Table of Contents

Artificial Intelligence Aided Physics Teaching (An Experimental Study on the Development of Artificial Intelligence in Teaching Physics at the School level)

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Abstract- *Students like to study Physics when there is creative approach. My teaching experience the students also tells a student doesn't like to read lengthy lessons and theories. So, it is a strong belief that as far as possible discovery and experimental method with gadgets to be done. So, my experimental study is on the development of Artificial Intelligence Aided Teaching of Physics.*

After dividing the 9th and 10th standard students in to 2 groups of mixed abilities such as high achiever, mediocre and low achiever, provided the traditional group with questionnaire in Physics concepts which they have to solve by pen and paper without using any technology aids.

Experimental group was provided with Artificial Intelligence aids such as Google assistant, Navigation app, Chatbots, Text editor and auto correct, Face recognition apps.

When the analysis of the answers provided by the control group and the experimental group, it was noticed that the answers provided by experimental group was more practical and having realistic life experiences. The A I aid they have used to learn and answer the physics questions helped them to be more research oriented and to get the precision in defending their answers.

Key Words: Artificial Intelligence, Teaching-Learning Aid, Google Assistant, A.I Assistant/Competitor/Friend.

Introduction

We all know, of course, how amazing the progress has been in A I in recent years. So, if all this progress is happening how can it be used to help to study Physics? In a lot of ways. Obviously, for example, we have machine learning used to detect Newton's third law of motion. It can be used to detect extrasolar planets and in various technological advances. Machine learning can be used to analyze data computation of moving objects in multi-dimensional fields.

Objectives

1. To study the impact of Artificial Intelligence in the field of teaching and learning Physics.
2. To compare the A.I aided teaching with the traditional method of Teaching Physics.
3. To facilitate children to learn Physics with the help of Artificial Intelligence.
4. To amalgamate the A. I into real life experience of Students and also to develop an I as a co-learner and competitor/friend to the students in studies.
5. To discourage classroom chalk and talk methods and shifting on A.I aided teaching of Physics.

Hypothesis

After reviewing how machine learning is becoming ever more widely used in physics, a thought came to explore how Artificial intelligence can help to learn physics for students. In a set up where A I aid was given to the students and traditional group was created. Hypothesis was that Artificial Intelligence aided learning can give better results in terms of real time calculations in realistic set up in the current scenario. It gives practical answers and caters to the needs of the 21st century learners.

Methods & Procedures

In order to carry out the project, 9th and 10th standard students were divided in to 2 groups. Both groups contained students of mixed abilities such as high achiever, mediocre and low achievers. Grouping was done by considering their academic achievement of 2 consecutive years.

One group was the control group and the other experimental group. Traditional group was provided with questionnaire in Physics concepts which they had to solve by pen and paper without using any technology aids. Data provided to them were Distance between two cities, Formulae, Definitions and Examples. Also certain materials like graph sheets, pen, paper and formulae list.

In fact, experimental group was with Artificial Intelligence aids such as Google assistant, Navigation app, Chatbots, Text editor and auto correct, Face recognition apps. Questionnaire contained following questions.

(1) Calculate the time required to travel from Ajmer to New Delhi?
(2) Why do the stars twinkle whereas planets don't twinkle?
(3) If you want to wear a goggle what is the best suitable goggle in dimensions you must have?
(4) Draw the V/I graph characteristics of Ohm's law and analyze the data.

S.No	Question Numbers	Answer and Accuracy in answers of A.I aided Group	Answer and Accuracy in answers of Traditional Group
1	1	387 Km (6hr 40min) 99%	400Km (7hr 30min) 60%
2	2	Point source objects 91%	71%
3	3	Using Face recognition app 99%	Traditional method 62%
4	4	Using computer and Geo-gebra82%	Using graph paper and pencil 55%

Results & Discussions

When the analysis of the answers provided by the control group and the experimental group was done, it was observed that a greater number of students scored better marks in the experimental group. 50% of traditional group students were not able to get the correct answers to most of the questions. Learning outcomes of experimental group was far better in terms of 21st century skills such as Collaboration, Communication, Creativity, Critical Thinking, and Computational Thinking. It was also noticed that the answers provided by experimental group were more practical and having realistic life experiences. The AI aid they used to learn and answer the physics questions helped them to be more research oriented and to get the precision in defending their answers.

Implications of the study

Artificial Intelligence aided physics learning will be more effective for students to improve their skills and to do the precise calculations. It will be good friend to explore and do research in the various branches of physics. It is found that A I help slow learners to understand the physics concepts better like a Teaching Learning Aid.

Artificial Intelligence will definitely cause workforce to evolve. The job loss is seen as great threat to humanity but the positive side is A I can create thousands of new jobs in the future.

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A T L Tinkering Labs.

Virtual experiments of Physics using Scilab

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Abstract: *There are certain areas of Physics where different experimental phenomena are explained using some theoretical concepts. It is often said that a certain theory is able to reproduce experimental results. Some of them can be verified easily, but some theories have very complex computations that cannot be solved easily, and so end results are shown directly by graphs, final values, etc. But as Richard P. Feynman[1] said 'What I cannot create, I do not understand', here we have tried to design experiments using theoretical concepts by writing simple programs, that allow students to observe the results and finally verify them by the available results. All this has been done using Scilab, which is open-source scientific computation software that can be used to perform numerical computations. It is easy to use even for people that have no previous programming experience.*

In this paper we have explained one such virtual experiment which is related to the study of the linear harmonic oscillator in which the student is able to observe the variation produced in the oscillation when mass and spring constant is varied and damping is introduced. Students can visualize each variation produced and interpret the result in a very easy manner. Several other experiments can also be designed by students themselves and make concept learning easier.

Keywords: Virtual lab, Scilab, open source, Linear Harmonic oscillator, Damping

Introduction

In Physics theory and practical go side by side. Theoretical learning provides us knowledge which is the base of doing anything practically. Theoretical learning tells us what the knowledge is about and practical learning is about how the knowledge was learned. Anything done practically can be dangerous sometimes without theoretical learning. But theoretical knowledge without practical is of no use. So to have a perfect learning experience one should gain both practical and theoretical knowledge.

In a virtual theoretical laboratory experiment, the students are able to gain a conceptual understanding of fundamental physics. They are able to interpret, in a simple way, the representation of physical quantities such as numbers, equations and diagrams, and are able to solve physics problems. In this way, they strengthen their understanding of practical knowledge.

There have been several efforts to introduce the concept of virtual labs to enhance the knowledge of Physics. Virtual labs [2]a project that has been initiated by MHRD, Govt. of India aims to provide remote access to Laboratories in various disciplines of Science. Similarly Praxilabs [3], Virtual Labs by Merlot [4], online labs for schools [5] are some other simulation platforms where students can perform virtual experiments. Many apps [6-7] that help students to understand Physics are also available for use.However all these platforms provide a fixed method of performing an experiment and does not allow any variation.

In this paper,we have explained a virtual experiment that is related to the study of the linear harmonic oscillator in which the student is able to observe the variation produced in the oscillation when mass and spring constant is varied and damping is introduced. Students can visualize each variation produced and interpret the result in a very easy manner. Also it can suitably change the program to view different results.

Objective

One of the central problems in physics is the linear harmonic oscillator. It can be used to understand the concept of springs, pendulums with small amplitudes, behavior of some electronic circuits and even some quantum mechanical phenomena. These can further be associated with problems involving a large number of harmonic oscillators or even used to investigate the behavior of coupled oscillators.

A very good example that everyone has observed is a playground swing. Each one of us has an intuitive understanding that a swing moves to & fro and if the rider drags his feet or due to air friction, it finally stops. This movement of swing can be approximated as sinusoidal motion and can therefore be considered as simple harmonic motion. Due to frictional forces damping occurs.

The main objective of this paper is to understand the behavior of objects in simple harmonic motion by examining the behavior of alinear harmonic oscillator system. In order to fulfill our main objective certain sub-objectives have been taken up. These include study of a linear harmonic oscillator and observe the variations produced in the oscillations when mass and spring constant of the system is varied. It also includes study of change in behaviour of linear harmonic oscillator when damping is introduced and damping coefficient is varied.

Requirements for virtual experiment

- First and foremost theoretical model that explains linear simple harmonic oscillator classically.
- Second, computational software to carry out the theoretical calculations.
- In this paper we have used SCILAB [8] which is open source scientific and numerical computation software. It has been chosen as it is free to download and uses very simple programming. Other similar soft wares [9-11] can also be used.

Theoretical concept

Before beginning any experiment in laboratory, virtually or through simulation it is necessary to develop an understanding of the theoretical model being employed so as to get clarity of what we have to observe.

A simple harmonic oscillator is a system that experiences a restoring force F when displaced from its mean equilibrium position. This force F is proportional to the displacement x from its mean position.

$\vec{F} = -kx$and$\vec{a} = -\frac{k}{m}x$where k is a positive constant.

If F is the only force acting on the system, the system is called a **simple harmonic oscillator**, and it undergoes simple harmonic motion to and fro about its mean position. The oscillations produced have constant amplitude and a constant frequency[12].

If a frictional force or damping is also present, then sucha harmonic oscillator is described as a **damped oscillator**. In this case

$\vec{F} = -kx - \mu\frac{dx}{dt}or\frac{d^2x}{dt^2} + \frac{\mu}{m}\frac{dx}{dt} + \frac{k}{m}x = 0$

Depending on the friction coefficient, the system:

- Oscillates with a frequency lower than in the undamped case where its amplitude decreases with time (under damped oscillator).
- Does not oscillate and decays to the equilibrium position, without oscillations (over damped oscillator).
- At a particular value of the friction coefficient, the boundary solution of an under damped oscillator and an over damped oscillator occurs at same point and this condition is called critically damped.

Steps to follow

1. Writing a program for studying linear simple harmonic oscillator in scilab.
2. Keeping k= constant vary m and keeping m= constant vary k, obtain time period along with graph between x and t for each case in linear simple harmonic oscillator.
3. Interpret the results obtained.
4. Next modify the above program for damped linear simple harmonic oscillator.
5. Vary damping coefficient to obtain conditions for under damping, critical damping and over damping.
6. Observe the graphs obtained and interpret the results.