IMPROVISING TRADITIONAL METHODS AND DEVELOPING NEW INSTRUCTIONAL TECHNIQUES FOR EFFECTIVE LEARNING OF PHYSICS

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Abstract— Physics is the systematic study of matter, energy and their interactions. It motivates young and old people equally and expands the frontiers of our knowledge about Nature. Physics generates fundamental knowledge needed for the future technological developments and improves quality of life by provid ing the basic understanding required for developing new instrumentation and techniques. But decreasing trend in the number of physics students at University level is a matter of concern in many countries around the world. The reason could be the general lack of understanding of the subject, it's inherent difficulty and reliance on mathematics which tends to discourage a student from studying physics. Teaching and learning physics are challenging tasks. While traditional methods have led to frequently disappointing results, new and innovative methods of teaching physics can be adopted to develop an interest among the students in learning physics. The aim of this article is to develop innovative practices in physics teaching, to motivate the students to learn physics and to improve the quality of physics teaching.

Index Terms— **Physics, education, learning, webinar, lecture, self assessment, project based learning**

1 INTRODUCTION

Physics is the systematic study of matter, energy and all the natural phenomena happening around us. The whole universe is built upon the principles of physics. It is a fascinating subject which relates to day to day activities and things around us.

The importance of physics to society today is most easily represented by our reliance on technology. Many of the technologies that are continually transforming the world we live in can be directly traced back to important research in Physics. For example, research on the physics of semiconductors enabled the first transistor to be developed in 1947. This seemingly simple device is the key component in all of our electronic systems, including computers, and it is now considered one of the most important inventions in human history. There are countless examples of research in physics leading to the development of important technologies. It is expected that today's research on nanostructures, quantum information or photonics will lead to the next generation of technologies including faster and more robust computers and communication systems.

Physics theories are produced from a rigorous and systematic method and they are constantly tested against experimental evidence. The study of physics in schools and universities is undoubtedly more relevant to society today. Therefore, grounding a scientific education in physics is essential as it is the foundation of science.

Enrollments in technology education at the college level have been declining [1]. The decreasing trend in the number of physics students in particular at University level is a matter of concern in many countries around the world. Perhaps it is the general lack of understanding of what physics is, combined with the subject's inherent difficulty and dependence on mathematics, which tends to discourage the students from studying physics. It is very important that students should know why physics is important and what career opportunities or other benefits may stem from studying physics.

A physics student usually possesses excellent analytical, quantitative, logical and problem solving skills. They have the ability to synthesize and analyze large amount of data and explain their analysis in an easily understandable form. They learn to systematically identify all factors contributing to a given problem and work out how those factors interact in order to solve the problem. These are important skills that can be applied in a range of careers.

Teaching practices in Physics Education

Conventional physics instructions are not effective enough to help the students to develop a real understanding of the subject. There is a strong need to change the nature of physics teaching. Some of the teaching methods are discussed below:

1. Improvising Lecture method

The lecture method is one of the most ancient of teaching methods. In the teaching of physics, it is generally used to demonstrate physical phenomena, to present derivatioor to solve numerical problems. The demonstrations are very important but most of the time is neglected by the teachers who feel compelled to cover more topics as most often they work under time constraint to complete the syllabus [2]. Good lecture demonstrations also have the capacity of being memorable.Most of the time of a lecture is used for presenting the solutions to specific physics problems. Just by solving some problems during lecture will not develop problem solving skills among the students. What we must keep in mind that physics problem-solving is a skill that has to be improved by repeated practice.

Lecture method is found to be more useful when students are forced to become active participants in the lecture [3]. Lecture method can be made more interesting and useful by active participation of the students. For that, let the teacher select a topic and do a lecture demonstration. Then give the students a problem to work out based on that topic in a specified time. Ask them to find out as many solutions as possible with the help of the concepts, equations known to them. Provide them graph papers, calculators if they need. After the specified time given to them to work out the problem, ask them to explain their solutions to the class and allow all the students to discuss about the merits or demerits of the solution. Let the teacher explain the best possible solutions and the concepts, equations involved in it.

This method has several advantages such as:

- The students utilize their time constructively during the lecture and their complete involvement in the lecture is assured.

- Students are bound to discuss physics with other fellow students and share their ideas.
- Students can correct any point of confusion and understand the concept thoroughly by taking immediate feedback.
- The teacher can ensure about his students' understanding of the topic.
- Students will learn to apply the physics concepts in a variety of situations and all kinds of physics problems.

Though this method forces the teacher to cover less material. The teacher can be selective and teach only those topics by this method where learning of fundamental concept is essentially required and where students find it difficult to apply the concepts in problem solving. This method not only engages students in the lecture but also promotes better understanding of the concepts and improves performance of the students in the exam.

Teaching through webinars

The term **webinar** is short for Web-based Seminar, a presentation, lecture, workshop or seminar that is transmitted over the Web to describe a specific type of web conference. These interactive sessions allow participants, who are granted access through a password, to experience a live workshop without attending in person.

Webinars offer online instruction to students who wouldn't be able to attend in person because of distance or any other issues. Webinars allow teachers to get to know their audience—the students through networking. This medium is more personal than a phone conversation because video facility allows students to see teachers and other participants. Webinars allow one-on-one communication between a teacher and students, as live questions can be answered in real time. Instant students' feedback can also be generated for the topic of discussion.

Webinars are flexible and students can record the content and can watch as per their convenient schedule in case they failed to watch the live presentation by the teacher. Webinars can feature live demonstrations and Power Point presentations. These presentations can be integrated with teleconferencing if the students fail to connect online. Various topics in Physics can be taught to students through webinars in an interesting and interactive manner.

Learning through self-assessment

Self-evaluation is defined as students evaluating the quality of their work, based on evidence and precise criteria, with the objective of doing better work in the future. When students are taught how to assess their own progress, and when they do so against known and challenging quality standards, then there is a lot to gain. Self-assessment is a potentially powerful technique because of its impact on student's performance through enhanced self-efficacy and increased intrinsic motivation [4]. Evidence about the positive effect of self-evaluation on student performance is particularly convincing for difficult tasks [5].

Providing opportunities for students to self assess their abilities creates the prospective for students to know exactly about their actual performance level and work toward achieving the needed proficiencies. The following procedure can be followed to help the students self assess their learning:

- Select a topic in Physics and make questions available on the Web, for example as

a quiz using web communication technology, whose answers require a good knowledge of the concepts, procedures, etc. To encourage timely student learning, a quiz can be made available during the time period students should be constructing specific knowledge and developing specific skills and withdrawn before the target learning experience begins. Depending on the learning objectives and the scope and size of the database of questions, students might be permitted to take a quiz as many times as possible.

- Ask students to publish their work, in the form of reports, papers, and projects and make it accessible to all the students through web. Encourage students to create an index page where their work is readily accessible, and provide necessary assistance for publishing their work.
- When they become aware of other students' work, students will often realize ways to improve their work and the diversity of ways to approach a given problem.
- Having students to reflect on what they have learned has the potential to prompt them to recognize their learning advances and lapses and to assume more responsibility for their own learning.
- Ask students to evaluate their work on a scale of 10 on the basis of few parameters such as understanding the concept, skills acquired, applications of same concept in different situations, innovative approach in problem solving etc.

The Use of Analogy in Physics Teaching and Learning

Analogies are used in the practice of physics as well as for teaching and learning. Analogies are not only useful to working physicists, but to physics teachers as well [6]. For instance, Coulomb's law is often taught in introductory courses as analogous to Newton's law of gravitation. Electric current is often likened to water flowing through a pipe. It helps the students to understand the difficult concepts in easy manner.

Promoting culturally comparative approach

The educational culture differs from country to country and also within a country. Each country has a different educational system and different policies. A comparative approach that differentiates between general conditions that apply to all countries and specific conditions that applies to one country should be in place. It will enable teachers from different countries to learn from each other and facilitate the innovation process of Physics education in the participating countries. This approach will be successful only if there is a complete involvement of the teachers in all participating groups. This will create communities of researchers and educators, promote networking of teachers who will work closely together, develop teaching and learning materials and learn the best practices from each other in teaching Physics.

Research based curriculum teaching

Research-based curricula should be developed to improve student's learning by helping students to change their common sense and conceptual beliefs through active engagement [7]. The research-based curricula require changes in teaching style so learning can be achieved effectively. It can be done by implementing variety of strategies/tools, such as conceptual questions, group projects, reading tasks, assignments with tutorial

review, blended learning, problems solving and a platform of e-learning [8].

Learning through projects based on common needs

Students learn a lot when they work on some projects by themselves and solve the problems as and when those arise during the project. The projects which involve some principles of physics and can be used in daily life can be assigned to the students. Some of the interesting topics mentioned below:

- Physics involved in sniping: To study the effect of gravity, air resistance, velocity and mass of the bullet on the trajectory of the bullet.
- Non-conventional sources of energy: Students can be asked to make a solar cooker, solar cell, a model of wind-mill, Bio-gas plant
- Generating electricity based on Piezo electric effect at a place where there is frequent pressure variations
- Use of Physics in regulating traffic on a busy road or street

Use of ICT in teaching Physics

Over the last decade, information and communication technologies have enabled changes in the way people live, work, interact and acquire knowledge. The implementation of a teaching strategy based in the use of ICT´s has shown to be very useful in order treat different topics in physics that are quite difficult to explain by using standard methods. It has been observed that the use of ICT´s contributes to enhance the interest of the students as well as to achieve a deep conceptual description of the studied phenomena. Some of the topics such as Wave Motion, Optics, Nuclear physics, Dynamics can be taught with the help of ICT.

Use of computer simulations

Computer simulations are applications of special interest in physics teaching because they can support powerful modeling environments involving physics concepts and processes. Some of the concepts of Kinematics such as velocity and acceleration in projectile motions can be understood very well with the help of Computer simulations. Computer simulations can also be used as an alternative instructional tool, in order to help students confront their cognitive constraints and develop functional understanding of physics [9].

CONCLUSION

A major goal of physics education is that students be able to understand the fundamental concepts of Physics and be able to apply this knowledge in variety of situations.

Physics learning should go beyond memorizing and develop logical and analytical thinking and problem solving skills among the students. Learning physics is more important today as all the technological advancements are based on the fundamental principles of physics. There is a strong need to use innovative instructional methods and make the learning more interactive, enjoyable and understandable with the help of Information & Communication Technology.

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