

A closer look at the incorporation of pedagogy aided with technology for Creating Conducive Learning Environment

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Abstract—Educational technology is important because it helps today's teachers to integrate new technologies and tools into their classrooms. This allows a student to flip the notion of a classroom on his/her head by choosing when and where to learn. Video lectures, recordings, and digital resources make it possible for students to learn at their own pace. The walls of the classrooms are no longer a barrier as technology enables new ways of learning, communicating, and working collaboratively. Technology has also begun to change the roles of teachers and learners. This paper discusses the systematic five-step teaching-learning process for effective engagement in the class. These five steps - The Instructional Process, Modular Design, and Course Delivery, Creating a Lively classroom, Employing technology and Assessment are proven processes, and, an effective implementation of the same yielded very good results in terms of enhancement of the skills and overall development of the students' learning perspectives. Giving varied assignments to different groups based on their interest, had a spike in exhibiting their potential. Assessment through rubrics increased the clarity for students to perform and present their work effectively. This was implemented for the computer networks course for CSE branch students and Biomedical Instrumentation and Digital Health course for Biotechnology branch. The impact and results were amazing. There was an overall development of their knowledge and skills.

Keywords—Evaluation; Learning; Pedagogy; Rubrics; Teaching; Technology.

JEET Category—Choose one: Research, Practice, or Op-Ed. (Please note, Op-Eds are by invite only. Refer to the Paper Submission and Review Guidelines for more details.)

I. INTRODUCTION

The emergency of the dreaded COVID-19 in the early 2020 (Tadesse et al., 2020) did not only shake the world but also threw everyone into a state of confusion. For the first time in the 21st Century all businesses, offices, and schools were shut down at the same time. School authorities were bereft of ideas on how to respond to the emergency, time was flying and school calendars were running out. A quick response was to resort to technology. COVID-19 has changed the ways we do things, and the educational system is not left out. It is referred to as the new normal. The advent of COVID-19 amplified the fact that the way we teach and learn is long overdue for change, especially in the era of disruptive technologies. In this era, learning should no longer be situated in a fixed location. Mobile learning advocates propose that, because both the learner and the technology are mobile, learning should happen on the go, anywhere, anytime (Udanor CN et al., 2016). The need for the integration of pedagogy and technology is no longer a desire, it has become imperative.

The incorporation of technology and pedagogy in education refers to the integration of technological tools, resources, and approaches into the teaching learning process to enhance educational outcomes. This involves combining effective teaching methods (pedagogy) with various forms of technology to create engaging and interactive learning experiences. Pedagogy in education has long been centered on traditional techniques, such as face-to-face lectures and pen & paper, chalk and talk, etc. However, the rise of technology-based tools within the education sector has shaken things up a bit. Think of portable devices, interactive textbooks, online education tools, and the likes. Long gone are the days of penned exams when you can have lockdown browsers and fully remote learning.

Tools like Microsoft Office and Adobe Creative Cloud are popular among engineering students; other tools like virtual and augmented reality can enrich classroom learning. Teachers can take their students on an educational virtual field trip they may not otherwise get to travel to. 3D printing opens another door for students to flex their critical thinking, creativity, and imagination while learning how to use a piece of innovative technology. Tech- based applications in pedagogy can create a hands- on, interactive experience for students in all disciplines of all ages.

In the current research paper, section 2 includes the literature review. Section 3 the complete teaching learning process is divided into 5 subsections, comprising of subsection-A which includes the instructional process, subsection-B involves the Modular Design and Course Delivery (MDCD) with two Unit level planning of Courses, Computer Networks (CN) and Biomedical Instrumentation and Digital Health (BIDH) as examples, subsection-C consists of creating a lively classroom elaborated with classroom activities Team Assisted Individualization (TAI) and Peer-Supported Independent Study (PSIS), subsection-D includes how technology is employed and its impact on learning and the last subsection-E comprises of evaluation with and sample rubrics for experiential learning and its impact on assessment. Conclusion in section 4 and finally References are listed in section 5.

II. LITERATURE REVIEW

Digital technologies can help improve education in various ways, such as making it easier for instructors to generate instructional materials and providing new methods for people to learn and collaborate. Thus, it will be up to instructional designers and educationists to use advanced digital technology's potential to revolutionize education such that effective and efficient education is available to everyone and everywhere (V. Varea et al., 2022). The current technology has digitized classrooms through digital learning tools like computers, ipads, smartphones, and smart digital whiteboards. It also expanded course offerings, and increased student's engagement and motivation towards improved learning (A Roy, 2019).

The novel teaching strategy had a positive impact on student learning, and can be applicable for in- person, online and asynchronous learning, providing a mechanism for educators to deliver to students who wish to attend in-person classes, providing options for flexible delivery too (Lewohl, 2023). Digital technologies have brought changes to the entire nature and scope of education. Versatile and disruptive technological innovations, such as smart devices, Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR) and virtual reality (VR), block chain, and software applications have opened up new opportunities for advancing teaching and learning (Gaol FL, 2022). The affordances of social media that students value for collaboration, discussion, information finding and sharing, and practise activities related to their learning can enable interactive, critical engagement and

participatory interaction (Smith et al., 2023).

Assessment and grading is an important phase of any Teaching Learning activity. And the students would be clear in what they are required to do "for a good grade" (Tractenberg, R.E, 2021). Graded assessment tasks in higher education will be a key component in assuring that students have achieved the learning outcomes prescribed by the university, the degree or the unit of study. Summative assessment is commonly described as directing learning mostly in terms of communicating what students need to learn (Tractenberg, R.E et al., 2021) and even as a motivational device necessary to prompt students to engage with specific tasks (Rust, C, 2002).

True rubrics feature criteria appropriate to an assessment's purpose, and they describe these criteria across a continuum of performance levels. The presence of both criteria and performance level descriptions distinguishes rubrics from other kinds of evaluation tools (e.g., checklists, rating scales) (Brookhart, 2018). At its best, a rubric is a carefully wrought expression of the professional judgement of a teacher, and identifies the learning goals and aspirations of performance (Ragupathi, K et al., 2020).

III. PROCESS FOR TEACHING LEARNING

Teaching learning process is very important to keep the students engaged and motivated. For delivery of the content one need to understand the Teaching Learning process, the fundamentals of different learning modes, delivering in small chunks, summing up one aspect then moving slowly to the next aspect without overloading of information. Always engage students and ensure his/her participation in the class activities. Well defined process should be practiced to achieve the same. The figure 1 shows the organised process to be

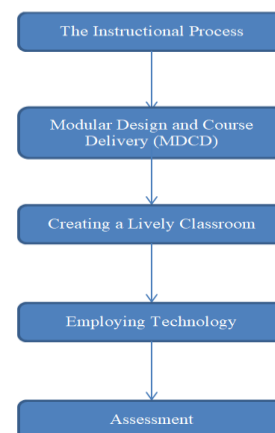


Fig. 1. Flow diagram for teaching learning process.

followed for the teaching learning process to aid effective classroom engagement.

Detailed discussions about all the five processes are showcased below.

A. The Instructional Process

The Teaching-Learning/instructional process should start with introspecting ourselves, where we stand as engineering college educators because there is no formal training for Engineering faculty unlike for primary, secondary education and other degree courses where its mandatory for teachers to have teacher training programs like B.Ed., M.Ed. degrees which mainly focuses on method of teaching.

In line with this it is mandatory for the Engineering faculty to undergo some certification courses on Teaching learning pedagogies, blended learning, use of technology for teaching. Every teacher's dream is to excellently teach and keep updating her/his knowledge. For achieving this, the teacher has to be a good organiser, well planner and dedicated. Prior preparation is important. The curriculum should be well framed with clear objectives and outcomes.

From the students' perspective, the learning objectives must be clear. In a diversified class, students have different styles of learning, i.e., impending learning, different levels of intellect, different knowledge and skill sets. The present generation Z students whom we are teaching are very tech savvy with a lot of distractions that keep their concentration level less than 10 minutes. Teachers should cater to the needs of this generation. There is the need to train students on how to apply the theoretical concepts in practice. Team activities play a vital role in solving complex problems which also encourages them to exhibit good team dynamics. All these approaches enhance the students' learning and help maintain good rapport with other students, more inclined towards goal orientation, relevance, and the development of confidence and satisfaction.

The different approaches/tips for effective student learning are:

- Delivering the content in small chunks so that it is not overwhelming for students.
- Making content more relevant and application specific.
- Planning and initiating collaborative and cooperative learning.
- Conducting both short and long active learning strategies and keeping the class interactive.
- Learners can clarify doubts, discuss and exchange ideas about this subject (during office hours)
- Assigning Interesting and arty activities for a topic from the course that enthruses them and boosts creativity like sketching, composing a song /poem, creating videos, word or picture puzzles, preparing models etc.

B. Modular Design and Course Delivery(MDCD)

The modular course design and delivery is very crucial for effective learning. The traditional course design lacks the connectivity between the course material, the assignment of what is expected from the students and the learning outcomes. So it is essential to design our courses effectively and one such method used is backward design for course design. Identifying the desired results first, then the method of assessment to achieve those results and plan the content which can be delivered through different methods is backward design. The theory concepts should be aligned with the applications. The assignments and tests must be designed keeping in mind the Higher Order Thinking Skills (HOTS) so that there is an exponential growth in learning.

Course	Title/Core concepts	Learning Outcomes	total hours: 8 Session duration	Students activities/Practical work	Assignments/Assessments
CN	Transport services and Protocols: Services provided to upper layers, Introduction to UDP, RPC, TCP, its duties, header formats, their working.	CO3	1 hour	Crossword puzzle -for understanding these protocols	Study and analyze how Anydesk and team viewer work-to get a better understanding of RPC protocol
CN	Implementation of Chat room Server/Client programs for various real time applications- working in groups	CO4	1 hour	Lab activity: students form a team of two and brainstorm and design the chat application	Make a video presentation explaining the working of chat application
BIDH	Cardiovascular measurements: Measurement of blood pressure, blood flow characteristics,	CO1	1 hour	MOOCs lecture /video Measurement of BP practical	Quiz for 5 marks 3 Short answers questions for 5 marks
BIDH	Electrocardiogram (ECG) lead configuration and recorders	CO4	1 hour	activity planned: Peer-supported Independent Study in lab	Quiz is planned for 5 minutes and 3 marks Test is planned for 10 mins and 10 marks

Fig. 2. Macro Level Planning for a Part of Unit in the Course

MDCD is designed for two different courses- Computer Networks (CN) and Biomedical Instrumentation and Digital Health (BIDH). A screen shot of sample course design for one unit is done but is depicted in figure 2 for one topic from both the courses CN and BIDH.

Planning and designing the course in this way, assisted not only in organized way of delivering the content but also in effective dissemination, and the activities planned were executed well as students participated with full energy. Further, our focus was to promote teamwork, self- learning and self- reflection. Hence the next step was to create a conducive environment for dynamic learning.

C. Creating a Lively Classroom

It is very important to engage the students effectively in the classroom. Involving students actively using Active learning strategies is the key. Active learning techniques encourage students to participate in their Learning by analysing, debating and researching. In class, students put their knowledge into practice, work through difficult decisions, solve issues, offer answers, and articulate concepts in their own terms through writing and debate. Hence active learning interactive lectures will shift the focus from teacher-centred to student centric. Active learning includes short in class activities viz., Minute paper, TPS, class poll, Thinking Aloud Pair Problems Solving (TAPPS), visible quiz, etc. and most of these activities are conducted in the day to dayclass.

Collaborative learning may include group learning activities where in brainstorming, sharing of ideas, discussions, interaction to improve individuals' knowledge for a given problem and an assignment is emphasized. These activities may have accountability to the individual as well as the group, positive interdependence and group processing. Large classroom activities like Jigsaw, Flipped class; Peer Supported Independent Study (PSIS), Team Assisted Individualization (TAI), etc.can be incorporated in the class. The TAI has been developed in an attempt to make individualized instruction workable in the classroom by adding components of cooperative learning. Here TAI activity is incorporated for the topic Sterilization of medical devices. Glimpses of the same are shown below:

1) *Team Assisted Individualization (TAI)Activity*

- Topic chosen: Sterilization of Medical Devices.
- No. of students present: 12 (Elective Class)

The activity steps followed:

- Topic explanation in the classroom: 30 minutes
- Explanation of the topic and randomly asked the questions to each of the students based on their answers, the informal groups were formed
- Four groups were made, three in each.
- Distributed the reference material of the topic discussed to all the groups. Kindly go through the same and have a discussion among your group for 10 minutes.
- Then after 10 minutes of discussion, asked a few earlier and new questions pertaining to the topic.
- Announcement was made to float feedback through Google forms.

Overall the activity was good enough to implement and if proper planning and home work is done then TAI can be executed in the expected manner in the classroom. After a successful completion of the TAI activity, a google form was floated where eight students gave feedback about this activity. The Feedback results are shown in figure 3. The

marks were plotted students on X-axis and as a percentage on Y-axis in terms of excellent=3, very good=2, good=1 and none/nil=0.

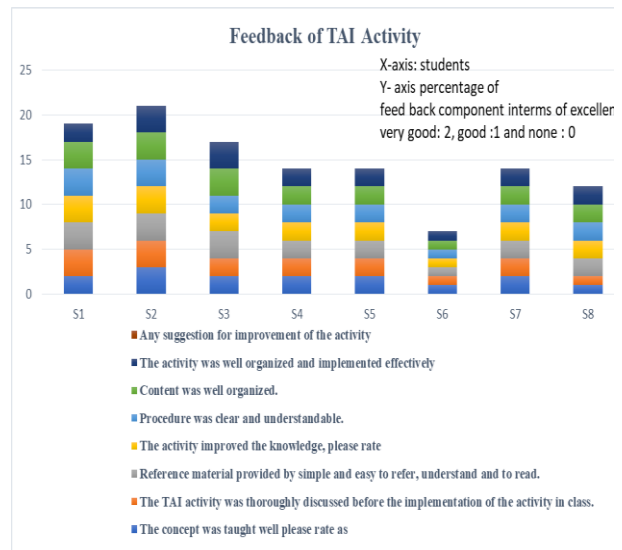


Fig. 3. Representation Of The Feedback

2) *Peer-Supported Independent Study (PSIS) -*

An Effective Model for Enhancing Student Engagement and Optimizing Class Time, PSIS requires the instructor to identify sections of the regular coursework that students can manage by themselves. The instructor creates tasks from the identified course content that are completed independently by peer groups of 3 to 5 students [16]. PSIS activity for 4th semester students for the CN course was conducted. Team Size was 4, Task Duration was 2 Weeks, Total Class strength was 60 and the number of teams was 15 (formal teams)

- The segment selected for PSIS was Transport Layer (TL) and Application layer (AL) protocols.
- Justification for choosing this topic for this activity: Students can manage this topic themselves because the previous unit covered the fundamentals of the TL and some protocols. Also for Application layer (AL) protocols, an invited talk from industry personnel was arranged where they covered the basics of a few AL protocols and also because they are familiar with emails and web browsing, this would be very easy for them. These topics are quite interesting, and they will be motivated to learn more about them.
- Learning Outcomes for this activity was specified viz. Explore and acquire thorough knowledge about Transport layer protocols, Apply theoretical concepts to real world problems, exhibit good team dynamics as collaborative learning enhances self-learning, responsibility, leadership skills etc.

- Few Topics assigned to groups:
 - Design the chat feature in the online conferencing tool.
 - Design the multimodal learning virtual classroom tool by Identifying the Learning Gaps in Online Education
- The progress of the groups was monitored by conducting a quiz every three days to know whether the concepts are clear. Scheduled doubt-clearing sessions by the end of the first week.
- Evaluation of the activity was purely based on rubrics. Subject experts from different departments of our college evaluated based on the rubrics.
- Outcome and its result: Learners very confidently used the knowledge gained from this activity in practice. They have developed websites and also virtual classroom tools with good features. Many students were self-driven, immersed in learning Teams dynamics exhibited by few teams were commendable but with few teams, it was not great.
- After successful completion of this activity a google form was floated where students expressed their Views about this activity. The Feedback results are shown in figures 4a and b.



Fig. 4a. Screenshots For Few Feedback Questions (PSIS Activity) Responses



Fig. 4b. Screenshots For Few Feedback Questions (PSIS Activity)- 54 Responses

Some observations where the PSIS activity could be improved:

- Random groups could have served better rather than the groups formed by themselves.
- Motivating students is very challenging, although some were very excited and others not.
- Lack of usage of materials provided Students need to become like T-shaped people as T-shaped people will have deep knowledge in one area and a broadbase of other skills.

Reflections:

Although students appreciated this activity and the problem solving tasks given to them were good, lot of pre-planning was required. Design good and interesting learning materials so they are motivated and self-driven. Conduct this activity by giving sufficient time. Next time the work carried out by them should be mandated to be presented in the conference, hackathons, project exhibitions, publications; competitions etc and assign some credits for this activity.

D. Employing Technology

Technology usage in education eases our job by automating the process of evaluation, monitoring, content preparation, hosting etc. The modern technology can be used in class for sharing reading materials, conducting quiz, test, problem solving, on-line interactive virtual labs, online presentations, discussion forums, office hours through zoom, google meet etc. review session online, online proctored exam. These can be hosted on LMS or on our course sites. The present generation students are very happy to use modern technology as they are more tech savvy.

The technology can bring about a transformation in the teaching community in terms of the teacher delivering in the most effective way to the students. Faculty should be well equipped with the technology to tackle the gen Z learning. Table I depicts the tools used for various activities.

Impact of Technology on the Learning

Technology plays a crucial part in learning alongside teaching. The benefits include an improved learning environment., Personalized Learning, Active Participation, Access to Information, Assessment and Feedback, Flipped Classroom, Higher-Order Thinking, Teacher Role Transformation, Real-World Connections and Global Learning, Pedagogical Integration,

Table 1: Tools used for various activities

Sl. No.	Activity	Technology / Digitaltools used
1	Visible quiz	Plickers, quizizz, Kahoot
2	Minute paper	Padlet
3	Video creation (Flipped classroom-out ofclass strategy)	OBS, Screencast Cast- o-matic, Animaker, Canva
4	Uploading the content	LCMS-Gnomio, Moodle, Google sites, Google doc
5	Polls	Mentimeter
6	Presentations	Active presenter, Prezi, google slides
7	Virtual Experiments	Vlabs, SWebok
8	Report writing	Google Docs, Microsoftword etc.
9	Experiments	PhET InteractiveSimulations
10	Editing the video to create your lesson	edpuzzle
11	PSIS, TAI activity	Google classroom, google sites, quizziz, padlet

E. Assessment

Assessment is the gathering of information from various sources to evaluate the student's knowledge and comprehension. Assessments in education have two purposes. With each assessment, it gives the students a chance to show what they've learned, receive feedback on their mistakes, and improve their performance. It serves as a great tool for teachers to assess whether their chosen technique of instruction is effective or not.

Rubrics provide a clear and consistent way to assess assignments, projects, presentations, and other tasks. Rubrics outline the expectations for different levels of performance. The Components of an Assessment Rubric were mainly the criteria, level of performance and the grading. Rubrics can be implemented based on the criteria, level of performance and grading.

Criteria: These criteria can encompass various skills, knowledge, and qualities relevant to the task. Identify the key criteria that will be assessed in the assignment. These should align with the learning objectives and skills you want to evaluate.

Levels of Performance: Each criterion is accompanied by a set of levels that describe different degrees of achievement. These levels often include descriptors that detail what is expected at each level, ranging from excellent to poor performance. Create descriptors for each level of performance within each criterion.

Scoring or Grading: Rubrics usually assign numerical scores or letter grades to each level of performance. These scores or grades reflect how well the student has met the criteria. Clearly explain what distinguishes excellent, proficient, basic, and poor performance.

Table 2: Experiential Learning Phase 2 Rubrics

Experiential Learning	Excellent	Good	Average	Poor
Review of Problem 10M	Includes real problems from Applications of AIML, CPSS, Block Chain and maps to the subjects.	Includes adequate research problems and novel ideas selecting from journals	Includes no research problem but good idea	No research or no novel ideas, general problem is selected
	5	3-4	2	1
Use of rapid development tools 10M	Real implementation oriented and practically feasible.	Possible to implement in future but not yet practically oriented.	Only ideas but no practical aspect.	Neither idea nor implementation oriented.
	(9-10)	(6-8)	(4-5)	(1-3)
Demonstration 20M	Confident, clear, good demo of working prototype	Clear, good demo of working prototype	Only ideas but no practical aspect.	Neither idea nor implementation oriented.
	(15-20)	(10-15)	(6-10)	(1-5)
Complexity of Implementation 10M	Highly complex, has strong mathematical models	Moderately complex, has some models which are not strong enough	Simple but good, no mathematical models	Very general, no models at all
	(9-10)	(6-8)	(4-5)	(1-3)
Experimental analysis and presentation of result 15M	Correlated Graphs, statistics, simulation	Any of these: Graphs, statistics, simulation	Qualitative conclusion	Vague conclusion
	(12-15)	(8-11)	(6-10)	(1-5)
Documentation and Presentation (report) 20M	Clear, effective, and well organized presentation followed by individual report.	Generally effective presentation with some difficulty in explaining key points and neat report.	Poor presentation and moderate report.	Poor presentation, difficult to follow and understand and randomly organized report.
	(12-15)	(8-11)	(6-10)	(1-5)
Future Scope 10M	Capable of continuity in next sem	Capable of continuity in next sem and by juniors	Not Capable of continuity	No continuation possible
	(9-10)	(6-8)	(4-5)	(1-3)
Teamwork Dynamics	Both are actively involved and motivated	Both are participating but still needs co-ordination	Only one is participating and other is passive	Both are passively presenting without motivation
	5	3-4	2	1

Impact of Assessment Rubrics

Rubrics highlight the specific skills and qualities students should develop for success. This encourages skill-building and learning beyond just completing assignments. Rubrics

contribute transparency, consistency and efficiency. Rubrics streamline the grading process, making it more efficient for educators. They can quickly assess and provide feedback based on predetermined criteria.

Rubrics are designed for both phase 1 and phase 2. Here for simplicity, only one phase 2 rubric is shown in the table 2.

IV. CONCLUSION:

Incorporating technology and pedagogy in education is about leveraging the strengths of both faculty and learners to create a more effective, conducive and engaging learning environment. It's important to approach this integration with a clear understanding of learning objectives, the needs of students, and the potential benefits and challenges of using technology in education.

While the impact of technology and pedagogy on the learning environment is overwhelmingly positive, it's important to remember that successful integration requires thoughtful planning and consideration of individual learners' needs. Balancing technology with effective pedagogical practices is essential to create a holistic and effective learning environment and this was witnessed when this teaching learning process model was incorporated for the two courses mentioned here. Active learning techniques practiced here improved students' critical thinking abilities, knowledge retention, and self-learning and classroom engagement. Experiential learning was an eye opener for both students and teachers as students performed extremely well as the knowledge about the fundamentals of the subjects were well disseminated to them and they applied it practically. Rubrics were a great tool for assessment. These activities were conducted for the 4th semester students, the learning curve was enhanced and many of the students got internships in good networking and other companies. Based on their performance, some of the internships are converted to full time offers also. This is a clear indication of the positive impact of inculcating active learning strategies in the class in line with the Teaching learning process.

In future, the authors would like to implement this process for other courses and also explore varied techniques and tools. Impact analysis will be done for the batch for whom experimentation was carried out.

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