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# Problem-oriented and project-based learning (Popbl) as an innovative learning strategy for sustainable development in engineering education

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## ABSTRACT

Each and every student is a unique individual who desires a caring and inspiring atmosphere in which to develop intellectually, mentally, and socially. My vision as an educator is to pass on quality education by adopting a novel teaching-learning practice and to contribute to the betterment of society by adopting good certified practices for economic and technological development. As a teacher, my motto is to direct and provide contact to information rather than acting as the main source of information. In our institution, we aim at providing complete value based education to meet the requirements of society. To develop the skills in my students I make them engage in learning by giving them the background of the subjects, its need, and application in the real world. Currently, I am dealing with Antenna and Wave propagation subject for the 3rd year Electronics and Communication Engineering students who have most of the times worked with circuits, software's, and design devices, etc., without knowing the internal design details and its techniques. This course gives them a clear idea about the communication techniques and also how Antenna plays a vital role in the transmission and receiving process.

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## 1. Introduction

The success of a teacher is assessed by thriving performance of the students. The performance evaluation process includes mid-semester, end semester exams, assignments, seminars, quizzes and, feedbacks from the students. For this, I continuously refer to the updates associated with the topics on the web, go through the online material, and attend workshops. As an instructor, I have to improve my skill in engaging the millennial students and create interest to think in a perspective logical needed to benefit society. In my first class, I posed a number of questions (brainstorming) regarding general ideas about the subject and its applications in the real world. The students have participated in the discussion related to the topic they are about to explore, this helped in creating interest in the students. Education is a student-centric process that involves the student's active participation in class. Our institute has designed a program curriculum with objectives and outcomes that are given to the students at the beginning of the course. To prepare the lesson plan for the subject I considered

the feedback from the students and faculty of the previous semester [1–4]. This gives me an immense idea about the student's perceptive levels, ability to solve logical problems and critical thinking analysis. Based on these points I designed my lesson plan and the activities that are to be carried out during the respective course work. My final goal is to make the students understand, analyze the concepts and emergent their skills and apply those skills in real-world applications [3].

Outline to Engineering is a course which offers an (Tables 1 and 2) acquaintance to the range of multi-disciplinary engineering career prospects, and generates a practical framework for the engineering students study. This is made through a session of lectures, activity based sessions, assignments, group-based activities, pain storming sessions, brain storming sessions, presentations, skill development and designing a prototype. Since the chief quality of efficacious qualified engineers is the capability to transfermeritoriously, the course emphasizes on refining required aids. As part of a clusterlearners will effort the Engineers with-out Margins of challenge, which is an occasion to develop engineering clarifications to a critical situation by certain emergingpublic. This branch offers an interactive learning exposure for students keen about the activearena of Engineering Discipline. Lessons will state the practical and

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**Table 1**  
ARCS Model.

| S.No       | Objective  | Strategy   | Example  |
|------------|--|--|--|
| Attention  | To emphasis students kindness to learn basic concepts.                     | Perceptual Encouragement (Concreteness) – Use exact, significant illustrations. Investigation Arousal (Participation) – Offer role performance or practical skill.   | Which type of antennas are you using in different communication purposes? Let the students analyze which material is used for antenna and what are its limitations   |
| Relevance  | To elucidate the importance of Antennas.                                   | Aim Orientation (Future Usefulness) – Describe how the knowledge will help in the <i>forthcoming</i> (getting into university, finding an occupation, getting an upgrade, finishing allotted jobs). Familiarity (Modeling) – Bring in character copies (society who have used the facts that you are awarding to recover their survives).    | In an interview, the Questions will generally be: which mathematical condition explains about the working of the Antenna. Industrial expert talk: to create awareness and exposure for the students with respect to the different types of Antennas and changes in the Antennas. |
| Confidence | Assist to develop assurance in the critical thinking assistances educated. | Learning Desires- Beginners must be provided with knowledge ethics and evaluative principles (rubric) upfront to launch confident prospects for accomplishing achievement. Success Opportunities –Beginners must be assumed the chance to attain achievement through several, diverse, and inspiring knowledge's that form upon one another. | After finishing the course, students shall design the antenna parameters and its efficiency. Students will learn to identify the different types of antennas and which type of antenna is used for a specific application.   |

logicalaids that are energetic to complete a course and occupation in starting level of technology [5–8]. The course is useful for interested graduates who wants to gain exposure to the real-worldsolicitations of methodical theory and for individuals who goal to achieve higher courses in the technical field of technology [11].

## 2. Integrating the ARCS model into a lesson plan

### 2.1. Electronics and communication engineering

- I had used a few games, role play and puzzles to change the attention of the students in the class.
- I have conducted some motivational talks to build up the confidence in students

- I need to learn new technologies to update myself that will helps to millennial students.
- Need to design a few more activities in lecture with the ARCS model.

## 3. Fundamentals of course design

Design a hand book that to be distributed at the first day of a course, which provides department vision and mission, Topic learning outcomes and course learning outcomes mapped with program outcome and program specific outcomes, the ground rules, pre-requisites, assessment pattern with the honour code. Design different learning activities to address the needs of the students with different learning styles [9,10]. Write the learning outcomes in various levels of Blooms Taxonomy [11,12]. Design effective lectures to involve the scholars actively in large lecture room as shown in Fig. 1.

**Table 2**  
Construction of grading rubric.

| Criteria                | Exemplary   | Accomplished   | Developing  | Beginning  |
|-------------------------|---|--|---|--|
| Innovation and          | Creativity  | Eagerly followed instructions demonstrated. High level of enquiry on original idea related to design.  | Followed instructions. Basic level of enquiry and applied them to task.   | Some, but not all instructions were followed. Low level of enquiry and minimal effort on developing ideas.   |
| Did not follow          | instructions. No enquiry and evidence on development of idea.   |  |   |  |
| Knowledge and           | Cooperation   | The student has excellent knowledge of concepts and processes that supports their design task. Assigns a clearly defined role; and Always considers all views and helps team to reach fair decision. Group tries to solve its problems by itself without seeking outside help. | The student has good knowledge of concepts and processes that supports their design task. Assigns roles, and Usually considers all views and helps team to reach fair decision. Group seldom solves its problems as a team and asks classmates or teacher for help. | The student has satisfactory knowledge of concepts and processes that supports their design task. Assigns roles, but Often sides with friends instead of considering all views. Group settles problems and gives up easily |
| The student has limited | knowledge of concepts and processes that supports their design task. No effort made and Acts as cliques or individuals rather than group. Little attempt to solve problems; gives up easily |  |   |  |
| Principles of design    | Student work meets all the criteria and exceeding expectations in design. The design is efficient and easy to understand.   | Student work meets most of the criteria and meets expectations. The design is efficient and easy to understand.  | Student work meets some of the criteria and meets expectations to some extent. The design is inefficient.   | Student work meets none of the criteria and does not meet expectations. The design is inefficient and difficult to understand.   |
| Prototyping and Testing | The prototype produces the valid output. The prototype works completely for all valid inputs.   | The prototype produces the valid output. The prototype works for most inputs there may be some logical errors in the program.  | The prototype produces the output with some warnings. There may be some logical errors in the prototype.  | The prototype does not produce correct output for even the sample inputs. There may be more logical errors in the prototype.   |



Fig. 1. Brainstorming sessions among students.

### 3.1. Implementation of experimental course

- Course title : Antennas and Wave Propagation
- Discipline : Electronics Communication Engineering
- Level : B.Tech III year I semester
- Credits : 4
- CIE Marks : 30 Marks
- Mid 1 : 20 Marks (Scaled to 10 Marks)
- Mid 2 : 20 Marks (Scaled to 10 Marks)
- Day to day : 10 Marks
- SEE marks : 70 Marks
- My First Class
- Introduction about myself and class.
- Distributing Hand book.
- Introduction to the subject.
- Course Learning Objectives.
- Course Description Document.
- Ground Rules for the Course.
- Office Hours.
- Course Plan.
- Sifting of the contents.
- Course Delivery.
- Lecture Plan.
- Course Activity.

### 3.2. Reflections

- Conducted brain storming sessions as shown in Fig. 1 about the subject pre-requisites and its applications to know the students understanding levels.
- Conducted quizzes and group activities at the starting of the semester to know the learning styles of the students.
- Implemented some of the active learning strategies like group discussion, think-pair-share, minute paper and questioning for actively engaging the students in the class.
- Proper activities were designed for the day to day class.
- Most of the students were very much interested and actively participated.
- Improved results in mid-semester and end-semester examinations.

### 3.3. Difficulties faced

- I was lagging by lesson plan nine classes because the first time I am implementing this type of strategies which consuming more time.
- Pre-planning the course activities was difficult and bringing back the students after the activity was challenging.
- Time is not sufficient for some activities.
- Lack of basics in students with absenteeism.

### 3.4. Refinements

To overcome this I will post the material through mail after each class so that every student can access material even though they are absent.

I would like to take some pre-planning action by posting the course material, rules and regulations regarding the activity through e-mail well before the class. So, the students are prepared well in advance. Absentees can also actively participate in the activity and also complete on time.

## 4. Harnessing the power of technology

- Enhanced Students involvement.
- Helps students who were absent.
- Flipped class room technology, improved student performance.

### 4.1. Technology resources

- <http://jntuh-elsdm.in>
- This website had been maintaining by JNT University, Hyderabad.
- To access this site, faculty and students are provided with login-ID. This is the site that has course material readily available and can be accessed free of cost by the students and faculty.
- The material includes lecture notes with animations images, quiz questions and question papers.
- There is provision for faculty to add contents, author questions, and conduct quizzes/tests.
- <http://nptel.ac.in>
- NPTEL (National Programme on Technology Enhanced Learning) is an initiative by seven Indian Institutes of Technology (IIT Bombay, Madras, Delhi, Kanpur, Guwahati, Kharagpur and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
- From this site the students can view or download lecture notes and course recorded videos.

### 4.2. Flipped-Class implementation

I had conducted a flipped-class for III year I-semester ECE Students. I made a video of guidelines to the students to make the best use of the resource and which is posted in class WhatsApp group prior to the activity.

### 4.3. Assessment

- To assess the students in flipped class, they were supposed to attend quiz exam.
- After this the Students were given an assignment of submitting a documentation report on designing and applications of parabolic antenna.

#### 4.4. Results

- I have conducted flipped class on 04–09-2018.
- The pass percentage under traditional lecture style is 78% where as under flipped class it is 88.5%, a more than 10% increase.
- Also the average marks of class are increased.
- I have conducted quiz for 30 marks.

#### 4.5. Reflections

- I used pre- and post- flipped class surveys, which shows the change in students learning experiences and perceptions.
- In survey on flipped class they reported that, it increased their involvement in learning, understanding of the learning material, and confidence in their ability to understand it.
- They reported that, lower stress levels in flipped classroom environment compared to other classes.
- Helps students who were absent.
- Good resource for students who may not know what to focus on.

#### 4.6. Challenges faced

- I have to improve my skill set in making the videos interesting for the students
- I am unable to determine how much they are utilized the lecture notes or videos

#### 4.7. Refinements

- Finally, to improve flipped classroom, to have additional in class learning activities and better videos.

#### 5. Effective assessment

Rubrics are used for the effective and transparent assessment of the student's outcomes.

- Students are able to understand, what they are expected during the assessment.

#### 5.1. Assessment items

I taught "Introduction to Engineering", a freshmen course in engineering. In this course the students have to develop a prototyping model as part of their course project. To effectively assess the students I am considering the list of assessment objectives are as follows:

- Innovation and Creativity.
- Knowledge and Cooperation.
- Principles of design.
- Prototyping and Testing.

#### 5.2. Reflection

- It helped me in effectively evaluating the student performance.
- Assessment can be made transparent.
- The students were given the rubrics prior to the test that helped them while preparing for the tests.

#### 6. Conclusion

It gives me an immense pleasure to prepare this topic as a journal program. As an instructor I have conducted few interactive in-class sessions where students enjoyed the learning by active learning and collaborative learning strategies. It has helped me to develop a positive attitude among the slow learners and also helped me to upgrade myself towards new pedagogical strategies and latest technologies. These activities improved the student's active involvement and performance through various modules. I'm able to explore my strength and weakness, and also able to setup my short term and long term goals as an instructor. As a whole, I gained lots of knowledge in my teaching carrier through this program.

#### CRediT authorship contribution statement

**K. Rajkumar:** Conceptualization, Methodology, Software. **D. Srinivas:** Visualization. **P. Anuradha:** Data curation. **A. RajeshwarRao:** .

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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