



The Design and implementation of an online supplementary programme for laboratory instruction.

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Abstract: *This paper presents the design of supplementary online teaching support, in addition to conventional laboratory teaching, for students taking up laboratory course using the online-programmes feature provided by WIX. The intention behind this is to increase the self-learning abilities of the students and also to seek a solution to impart laboratory courses for large number of students in a batch with minimum number of instructors. This online teaching-learning device is only a supplement but not a substitute. This was successfully be implemented over one-semester with first year Under-graduate students as learners. The student satisfaction was reasonably good with this self-learning mechanism.*

Key Words: *laboratory course, Online learning, Self-learning, Student satisfaction.*

1. INTRODUCTION:

Laboratory experiments, a cornerstone of science education for over a century, are considered indispensable in science pedagogy¹. Today, they remain crucial in developing students' scientific skills, offering hands-on experience and practical skills through experimentation². These experiments provide theoretical knowledge while instilling an understanding of scientific concepts and methodologies in the natural world³. Furthermore, they allow students to directly engage with the material world, using instruments, data processing techniques, models, and scientific theories to express their understanding.

The landscape of laboratory experiences has evolved, shaping students' perspectives on engaging in such experiments. Initially, traditional laboratory setups dominated, characterized by hands-on experimentation with physical apparatus, a staple in science education. However, with technological advancements, this paradigm has shifted towards enhancing traditional methods with digital tools and simulations.

In the 21st century, advancements in computer and digital technology have led to a fusion of science education with various technological innovations. Educators now view technology as a powerful teaching tool. For example, it has been suggested that primary school educators in Nigeria use mobile applications to enhance teaching and learning⁴. This technological progression has given rise to virtual laboratories, offering simulated versions of traditional labs with virtual counterparts of real objects⁵. Students interact with these virtual environments, conducting experiments and taking measurements directly, facilitating a deeper understanding of the material.

Basic Science courses like Mathematics, Physics, and Chemistry are integral to the first-year B.Tech Engineering curriculum across the country, as Engineering and Technology skills are fundamentally built on the foundations of Physical Sciences. This is why students are tested in these subjects for admission into prestigious technological and engineering institutions. For instance, the IITs and NITs of India conduct a common Joint Entrance Examination, and the top-performing students are admitted into their programs. The difficulty of clearing this entrance examination is well understood by the students who undergo years of training in coaching institutions. Hence, the importance of basic sciences, particularly Physics, in Engineering and Technology programs is unquestionable. However, as these students have not been trained, in most of the cases, in laboratory courses, the laboratory skills of the students who take admissions in first year under-graduate programmes like B.Tech, are found to be minimal and often this makes them to keep themselves last in the queue in acquiring the engineering skills.



In order to encourage the students in acquiring the laboratory skills it was proposed to develop a supplementary, supportive digital platform where the students can prepare themselves in advance for attending the laboratory course. The procedure adopted for such an online supportive mechanism is presented in this paper which can very easily be adopted in any laboratory and by any individual instructor.

2. Design & Discussion :

The Applied Physics laboratory course was chosen for developing the online supportive module. This course contains 12 laboratory experiments which the students have to complete within a period of one semester. In general, every student will complete one experiment per week. The calculations, graphs and inferences will be carried out either in the leisure time in the laboratory or at home.

Every experiment is planned as a “online certificate course” using Wix platform. This allows to add public and private online courses to wix website and monetize them. To begin with a dedicated website was designed for this online supportive module.

Each experiment was divided into eight steps: Aim and Apparatus, Theory, Video lesson, Procedure, Observations, Calculations and graphs, Inference, Upload the results and Quiz.

PDF documents, videos and Quizzes are used as teaching tools. For building each experiment as online certification course, the courses app of WIX platform was used. The courses app has an intuitive curriculum builder, supports multiple lesson types, and offers decent learning and engagement tools. **The course builder supports a variety of content types. One can** add videos, audio, quizzes, and lesson downloads. The lesson editor is quite flexible in adding multiple content types to the same lesson. You can add multiple videos, text blocks, and embeds to a single lesson. In the present case, each experiment of Physics laboratory course is converted as a Wix lesson.

In order to improve the learning experience, Wix Online Programs offers a few features which also enhance course engagement. The Wix quizzing tool supports several question types, including multiple-choice, multiple-response, open-ended, and file upload questions. One can also set a passing score for the quiz. This tool supports open-ended questions and also file uploads.

Wix create and send certificates to students after the completion of the course. These certificates can be customized using a couple of templates. This enables the fixed lesson order option to prevent students from skipping lessons or steps involved. Wix provides a navigation bar on the left and lesson content on the right side of the screen. It also displays the student's progress. The students can easily navigate between the lessons from the sidebar or using the *Complete Step* button at the bottom of each lesson. Wix Online Programs provide basic Reporting tool information about the courses, such as the number of students and average completion rates. One can also see the progress of individual students. It lacks a more detailed reporting tool to give insights into student engagement, quiz results, lesson completion rates, or video engagement. However, this student engagement and the time the student spent over video, to complete the quiz, to read the text content provided as a text file or pdf file can be obtained through reaching other options which are not readily available on the screen.

The PDF documents which were added in steps like Aim and Apparatus, Theory, Procedure, Observations, Calculations and graphs and Inference were developed using MS-Word. The videos which includes the explanation and demonstration of the experiment were developed by the instructors using conventional video recorders with mobile phones. The procedures for plotting the model data was also presented as videos.

The step1, Aim and Apparatus, has to be completed by the student by reading the content and noting down the same in the observation book. The step2, Theory necessary, has to be completed by the students after reading the content and noting the important points of the PDF file in the observation notebook. In step3, the student has to watch the video lesson and understand the way the experiment has to be performed in the laboratory. The students are advised to note down the key points of the video in the observation note book.



In step4, the student has to note down the steps involved in the procedure of performing the experiment, which was given in the pdf form. The circuit diagrams, tabular forms for the observations have to be replicated in the observation note book in step 5. The model calculations and plotting the graphs for the model observations have to be learnt from the PDFs and video and the students have to draw the model graph in the observation note book. This is step 6. The step 7 involves a quiz containing objective and descriptive questions. Most of the questions that were presented in this step are the generally expected viva-voce questions. The students have to answer and complete the quiz. The step 8 was related to the previous experiment performed by the student in the laboratory in the previous week. The students have to upload the results and graphs of the previous week experiment by scanning the observation note book, calculations and graphs.

Once the students complete all these eight steps successfully, a certificate will be generated stating that the student has successfully completed all steps involved in the experiment. The student was expected to bring a copy of the certificate while attending the laboratory physically at the scheduled time in the next week as per the time table. The instructor will verify the certificate and allows them for performing the experiment after clarifying the doubts, if any. The students perform the experiment and note the readings. The instructors will support the students during the experiment and finally verifies the readings and certifies the readings. The rest of the calculations and plotting the graphs and drawing inferences will be carried out by the students at their convenient time.

3. Pattern and Results :

The home page of the Wix website will be typically as shown in fig.1 below. The button Experiments takes to program which contains all the experiments.

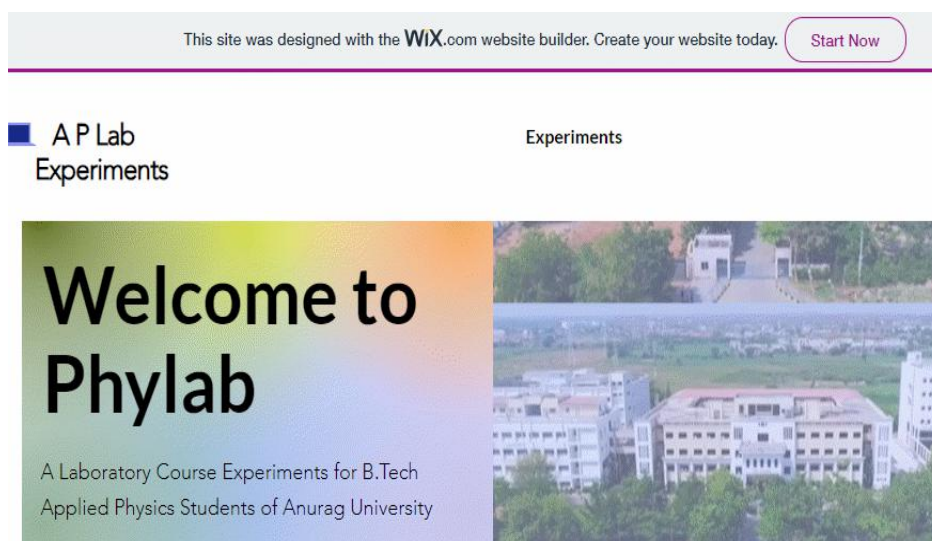


Fig.1. Home page of the website.

The typical programme list with all the experiments will be displayed on the screen as shown in fig.2. Each course will display the name of the experiment, number of the participants, whether it is a paid course or not (in present case, it shows Free as no payment has to be made) and a view button. The image for the experiment is optional. This was presented in Fig.3.




Experiments | Phylab

This site was designed with the [WIX.com](#) website builder. Create your website today. [Start Now](#)

Experiments & Lab Assignments

The program contains 10 experiments. Join in each one of the courses according to your time table given in the laboratory and complete it within 6 days. Get the print copy of the completion certificate in order to perform the experiment in the laboratory. All assignments should be completed before performing the experiment in the laboratory.

Completed




Light emitting diode LED

247 Participants

Free

[View](#)

Completed




Numerical Aperture

222 Participants

Free

[Join](#)

Completed




Dispersive power of prism

200 Participants

Free

[Join](#)

New to Participants




Solar Cell

242 Participants

Free

[View](#)

Completed




Diffraction grating

216 Participants

Free

[View](#)

Completed



Diffraction at Single Slit


187 Participants

Free

[Join](#)

Experiments

New to Participants




Time constant of R-C circuit

223 Participants

Free

[Join](#)

New to Participants




Time constant of R-C circuit

199 Participants

Free

[View](#)

New to Participants




Laser diode characteristics

26 Participants

Free

[View](#)

Completed



Newton Rings

214 Participants

Fig.2. Screenshot of all the courses/experiments



Light emitting diode LED

247 Participants

Free

View

Fig.3. Display of representative course



Typical structure of each experiment and steps involved as shown in fig.4. They include Previous week, Experiment introduction, Aim and Apparatus, Theory to be known, Equipment needed, procedure to be adapted, Model readings, Model graph and Model calculations and Quiz or descriptive question.

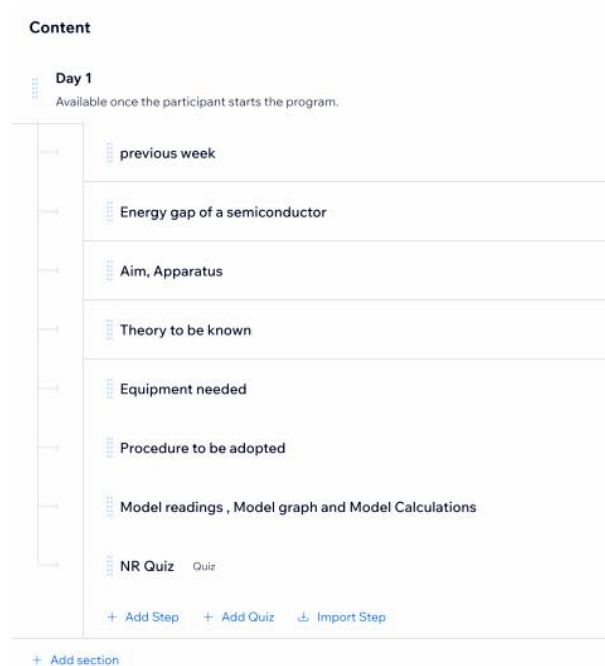


Fig.4. Steps involved in each course

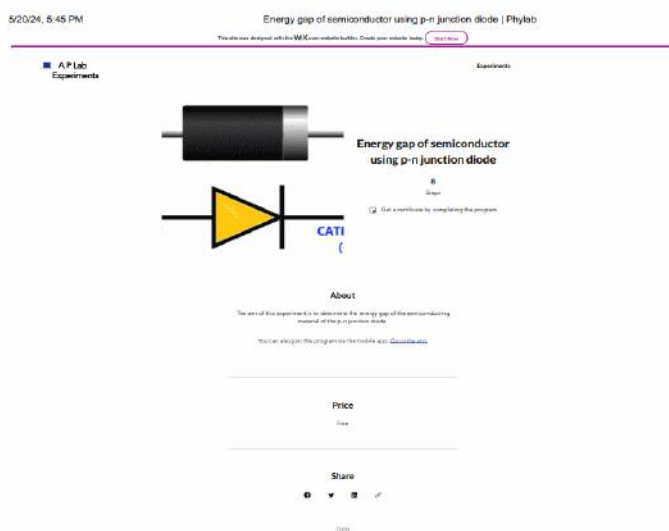


Fig.5. Initial login for each course

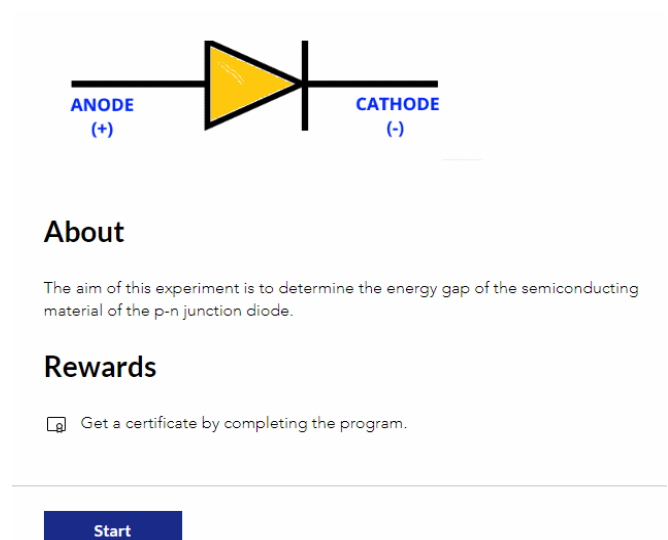


Fig.6. Start page of the course

The screen shots of all the steps involved to complete the course were presented in Fig.7. The step navigation will be displayed on the left and the contents related to that step will be displayed on the right. The contents were included as text, PDF files, video links and file uploads, descriptive questions or Quizzes.

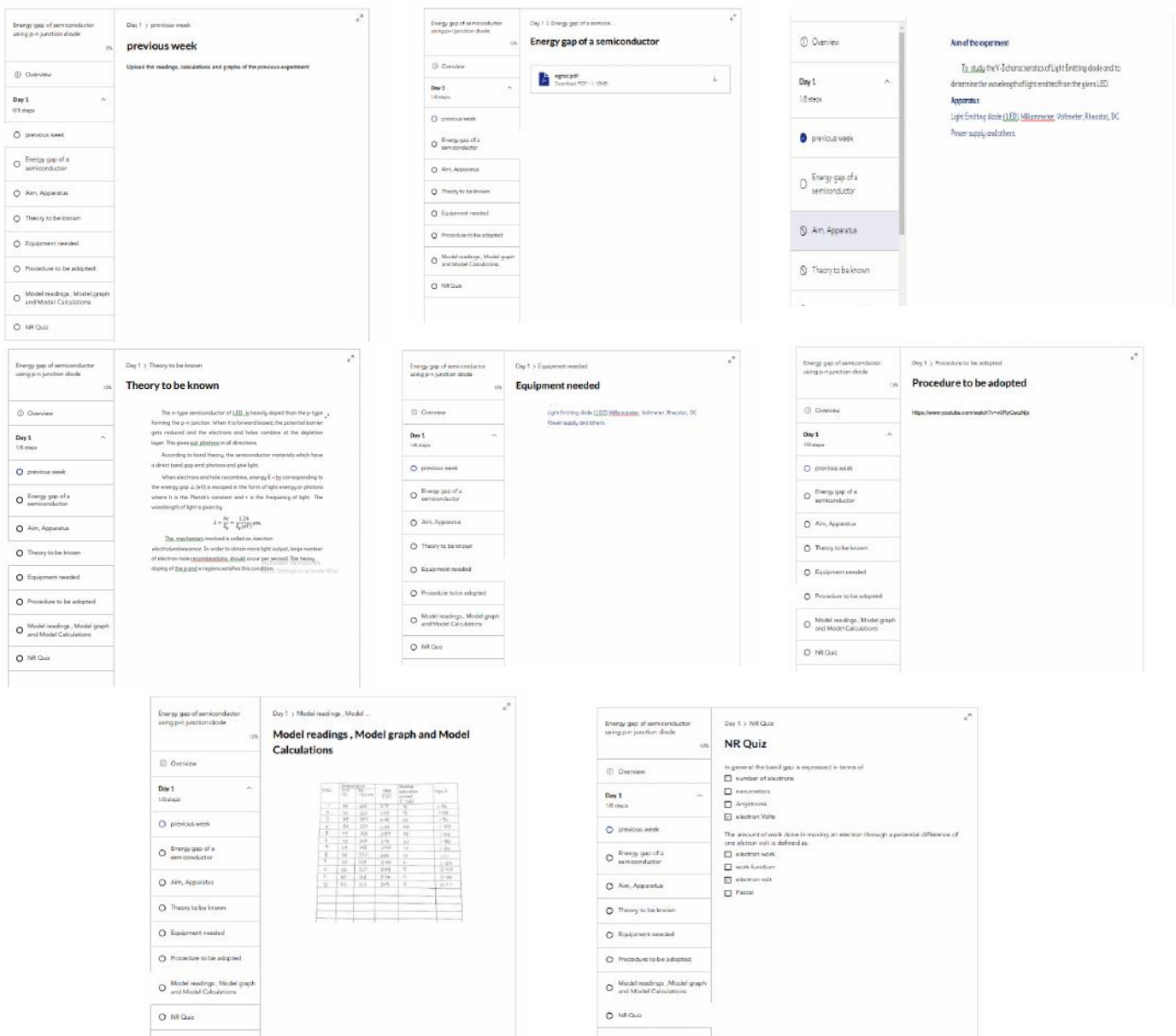


Fig.7.

Screenshots of each step involved in the course/experiment

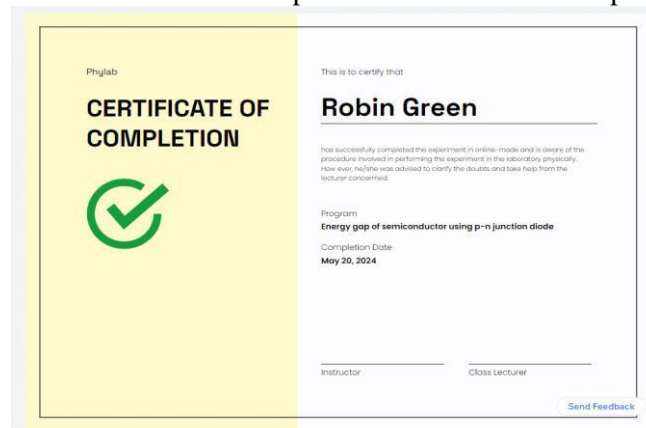


Fig.8. The certificate of completion of all steps.



4. CONCLUSIONS:

In this study, it was proposed to explore the possibility of using the on-line weekly modules as supplementary teaching tool to the regular conventional guidance provided in the laboratory.

The proposed supplementary online laboratory programme was implemented for one full semester for 66 B.Tech first year students. The student satisfaction was collected through interviews and it was found that the students could notice a significant change in the learning process. The adoption of this supplementary online learning brought remarkable difference in laboratory courses both in instruction and learning. The complete student satisfaction and the expectations of the students will be presented in the forthcoming publication. It was concluded that the addition of on-line weekly modules enhances the learning experiences of the students. Further as the oral explanation and demonstration will become easier for the instructor as the students have been already exposed to the procedures involved in the experiment, large classes with student strength of 40 to 60 can be easily handled by instructors by implementing this online laboratory instruction programme.

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