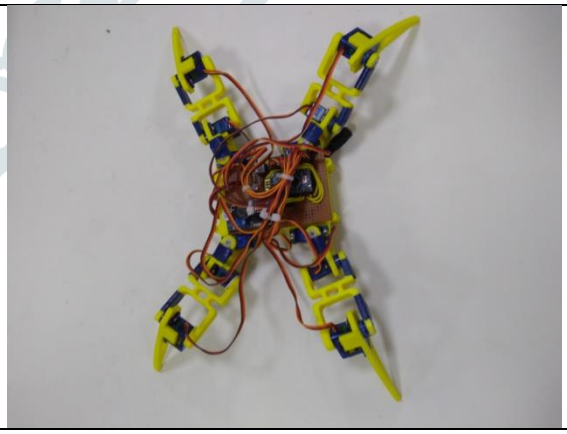
	
Life Cycle Design - Food order	Life Cycle Design - Insurance Policy
	
Life Cycle Design - Movie Ticket booking	Life Cycle Design - Students leave

Table 7: Results of example 2 for Jigsaw

	
Home appliances	Printers
	
Industry boiler	UAVs

Conclusion

In this paper some collaborative learning methods like role-play, concept map, think share pair, Jigsaw that can be used to increase student engagement based on the practical experiences of the authors in teaching courses in Electronics and Communication Engineering were discussed. Based on the student feedback and student interaction the above methods were found to increase the interest, understanding of subject and retention of knowledge.

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