Title: A Study of the Effectiveness of Including Experiential Method-Hand-on Activities in Teaching Physics for Secondary Students

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Introduction:

The Indian government unveiled the National Education Policy (NEP) 2020, a comprehensive framework designed to revolutionize the country's educational system. Its main goal is to get students ready for the workforce of the future, especially in a world that is tech-driven, digitized, and fiercely competitive. The complete development of children's cognitive, social, emotional, and creative abilities was frequently neglected in favor of a narrow concentration on academic accomplishment in traditional schooling. In order to develop a more competent and skilled workforce for India's future, NEP 2020 seeks to establish an inclusive, innovative, and modern society-aligned educational system. As a result, including experiential learning helps to advance the learning domains and fit with NEP 2020 goals.

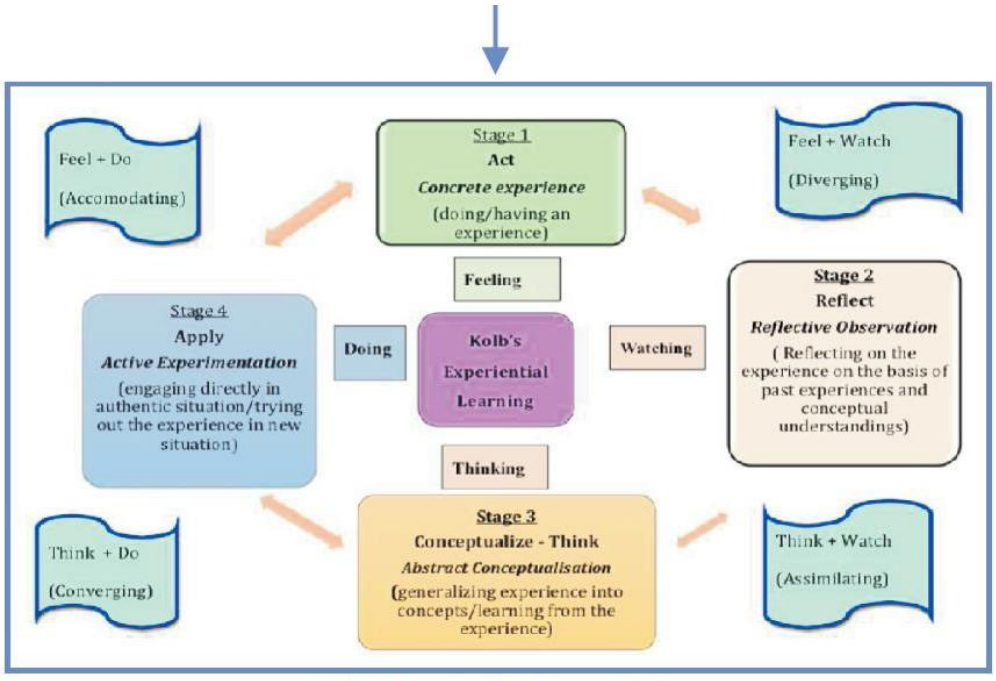
The experiential approach aims to make the educational environment student-centered. The students have control over their learning – the pace of learning,
the learning method, and the skills they need to utilize for this learning.
They can evaluate, think critically, make decisions, and master knowledge by constructing it. The teacher facilitates or guides the students. Learning experience may be cooperative, collaborative, or independent, encouraging the students to work together and learn how to question and evaluate evidence rather than accepting truths communicated by their teacher. Experiential learning is a well-known model in education, training, facilitation, and organizational development. The concept of experiential learning was first explored by John Dewey, Kurt Hahn, Kurt Lewin, and Jean Piaget, among others. It was made popular by David A. Kolb. The basic model of the experiential learning cycle is "do reflect decide". Kolb's Experiential Learning Theory (Kolb, 1984) defines experiential learning as "the

process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience."

A hands-on activity is an instructional technique that allows participants to learn by doing. During a hands-on activity participants are directly involved in their learning. Participants get direct practical experience as they apply their learning and learn from their failures. It challenges students to analyze data, make connections, and draw logical conclusions. They learn to question assumptions, test hypotheses, and think critically about the outcomes of their experiments. This analytical mindset prepares them for future scientific endeavors.

Benefits of including hands-on activities in teaching:

- Reflection, critical analysis, and synthesis
- Opportunities for students to take initiative, make decisions, and be accountable for the results
- Opportunities for students to engage intellectually, creatively, emotionally, socially, or physically
- A designed learning experience that includes the possibility of learning from natural consequences, mistakes, and successes



KOLB's Experiential Learning Cycle

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Objectives:

1. To compare the Experimental Group with the Control Group for achievement in Physics among Secondary students.
2. To compare the Effectiveness of developed instructional material between girls and boys in achievement of Physics among Secondary students.

Hypotheses:

1. There will not be a significant difference between the Experimental Group (Hands-on activities) with the Control Group with respect to achievement in Physics.
2. There will not be a significant difference between the achievement scores of girls and boys after teaching with the developed instructional material.

Research Methodology:

Analysis of data is an important part of the research design. Inferential Analysis is done to verify the null hypothesis and arrive at a conclusion based on acceptance or rejection. The quantitative part of the study follows the **quasi-experimental** research design of one group of Experimental and one group of Control group.

Experimental group: Instructional material- Hands-on activities

Control group: Traditional method of teaching (chalk-board method)

Sample:

The samples used for the study are purposive sampling techniques. This study has been conducted on secondary school students (grade 10). The total size of the sample is 70. The school that is selected for this study is affiliated to the CBSE board.

Tools of Investigation:

The researcher used hands-on activities to teach the concept of Reflection and Refraction of light to Secondary students.

The researcher developed a pre-achievement test to check the previous knowledge of both the Experimental Group and the Control Group.

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1. **Hands-on activities**- For the experimental group: The researcher developed instructional materials to conduct experiments with objects in the surrounding/laboratory to understand the concept of physics.

1. Nature of Mirror reflection activity:

The students engaged in a mirror reflection exercise. They measured the angle of incidence (the angle at which light strikes the mirror) and the angle of reflection using a protractor.

2. Nature of Refraction with a prism activity-

The pupils used a prism to practice refraction. To observe how the refraction changes, they changed the angle at which the light entered the prism. Students investigated how the spectrum of colors we see is caused by the varying levels of refraction of different light wavelengths, or colors. Students used prisms to study how light refracts. Students made use of a screen, white light, and prism.

3. Nature of Internal Total Reflection: Students performed the activity using plastic vessel, laser beam, mirror, water and protractor to see how a light ray traveling from a denser medium to a less dense medium is completely reflected back into the denser medium.

4. Nature of vibrations using tuning fork- Students checked the vibrations formed on the tunning fork on striking it against the rubber pad. The concept of Beats was also explained using sound of nearly equal frequencies.

5. Nature of confirming the laws of reflection activity- Students use screen, laser beam, protractor, mirror for the same.

6. Nature of Activity to check dispersion of light through prism- Students use white flash light, prism and white paper to perform this activity.

7. Activity to check Ink dispersion through water- Students use Water, food colouring or ink, clear glass, spoon. This activity illustrates how particles disperse in a liquid medium.

8. Activity of sound dispersion- wave phenomenon- Students strike a tuning fork and place it near different materials. Then they compare how the sound spreads through the air and the materials to see how sound waves disperse.

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9. Light passing through different liquids of varied density- water, oil and syrup- Students shine light through each liquid and observe how the light bends differently in each one. This happens because each liquid has a different refractive index.

10. Refraction through lenses- Students shine the flashlight through the magnifying glass or convex lens onto a white surface. They observe how the light bends and focuses at a point. Students are encouraged to experiment with different distances of the flashlight from the lens to see how the point where the light converges changes.

2. **Achievement test:** The researcher administered Pre-test and Post-test on both Experimental and Control group. Pre-test was conducted on both the groups to determine if the academic level of students is parallel. After administration of the developed instructional method of teaching on the Experimental group students, the researcher took a post-achievement test on both the groups.

The researcher has developed a criterion-referenced test to assess achievement in Physics. The researcher constructed the achievement test and consulted the same with subject experts in the field of Physics and their opinion was taken into consideration while finalizing the test. It had basically 5 sections, namely:

- Objective-type questions- Multiple choice answers
- Objective-type questions- Fill in the blanks
- Case-study based questions
- Numerically inclined word problems

Statistical technique:

An essential component of the research design is data analysis. It entails examining the structured content to uncover underlying truths. As a result, the researcher used both descriptive and inferential data processing and analysis. For the current study, the following analysis will be conducted:

To confirm the null hypothesis and reach a conclusion based on acceptance or rejection, inferential analysis was performed. To determine the likelihood that an observed difference between groups in this study was reliable or that it might have occurred by chance, the researcher employed a number of statistical tests. The following tests, which are listed below, were used to analyze the data for each of the objectives:

Statistical Test:
t-test was used to compare the Experimental Group with the Control group for achievement in Physics

Statistical Test:
t-test was used to compare the effectiveness of developed instructional material between girls and boys in achievement of Physics among senior secondary students

Result and Interpretation:

Table 1: Achievement in Physics of Students from Experimental Group and Control Group

Group	No. of students	Mean value	Standard deviation Value	t-test value	df
Experimental	35	28.26	3.0879	**8.716**	**68**
Control	35	18.69	5.719		

t-test was calculated which is shown in Table 1

The level of significance α at 0.01 is 2.660

In the present study, the first objective was to compare the Experimental Group with the Control Group for achievement in Physics among Secondary students.

To test this hypothesis, an independent samples t-test was conducted. The results are seen in Table 1 which indicates that the 35 students from the Experimental group (M = 28.26, SD = 3.0879) compared to the 35 students in the Control group (M = 18.69, SD = 5.719) demonstrated significantly better peak flow scores, t(68) = 8.716.

It was found that students who learned through Hands-on activities in the **Experimental group had their achievement scores in Physics significantly superior to students who learned under the conventional method in the Control group.** Hence, the null hypotheses namely- there will not be a significant difference between the Experimental Group (Hands-on activities) with the Control Group with respect to achievement in Physics is **rejected**.

A graphical Representation of the scores of students from the Experimental group and Control group. Scores were out of 35.

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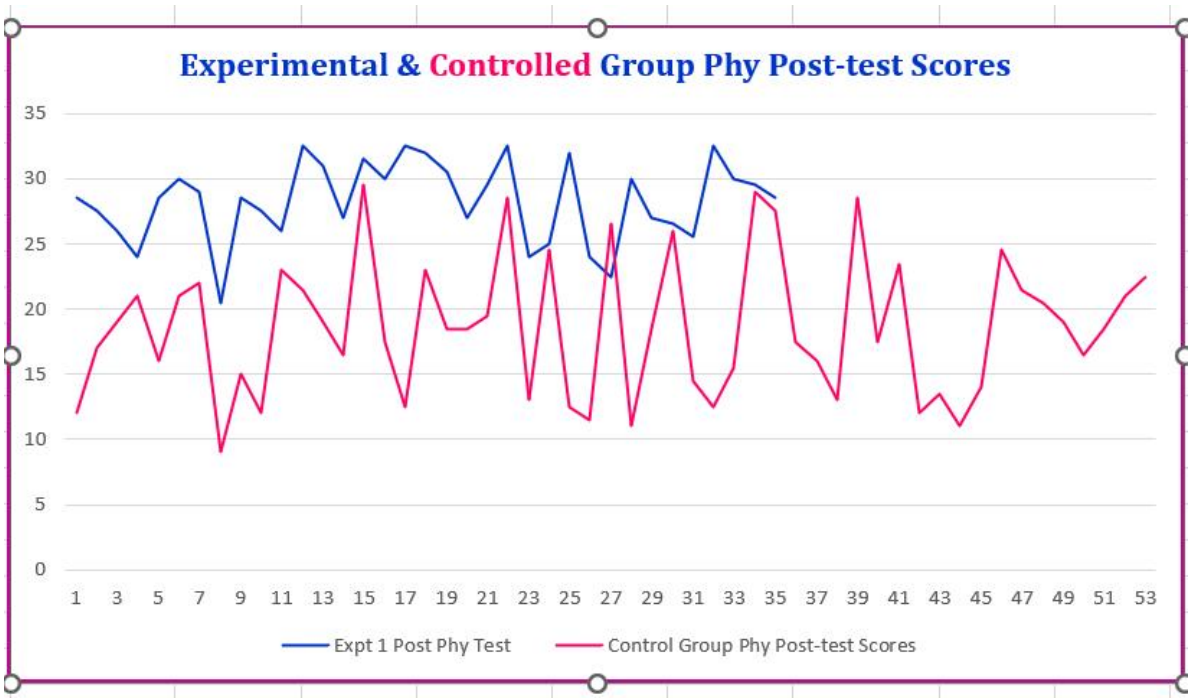

Avg Score	28.26	Max Score	32.5	Least Score	20.5
Avg Score	18.69	Max Score	29.5	Least Score	9

Table 2 : Achievement scores of Girls and Boys in Physics from the Experimental Group

Group	No. of students	Mean value	Standard deviation Value	t-test value	df
Group1 (Girls)	16	28	2.98	**1.75**	**33**
Group 2 (Boys)	19	29.61	4.52		

t-test was calculated which is shown in Table 2

The level of significance α at 0.01 is 2.750

A graphical Representation of the scores of Girls and Boys from the Experimental group. Scores were out of 35.

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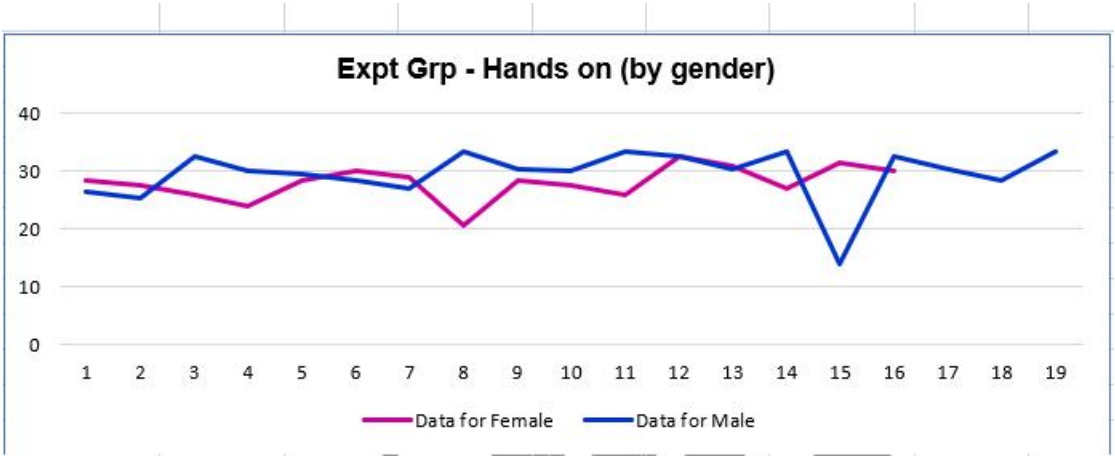

In the present study, the second objective was to compare the Effectiveness of developed instructional material between girls and boys in achievement of Physics among Secondary students.

To test this hypothesis, a t-test was conducted. The results are seen in Table 2 which indicates that the 16 girls from the Experimental group (M = 28, SD = 2.98) compared to the 19 boys also from the Experimental group (M = 29.61, SD = 4.52) demonstrated no significant effect, $t(33) = 1.75$

It was found that the developed instructional material (hands-on activities) for the Experimental group **did not significantly differ in Physics achievement between girls and boys.** This means there is no significant difference between the academic performance of girls and boys. Hence, the null hypotheses namely- there will not be a significant difference between the achievement scores of girls and boys after teaching with the developed instructional material is **accepted**.

Discussions:

From the study to compare the Experimental Group with the Control Group for Achievement in Physics among Secondary students, it has been understood that: Students in the Experimental group who learnt physics through hands-on activities outperformed students in the Control group who learned physics using the traditional technique by a large margin. This may be because the teaching materials were shown to be successful in helping students develop their comprehension, critical thinking, and problem-solving abilities. Since learning physics involves using all of the senses, students' achievement level was found to be higher when employing the hands-on activity technique as opposed to the traditional way.

From the study to compare the effectiveness of developed instructional material between girls and boys in the achievement of Physics among Secondary students, it has been understood that: there is no difference in achievement of Physics between the girls and boys of Secondary section students. The major reason for this can be that irrespective of their gender students can enhance communication and problem-solving skills.

Conclusion:

Hands-on activities make learning more engaging, which can enhance motivation and interest in the subject. When learners are directly involved, they are more likely to focus and feel invested in the learning process. students conducting experiments or building models are more likely to grasp scientific principles than from reading alone. While theoretical knowledge is essential, it can sometimes feel disconnected from real-world applications. Experiential learning helps bridge this gap by allowing students to apply what they've learned in practical situations. By actively engaging with problems and challenges in real contexts, learners hone their ability to think critically, analyze situations, and make informed decisions. Not all learners thrive through passive learning methods like reading or listening. Hands-on activities cater to kinesthetic learners (those who learn best through movement and doing) and can complement other learning styles (visual, auditory, etc.). When students participate in activities like simulations, role-playing, or creating projects, they retain information longer compared to just reading or listening to lectures. This is because they have actively processed and applied the information. Studies show that learners retain more information when they are actively involved in the learning process. Experiential learning helps deepen understanding by encouraging learners to think about concepts, use them in practice, and reflect on their experiences. Many hands-on activities are group-oriented, fostering collaboration and teamwork. This social aspect enhances communication skills and teaches learners how to work together, share ideas, and solve problems collectively.

Hands-on activities are crucial in helping students learn by doing. They increase engagement, deepen understanding, develop practical skills, and promote long-lasting learning outcomes. Whether it’s through real-world experiences, simulations, or interactive tasks, experiential learning nurtures critical skills for both academic success and life beyond the classroom.

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