Indian Knowledge System as a Pedagogical Tool for Fostering Attitudes Towards Learning Physics among Secondary School Students

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Abstract: ***India's ancient civilization has bequeathed a rich legacy of scientific excellence, with pioneering contributions from its sages and scholars. The NEP 2020 emphasizes the integration of Indian Knowledge System into the curriculum, ensuring the quality of education. In this study, the investigator aims to check the role of Indian Knowledge System in fostering attitude towards learning Physics among secondary school students by introducing students to prominent contributions of Indian physicists across various physics concepts. An experimental design was adopted for the study. The design of the study was a Pre-test – Post-test Non- Equivalent Group Design. The experiment was performed on a total sample of 74 secondary school students, 37 students each in the Experimental and Control Groups. The Physics learning attitude level of the sample was measured using Physics Learning Attitude Scale which is prepared and standardized by the Investigator. The data obtained from pre-test and post-test were subjected to statistical analysis like mean, median, skewness and kurtosis, the test of significance between means (t-test), paired t-test and ANCOVA. The findings of the study revealed that the integration of Indian Knowledge System into Physics teaching is effective in fostering the attitude towards learning Physics among of Secondary School students.***

Keywords: Indian Knowledge System, Attitude, Experimental Study

1. Introduction

Although India is a very old and wealthy culture with a long history of science and technology, the Western world does not fully recognize its contributions to physics, astronomy, mathematics, medicine, and the practical arts. Ancient Indian thinkers and scientists, including Kanada, Aryabhata, and Varahamihira, significantly advanced our understanding of nature. However, the current physics education system often overlooks ancient contributions, causing a gap between students' scientific understanding and their cultural background, hindering motivation, interest, and learning attitudes.

Many of the students find physics difficult because of their lack of mathematical knowledge, pessimistic attitudes towards the subject, unknown about the relevancy of the concepts and insufficient study time. By introducing students to prominent contributions of ancient Indian physicists across various physics concepts, they help students to connect the present and past, show the evolution of the ideas they are learning, and make the concepts more interesting.

2. Indian Knowledge System

The Indian Knowledge System (IKS) is a structured process of knowledge transfer based on Vedic literature, Upanishads, Vedas, and Upvedas. It is recognized by the NEP-2020 National Education Policy as a guiding principle. The IKS comprises Jnan, Vignan, and Jeevan Darshan, derived from experience, observation, experimentation, and rigorous analysis (Mandavkar, P. 2023). Indian civilization has a long-recorded history of scientific culture that goes back to more than 5000 years. Scholars such as Varahamihira, Aryabhatta, Vagbhatta, and Susruta made substantial contributions to knowledge advancement, putting India at the forefront of scientific advancement.

3. Review of Related Literature

Khan & Sharma (2024) discuss the Indian Knowledge System (IKS)'s potential to tackle societal issues by integrating Vedic literature, enhancing instruction, and promoting innovation through initiatives like Grand National Challenges, National Competitions, and Hackathons. Das (2024) highlights India's spiritually-rooted Knowledge System, encompassing literature, medicine, art, ethics, and more, with the National Education Policy 2020 aiming to establish India as a world leader. Portia and Gupta (2024) discuss the integration of Indian Knowledge Systems (IKS) with modern technology, highlighting its benefits in holistic development, cultural awareness, community building, and moral growth, and suggesting its potential for innovative solutions across industries. Sudhakar (2024) discusses the "Ingrained in India" concept in the New Education Policy, which integrates India's intellectual, historical, cultural, and spiritual heritage for a comprehensive, inclusive learning experience, emphasizing ethical and moral values.

Smitha (2014) emphasizes the inclusion of Vedic mathematics into school curriculum for reducing their mathematics anxiety in order to achieve success in their future life. Smitha (2018) studied the applications of Indian Intellectual traditions of Vedic Mathematics in enhancing employability skills of educated unemployed youths. Qasim (2024) discusses the Indian Knowledge System (IKS), which integrates ancient Indian wisdom with modern education, promoting interdisciplinary learning and fostering social responsibility, compassion, and ethical decision-making among students, thereby promoting balanced living and societal duty. Gupta (2024) explores ancient Indian practices that influenced scientific mindset, focusing on astronomy, mathematics, medicine, physics, and technology. The Indian Knowledge System (IKS) and its integration with philosophy and spirituality are highlighted. Further research is needed to understand their significance. Badoni, Prasad, and Chand (2024) explore the link between ancient Vedic texts and modern physics, highlighting the importance of Vedic physics in understanding natural phenomena and concepts like energy and motion, which predate modern scientific discoveries, and the continuity of knowledge in the Indian Knowledge System.

4. Need and Significance of the Study

Indian culture, a rich heritage of knowledge passed down through generations, is being reshaped by the National Education Policy 2020. The policy aims to promote Indian languages, arts, and culture, and to bridge the knowledge gap by incorporating Indian Knowledge System (IKS) into all educational curricula. India has a wealth of talent that should be harnessed in a productive and efficient manner. But Many of the students find physics difficult because of their lack of mathematical knowledge, pessimistic attitudes towards the subject, unknown about the relevancy of the concepts and insufficient study time. It is the responsibility of all educators to inspire their students to think creatively. It is essential to cultivate an enthusiasm, a spirit of scientific inquiry and a positive attitude towards learning subject among students. By incorporating traditional Indian scientific knowledge into the teaching of physics by exposing students to notable contributions made by Indian physicists on a range of physics topics, the students will be inspired to reconnect with their cultural roots and recognize the beauty and significance of physics which will develop a positive learning attitude towards Physics.

Objectives of the Study

1) To determine the initial level of Physics learning attitude among secondary school students prior to the experiment.
2) To assess the level of Physics learning attitude among secondary school students after the implementation of the experiment.
3) To evaluate the effectiveness of the Indian Knowledge System (IKS) integrated teaching in enhancing the Physics learning attitude of secondary school students.
4) To compare the effectiveness of the Indian Knowledge System integrated teaching method with that of the conventional method in improving the Physics learning attitude of secondary school students.

Hypotheses of the Study

1) There is no significant difference in the pre-test scores of Physics learning attitude between the experimental group and the control group.
2) There is no significant difference in the post-test scores of Physics learning attitude between the experimental group and the control group.
3) The Indian Knowledge System (IKS) integrated method of teaching has no significant effect on the Physics learning attitude of secondary school students.
4) There is no significant difference between the effectiveness of the Indian Knowledge System integrated method and the conventional method in enhancing the Physics learning attitude of secondary school students.

5. Methodology

The experimental method was selected for the present study. The design selected for the study was a non-equivalent, pre-test post-test control group design. The experiment was performed on a total sample of 74 secondary school students, 37 students each in the Experimental and Control Groups. Experimental group and Control groups were selected randomly. The experimental group was taught according to the IKS integrated method of teaching and the control group was taught according to the existing method of teaching. The Physics learning attitude level of the experimental and control groups were measured using Physics Learning Attitude Scale which is prepared and standardized by the Investigator. The same scale was given as pretest and post-test for the both groups. The data thus collected were tabulated and analyzed statistically.

The IKS based teaching uses brief descriptions of historical development and significance regarding each physics concepts which is termed as Historical snapshots. The physics concepts selected for the study were Atomic Theory, Laws of Motions, Equations of Motion, Law of Gravitation and electricity. The historical snapshots on each concepts were subjected to expert validation and their suggestions were considered for the improvement of the snapshots.

Research Method

The experimental method was adopted for the present study to investigate the effectiveness of the Indigenous Knowledge Systems (IKS) integrated method of teaching in enhancing students' attitude towards learning Physics.

Research Design

The design employed was a non-equivalent pre-test post-test control group design. The sample consisted of 74 secondary school students, divided into two groups: an Experimental Group (n = 37) and a Control Group (n = 37). Although the groups were selected randomly, intact classes were used, hence the non-equivalent nature.

Sample

- Total number of participants: 74
- Experimental Group: 37 students
- Control Group: 37 students
- Sampling method: Random selection of intact classes from secondary schools

Intervention

- **Experimental Group**: Taught using the **IKS integrated teaching method**, which included **Historical Snapshots** related to each physics concept such as Atomic Theory, Laws of Motion, Equations of Motion, Law of Gravitation, and Electricity. Historical snapshots explaining the development and significance of each concept were validated by subject matter experts before implementation.

- **Control Group**: Taught using the **traditional/existing method** of instruction on the same concepts.

Variables

Independent Variable

Method of Teaching
- IKS Integrated Method (Experimental)
- Traditional Method (Control)

Dependent Variable
- Attitude towards Learning Physics

Tools Used for Data Collection

Physics Learning Attitude Scale (PLAS)
- Developed and standardized by the investigator
- Used as both pre-test and post-test
- Measures the students' attitudes towards learning Physics

Physics Learning Attitude Scale

A 50-item scale was developed by the investigator to measure student's Physics learning attitude. The scale has a five-point Likert-type scale. From the light of related literature, the scale assesses five components of attitude toward learning Physics: value perception, perceived relevance of concepts, open-mindedness, relevance to future career, and self-confidence. Item analysis ensured the standardization of the scale. This scale consists of favourable and unfavourable statements, with each response being assigned a score of 5,4,3, 2, or 1 for "Always," "Often," "Sometimes," "Rarely," and "Never," respectively. This scoring system allows for a comprehensive evaluation of the perceptions of students. Weights of 5,4,3,2 and 1 were given for favorable statements, and for unfavorable statements, the scoring system was reversed. The scale demonstrates both content and construct validity, as well as high reliability with a coefficient of 0.99.

6. Data Analysis

Comparison of Pre-test scores of student's Physics learning attitude level in Control group and Experimental group.

Table 1: Data and Result of independent t-test for comparing pre-test scores of Control group and Experimental group

Test	N	Control group		Experimental group		T
		Mean m1	SD1	Mean m2	SD2	
Pre test	37	137	5.07	137	5.05	0.138
**p>.001						

The table value of t with df=72 is 2.646 at 0.01 level and 1.993 at 0.05 level, The calculated t value, 0.138 is not significant at level 0.01 level (t=0.138; p>0.01), it means that there is no significant difference between the means of the pretest scores in Control group and Experimental group.

Comparison of Post-test scores of student's Physics learning attitude level in Control group and Experimental group.

Table 2: Data and Result of independent t-test for comparing post-test scores of Control group and Experimental group

Test	N	Control group		Experimental group		T
		Mean m1	SD1	Mean m2	SD2	
Post test	37	143	7.33	158	6.41	9.10
**p<.001						

The table value of t with df=72 is 2.646 at 0.01 level and 1.993 at 0.05 level, The calculated t value, 9.10 is significant at level 0.01 level (t= 9.10; p<.001), it means that there is a significant difference between the means of the post-test scores in Control group and Experimental group.

Comparison of Pre-test and Post-Test scores of student's Physics learning attitude level in Experimental group.

Table 2: Data and Result of paired t-test for comparing pre-test and post-test scores of Experimental group.

Group	N	Post-test		Pre-test		T
		Mean m1	SD1	Mean m2	SD2	
Experiment	37	158	6.41	137	5.05	5.07
**p<.001						

The table value of t with df= 36 is 2.719 at 0.01 level and 2.028 at 0.05 level, The calculated t value, 5.07 is significant at level 0.01 level (t= 5.07; p<.001), it means that there is a significant difference between the means of the post-test and pretest scores in Experimental group.

Comparison of Effect IKS-Based Teaching and Conventional Method of Teaching on Physics learning attitude level Using ANCOVA.

To compare the effect of Indian Knowledge System integrated method and conventional method of teaching on Physics learning attitude, the pre-test and post-test scores were subjected to the statistical technique of Analysis of Covariance, and the results obtained were presented as follows in table 3.

Table 3: Summary of analysis of Co-variance of pre-test and post-test scores in Physics learning attitude among students in Experimental and Control groups

Group	N	Pre-test		Post-test	
		M	SD	M	SD
Experimental	37	137	5.05	158	6.41
Control	37	137	5.07	143	7.33
Source	Df	SS	MS	F	P
Pre-test	1	90.8	90.8	1.94	0.168
Instruction condition	1	3905.6	3905.6	83.41	<.001
Error	71	3324.3	46.8		
Corrected Total	73	7320.7			

Note. *M = mean, SD = Standard deviation, df = degree of freedom, SS = sum of squares, MS = mean square, F = variance ratio.*

ANCOVA result shows the Table value of F with df 1/71 is 7.01 at 0.01 level and 3.98 at 0.05 level. The obtained F ratio is F (1/71) = 83.41; p < 0.001. The observed means show that students taught using Indian Knowledge System integrated method performed better compared to the students taught through the conventional method of teaching Physics. It may, therefore, be interpreted that teaching using IKS-based teaching is superior to the conventional method of teaching Physics for enhancing the learning attitude level towards learning Physics among Secondary school students. The p-value 0.168 is greater than 0.05, which shows there is no significant effect of pretest scores on post-test scores. The superiority of the Indian Knowledge System integrated method in enhancing attitudes toward learning Physics among secondary school students is also clear from Figure 1.

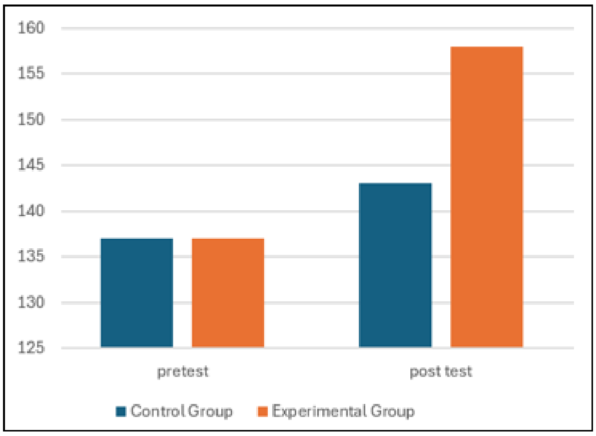

Figure 1: The bar diagram shows the pre-test and post-test means of physics learning attitude among the students in Experimental and Control groups

Tenability of the Hypothesis
The first null hypothesis formulated is:

There is no significant difference in the pre-test scores of Physics learning attitude between the experimental group and the control group

The above-stated hypothesis was tested for significance and the findings are given below:

The calculated t value, 0.138, is significant at level 0.01 level ($t= 0.138; p>0.001$), which means that there is no significant difference between the means of the pre-test scores in the Control group and the Experimental group. Hence null hypothesis is accepted.

The second null hypothesis formulated is:

There is no significant difference in the post-test scores of Physics learning attitude between the experimental group and the control group.

The above-stated hypothesis was tested for significance and the findings are given below:

The calculated t value, 9.10, is significant at level 0.01 level ($t= 9.10; p>.001$), which means that there is a significant difference between the means of the post-test scores in the Control group and the Experimental group. Hence, the null hypothesis is rejected, and the alternate hypothesis is accepted.

There is a significant difference in the post-test scores of Physics learning attitude between the experimental group and the control group.

The third null hypothesis formulated is:

The Indian Knowledge System (IKS) integrated method of teaching has no significant effect on the Physics learning attitude of secondary school students.

The above-stated hypothesis was tested for significance and the findings are given below:

The calculated t value, 5.07, is significant at level 0.01 level ($t= 5.07; p<.001$), which means that there is a significant difference between the means of the post-test and pretest scores in the Experimental group. Hence the null hypothesis is rejected and alternate hypothesis is accepted.

The Indian Knowledge System (IKS) integrated method of teaching has significant effect on the Physics learning attitude of secondary school students.

The fourth null hypothesis formulated is:

There is no significant difference between the effectiveness of the Indian Knowledge System integrated method of teaching and the conventional method in enhancing the Physics learning attitude of secondary school students.

The above-stated hypothesis was tested for significance and the findings are given below:

The Analysis of Co-Variance of the pre-test and post-test scores of students in Experimental and Control groups showed that there was a significant difference between their means of post-test scores ($F (1/71) = 83.41; p < .001$). The Experimental group was found to be superior to the Control group. Hence null hypothesis is rejected. Hence the alternate hypothesis is accepted.

There is significant difference between the effectiveness of the Indian Knowledge System integrated method of teaching and the conventional method in enhancing the Physics learning attitude of secondary school students.

7. Findings of the Study

The Analysis of Co-Variance of the pre-test and post-test scores in physics learning attitude among Experimental and Control groups showed that there was a significant difference between their mean ($F (1/71) = 83.41; p < .001$). The Experimental group being superior to the Control group. Hence from the data analysis the study revealed that Indian Knowledge System integrated method is superior to the conventional method of teaching Physics for enhancing the Physics learning attitude level among Secondary school students.

8. Educational Implications

The research highlights the potential of integrating Indian Knowledge Systems (IKS) into physics education. By

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connecting scientific principles to cultural contexts, it can deepen students' understanding and appreciation of the subject, increasing engagement, cultural awareness, a sense of Indianness, and motivation to learn. IKS can also promote interdisciplinary learning, linking physics with history and culture. Successful implementation requires teacher training and high-quality curriculum materials. The study suggests further research on the long-term impact of IKS integration on student learning outcomes and its effectiveness across diverse student populations and educational settings.

9. Conclusion

The study explores the impact of integrating Indian Knowledge Systems (IKS) into secondary school physics instruction. It aims to align with the National Education Policy 2020's emphasis on IKS in the curriculum. The findings show that IKS integration significantly enhances students' attitudes towards learning physics, connecting abstract scientific concepts to the rich heritage of Indian thought. The study suggests that further research could explore the long-term impact of IKS integration on student learning outcomes, academic achievement, and critical thinking skills. It also suggests that IKS can create an inclusive learning environment that empowers students to connect with their cultural heritage.

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