

Flipped Learning - A Novel Classroom Model to Teach Undergraduate**Physics Students**

Ghosh, Sumit

Department of Physics & Electronics, Andhra Vidyalaya College of Arts, Science & Commerce
(Autonomous)**Abstract**

Teaching a complex abstract subject like physics becomes strenuous for an undergraduate teacher since these students lack the basic core concepts which are fundamental to understand and absorb physics. Hence adopting an innovative pedagogical model becomes imperative. By introducing a teaching learning model, which consists of interactive collaborative tools, through which such students are made to familiarize with real world relatable concepts of physics and also involve active learning through hands-on training kits, performing experiments using visual aids, assignments, simulations etc., can prove to be beneficial for these students and can serve as a vital component for teachers to teach undergraduate physics syllabus. A type of inverted classroom known as the "flipped model" involves active participation from both the teacher and the students. To better meet the needs of undergraduate physics students, we have made minor adjustments to our flipped classroom approach. In this study, we address how the flipped approach has been included into the course module to instruct undergraduate students in physics. This model's qualitative effectiveness in the Indian setting has been demonstrated.

Keywords: Flipped Model, Undergraduate Physics, Hands-on visual aid

Introduction

Science students who complete higher secondary education from corporate colleges endure through rigorous structured curriculum, peer pressure, mental stress and rote study. Many of these students go for higher studies and select physics as the major course. Over the last few years, the teaching-learning process has seen a humongous growth. There have been suggestions for new

educational approaches that make learning more interactive and collaborative for students [1]. Flipped classrooms have been used in several western nations, with varying degrees of effectiveness [2]. Both students and teachers participate actively in this type of inverted classroom, which extends outside the classroom's four walls [2].

In India, the system for delivering education is more dependent on conventional techniques and emphasizes passive learning [2]. Here, flipping is a relatively recent idea. However, the previous ten years have seen significant technology integration and breakthroughs, such as social media, smartphones, and ubiquitous internet access, which have completely changed how people think [2,3].

Methodology

Degree college students will learn the fundamentals of physics using a new classroom model that focuses on a collaborative manner while concurrently integrating technology [2,3]. This has been accomplished through the use of flipped learning, a self-regulated, higher order thinking approach [2]. Flipping was motivated by the idea that if students actively participate in a class assignment, the teacher will give them more one-on-one attention [2,4]. Students were given an overview of the curriculum's goals and breadth as well as the teaching methodology [2]. Since Wi-Fi had been installed on the college campus and the majority of the students had cell phones, we used flipped learning to teach some of the physics curriculum. Flipped classroom which involves observing web-based content, is typically adjusted and adapted to meet our needs [1,4]. Before class, students were not expected to have a thorough understanding of the subject or to spend endless hours collecting information. Students were given tasks to complete in designated content zones. Reviewing reference books, scientific journals, and periodicals from the library as well as using the internet to watch lectures and video classes were all part of the homework [2,5]. In certain cases, information was shared via social media portals. It was also advised that they record their findings [5].

Description of Optics toolkit

An integral component in our flipped classroom model are the hands-on minds-on kits. One such experimental tool is the optics kit [6] which is an innovative, interactive presentation package designed to introduce the students to the dynamic and exciting world of light. Each kit includes a

teaching guide and materials for demonstrations and experiments that teach about optics in a fun, hands-on atmosphere. Topics include polarization, diffraction and selective reflection. The kit also contains individual experiments (see Fig-1) which are designed for students to take home and share with their friends and family as a reinforcement of the classroom lessons. The optics kit has a facility to project three rays, with the beam of light in red, blue and green colour. Individual switches help to interact with different mediums by transmission including refraction, absorption or scattering. The kit has individual components which help to show the peculiarities of light when passing through different shapes of glass and lenses.

Concepts such as angle of reflection, Snell's law of refraction, index of refraction, dispersion of light, rainbows, mixing colours, blocking colours with prisms, detection colours, study of concave and convex mirrors/lenses, spherical aberration, convex and concave ray diagrams, how the eye works, how reading glasses work can be understood by the students. These educational light-based experimental kits are designed to teach the students the power, properties and principles of optics through fun and investigation. It provides students with hands-on minds-on activities that introduce them to the science of light. To use these kits in conjunction with flipped model, a three-pronged strategy has been adopted.

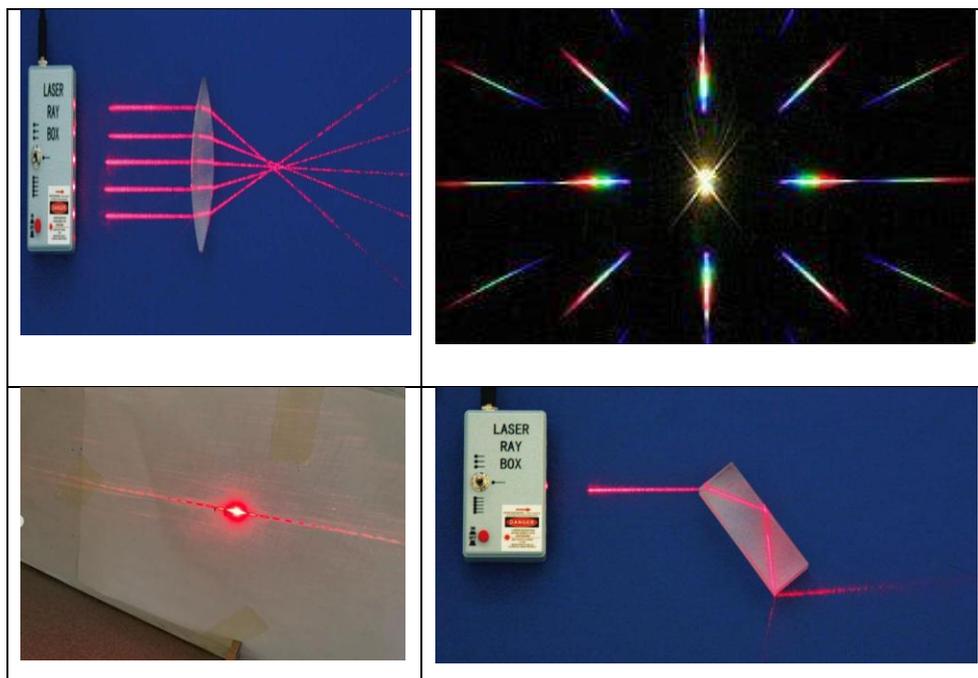


Fig-1

- Firstly, materials are supplied to students after being introduced to the basic concepts of a new topic. Students were given the opportunity to explore freely activities and materials to generate interests and prompt questions related to the topic.
- Secondly, hands-on activities are used to enable students to observe phenomena that are presented in their reference books.
- Finally, students were given an opportunity to design new experiments based on the knowledge they have acquired.

Results and Discussions

Science teaching should make the students understand the thinking process of scientists and their efforts behind each discovery. What good would be a concept-based activity if the student is unable to experiment it right in the classroom? Our inclusive model has been designed to assess the students learning during the teaching learning process by facilitating effective learning



Fig -2

of various concepts of light through scientific methods apart from getting knowledge of the concepts. Undergraduate students possess the cognitive capacity of comprehending nature and characteristics of the world surrounding them and we need to sustain it. Our modified flipped

classroom model approach for enhancing and enlivening classroom environments involves systematic hands-on minds-on investigation of the concepts that are taught in the class by supplementing intra-curricular experimental kits which are readymade, simple and ready to use equipment by student-teacher participation. The use of these intra-curricular kits has no doubt improved the teaching-learning experience of all the stakeholders (see Fig 2-3). The results revealed that although classroom teaching remains integral to the understanding of the subject, the flipped system when used in conjunction has helped to absorb the actual underlying essence and principle of light.

Consequently, we could enhance the analytical, investigation, reasoning, observational and communication skills and provide a meaningful, quality, joyful, enthusiastic, motivated and sustainable student learning environment. Our flipped classroom model assisted the students in becoming self-reliant researchers capable of thinking innovatively in scientific terms. Thus, we could cultivate a generation with scientific thinking.



Fig-3

Students particularly appreciated the engaged discussions in which they actively participated which shows a fundamental transformation from exclusive rote learning to an inclusive application based interdisciplinary learning. Our new innovative idea to improve student learning by introducing the pedagogy which helps in developing critical thinking among students is the need

of the hour. The consummation of flipped classroom teaching with these hands-on minds-on intra curricular experimental kits promotes interaction, enhances imagination, supports creativity, active learning and high order thinking. Our method develops the student-teacher relationship, where the teacher acts as an observer; standing back to let learning happen and letting the students solve problems which indirectly leads to the cognitive development of the student.

The response we have obtained is overwhelming and encouraging and students have acknowledged that they have learnt new things, which up to now they were ignorant of. Many students have participated in these events and from their feedback we could understand that they not only enjoyed the events but also learnt new aspects using a learn with fun approach which was hitherto unknown to them.

“Flipping classrooms can be a useful technique for a degree college student, if one has the patience and dedication to maintain the learning momentum”, according to stakeholder comments.

Conclusion

The synchronization of theory and practice is a necessary component of real learning. Flipped classes will undoubtedly benefit the student body, but their inherent complexity could be a barrier. It would be rash, unrealistic, and premature to generalize that flipped classrooms can take the place of conventional teaching approaches. Rigid teaching methods, the digital divide, the uneven student-teacher ratio, and the knowledge gap between urban and rural pupils can all be obstacles. In light of the diverse and heterogeneous nature of the educational environment, we suggest that our customized inclusive flipped classroom, which involves the stakeholders using active learning experiential supplemental modules, would be more prudent and effective for comprehensive and efficient learning gains.

References:

1. Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*, 31(1), 30–43.
2. Ghosh, S. (2016). *Introducing an innovative active learning technique: Flipping optics classroom*. *Frontiers in Optics/Laser Science* 2016.

3. Nickerson, R. S. (1995). *Can technology help teach for understanding?* Oxford University Press.
4. Ghosh, S. (2004). An innovative teaching methodology by using specially designed student study kits. *Journal of Pure Applied and Industrial Physics (JPAP)*, 1, 24–30.
5. Ghosh, S. (2019). *Proceedings Vol 11143, XV ETOP conference 2019*. SPIE.
6. Optica. (n.d.). *Optics suitcase*. USA.
7. Anita, A. (2024). Educational technology and e-Learning. *Shodh Sari-An International Multidisciplinary Journal*, 03(04), 353–365. <https://doi.org/10.59231/sari7768>

Received: Dec 31, 2025

Accepted: Feb 20, 2026

Published: Mar 10, 2026

Flipped Learning - A Novel Classroom Model to Teach Undergraduate Physics Students © 2026 by Sumit Ghosh is licensed under CC BY-NC-ND 4.0