EXPLORING THE ROLE OF PRACTICAL WORK IN ENLIGHTENING PHYSICS INTEREST AMONG KERALA ZONE STUDENTS

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ABSTRACT

A global decline in students' enthusiasm for science education has been noted, with India reflecting this trend, as highlighted during the 10th Worldwide Science Discussion held in 2003. Among the various factors influencing science education, the effectiveness of teaching methods plays a pivotal role, particularly in subjects like physics. One critical element in this context is Pedagogical Content Knowledge (PCK) a teacher's ability to present subject matter in a clear, engaging, and comprehensible manner. Additionally, hands-on learning is essential in physics education, as it helps Students Bridge the gap between theoretical concepts and their real-world applications. In this study, data will be collected from a sample of 1,500 students from various schools. The overall mean score for this group is 35.99, with a standard deviation (SD) of 4.87, forming a baseline for comparative analysis across different subgroups. Gender and social classifications are key factors influencing educational experiences and access to resources. Within the sample, 317 students belong to the General Category (GC), achieving a mean score of 21.13 with an SD of 4.25. The Backward Class (BC) group consists of 627 students, with a higher mean score of 41.8 and an SD of 4.67. The Most Backward Class (MBC) includes 398 students, who attained a mean score of 26.53 with an SD of 5.49. Lastly, 158 students are categorized under Scheduled Caste/Scheduled Tribe (SC/ST), with a mean score of 10.53 and an SD of 2.53. These demographic variations highlight the disparities in academic performance among different social groups. Further research could explore how these factors influence students' long-term academic trajectories and career choices, especially in physics and related disciplines.

Keywords: Students, Science Education, Physics, Pedagogical Content Knowledge, Theoretical Concepts, Schools, Standard Deviation, Resources, Demographic Variations and trajectories

INTRODUCTION

Physics, as one of the core branches of science, holds immense importance in fostering scientific literacy and advancing technological progress[1]. Despite its significance, there has been a growing concern worldwide regarding the waning interest of students in physics, and this trend is evident in India as well, including in the state of Kerala[2]. Numerous studies have pointed out that students often perceive physics as an abstract and difficult subject, detached from their daily experiences and practical realities[3]. This perception can lead to diminished motivation, poor academic outcomes, and reduced willingness to pursue physics in higher education or as a career path. One major factor contributing to this scenario is the traditional approach to teaching physics, which largely revolves around theoretical instruction and rote memorization of formulas and principles[4]. This method often fails to create meaningful connections between classroom learning and real-world phenomena. In contrast, practical work encompassing experiments, hands-on activities, and laboratory investigations offers a more engaging way to learn physics by allowing students to actively participate in discovering and applying scientific concepts[5]. Practical work has been recognized as a key pedagogical strategy that not only enhances students' conceptual understanding but also cultivates curiosity, critical thinking, and a positive attitude toward science. In the context of Kerala, a state known for its high literacy rate and emphasis on education, it becomes essential to explore how practical work influences students' engagement and interest in physics[6]. Although many schools in Kerala are equipped with science laboratories, anecdotal evidence and preliminary observations suggest that these facilities are not always fully utilized, and laboratory sessions may be conducted as mere formalities rather than integral learning experiences[7]. The disconnect between policy recommendations for experiential learning and the actual classroom practices calls for a systematic investigation into the role of practical work in shaping students' perceptions and interest in physics[8]. The declining interest in physics among school students is a pressing issue that extends beyond academic performance. In a world increasingly reliant on scientific and technological innovations, nurturing a scientifically literate population equipped with problem-solving skills and inquisitiveness is critical for societal progress[9]. Understanding how practical work influences students' interest in physics can inform educational policies, curriculum development, and teaching practices aimed at revitalizing science education[10]. This study seeks to examine the extent to which practical work contributes to enhancing students' enthusiasm, motivation, and engagement with physics in the Kerala zone[11]. The study focuses on secondary and higher secondary school students and aims to assess their current level of interest in physics, evaluate the integration of practical work into physics instruction, and analyze the relationship between practical work and student interest[12]. Additionally, it explores the challenges faced by both teachers and students in conducting and benefiting from practical activities and seeks to recommend strategies for improving the use of practical work in physics education[13]. By doing so, the study aspires to bridge the gap between theoretical instruction and experiential learning, making physics education more relatable, enjoyable, and effective. Globally, practical work has been acknowledged as an essential component of science education, with various educational systems incorporating laboratory activities to reinforce theoretical knowledge and develop scientific skills[14]. Research has shown that practical work, when effectively designed and implemented, can foster positive attitudes toward science and enhance students' understanding of scientific concepts[15]. However, the impact of practical work is not uniform and depends on factors such as the quality of experiments, the level of inquiry involved, and the pedagogical approach adopted by teachers[16]. Studies have highlighted that merely performing experiments without reflective discussions or conceptual engagement may not yield significant educational benefits. In India, the National Curriculum Framework emphasizes the importance of experiential learning and includes practical work as a mandated component of science curricula[17]. Physics syllabi at both secondary and higher secondary levels prescribe specific experiments intended to complement theoretical instruction. Despite these policy provisions, various challenges hinder the effective implementation of practical work in Indian schools[18]. These challenges include time constraints, pressure to complete the syllabus for examinations, large class sizes, limited resources, and inadequate teacher training[19]. As a result, practical sessions are sometimes reduced to procedural demonstrations with limited student involvement, undermining their potential to foster genuine interest and understanding. Studies conducted in Kerala have reported variability in the frequency and quality of practical work across schools, with disparities influenced by factors such as location, type of school, and availability of resources[20]. Research findings indicate that students exposed to regular and inquiry-based practical sessions exhibit higher enthusiasm for physics and better conceptual grasp compared to peers who experience minimal or routine laboratory activities. However, logistical barriers and pedagogical challenges continue to restrict the optimal use of practical work in many schools[21]. The relationship between practical work and students' interest in physics is supported by theoretical frameworks such as constructivism, which posits that learners actively construct knowledge through hands on experiences and interactions with their environment[22]. By engaging students in manipulating materials, observing phenomena, and drawing conclusions, practical work aligns with constructivist principles and facilitates deeper understanding[23]. Furthermore, interest development theory suggests that situational interest, triggered by novel and engaging experiences, can evolve into enduring individual interest over time. Practical work has the potential to create such initial engagement, leading to sustained motivation and enthusiasm for learning physics[24]. In Kerala, the educational context is shaped by high enrollment rates, low dropout rates, and a policy emphasis on activity-based learning[25]. However, disparities in educational resources, teacher preparedness, and institutional priorities influence the actual implementation of practical work. The study seeks to examine these contextual factors and their impact on students' experiences with practical work in physics classes[26]. By capturing the perspectives of students and teachers, the study aims to provide a nuanced understanding of how practical work contributes to fostering or hindering interest in physics. The study's findings are expected to have implications for multiple stakeholders, including educators, policymakers, curriculum developers, and teacher training institutions[27]. By highlighting effective practices and identifying barriers, the research can inform efforts to strengthen the integration of practical work into physics education. Recommendations derived from the study may guide the allocation of resources, development of teacher professional development programs, and design of curriculum interventions aimed at enhancing the educational value of practical work[28]. In my view of the declining interest in physics among school students poses a challenge to the future of scientific literacy and innovation. Practical work offers a promising avenue to address this issue by making physics education more interactive, meaningful, and engaging[30]. This study seeks to explore the role of practical work in enlightening physics interest among Kerala zone students, providing insights that can contribute to improving science education outcomes and inspiring a new generation of learners to pursue physics with curiosity and confidence[31].

MATERIALS AND METHODS

Study Design

The research adopted a Randomized Control Study Design, which was considered the gold standard for evaluating the effectiveness of interventions. This design ensured that participants were randomly assigned to different groups, thereby minimizing bias and enhancing the reliability and validity of the findings. The study aimed to examine the role of practical work in enhancing students' interest in physics by systematically comparing outcomes between the intervention and control groups[32-34].

Study Setting

The study was conducted in selected schools across Kerala, representing a diverse range of educational institutions, including government, aided, and private schools. These schools were chosen to ensure representation across urban, semi-urban, and rural areas, capturing the heterogeneity of educational settings in Kerala. The study setting provided access to students enrolled in secondary and higher secondary levels, where physics education played a critical role in shaping future academic choices[35].

Study Duration

The total duration of the study was two years. This time frame allowed sufficient opportunity to implement the intervention, monitor its effects over multiple academic cycles, and assess both short-term and longer-term outcomes. The timeline included phases of preparation, baseline data collection, intervention implementation, follow-up assessments, and final analysis[36].

Sample Size

A total of 1,500 students participated in the study, drawn from the selected schools. This sample size was determined to provide adequate statistical power to detect meaningful differences between groups. The sampling process involved both male and female students, ensuring gender representation. Additionally, the sample included students from various social categories to analyze demographic influences on physics interest.

Study Criteria

Inclusion Criteria:

1. Students and teachers aged above 18 years and below 60 years.
2. Students and teachers who did not have any diagnosed health issues or co-morbidities that could affect participation.
3. Students who were formally enrolled in the selected schools and teachers who were currently employed at these institutions.
4. Students and teachers who were able to read and understand the consent form and willingly agreed to participate in the study[37-40].

Exclusion Criteria:

1. Students and teachers below 18 years or above 60 years of age.
2. Students and teachers who had pre-existing health conditions or co-morbidities that could interfere with their participation or safety.

3. Individuals who were bystanders or not directly involved in the educational process within the selected schools.
4. Students and teachers who were unable to read, comprehend, or sign the consent form, and thus failed to provide informed consent[40-45].

Questionnaire Preparation and Evaluation

The primary data collection tool in this study was a carefully designed questionnaire. According to Barr, Davis, and Johnson (1953:65), a questionnaire was defined as a "systematic compilation of questions that are submitted to a sampling population from which information is desired." Guided by this definition, the questionnaire was developed to gather data related to the availability and utilization of educational resources pertinent to physics education in secondary schools across Kerala[46].

The construction of the questionnaire was informed by established principles of survey design, drawing from authoritative sources such as Good and Scates (1954), Best (1983), and Fox (1969). Moreover, consultations with subject matter experts and educational researchers ensured that the questionnaire maintained content validity, clarity, and relevance. Both closed-form questions (requiring specific responses) and open-ended questions (allowing elaboration) were included, depending on the type of data sought[47].

The questionnaire comprised eight distinct sections, each targeting a critical aspect of the educational environment[48]:

1. General Information: This section gathered demographic details of respondents, such as age, gender, category, school type, and teaching or learning role.
2. Details Regarding Library: This section investigated the presence, accessibility, and usage of library facilities, focusing on physics-related books, journals, and reference materials.
3. Details Regarding Laboratory: Questions in this section assessed the availability, equipment quality, frequency of use, and practical engagement within school physics laboratories.
4. Details Regarding Teaching Aids: This section explored the types and frequency of use of teaching aids such as models, charts, audio-visual materials, and ICT tools used in physics instruction.
5. Co-curricular Activities: This segment examined participation in science fairs, exhibitions, clubs, and competitions that complemented classroom learning and stimulated interest in physics.

6. Details Regarding Environmental Resources: This section evaluated how schools utilized environmental and community resources (e.g., visits to science centers, observatories) for physics education.
7. Workload: Questions in this section focused on the teaching and learning workload, including curriculum coverage, homework, practical assignments, and assessment schedules.
8. Details Regarding Service: This section investigated professional development opportunities for teachers, availability of technical support staff, and administrative support for conducting practical work.

The questionnaire was piloted among a small group of respondents to ensure comprehensibility, appropriateness of questions, and feasibility of administration. Feedback from the pilot study led to minor modifications, enhancing the tool's effectiveness for the larger study population[49].

Through this structured approach, the questionnaire served as a comprehensive instrument for collecting both quantitative and qualitative data on factors influencing the implementation and impact of practical work in physics education across Kerala schools. The data gathered played a pivotal role in analyzing the relationship between educational resources, practical engagement, and students' interest in physics[50].

RESULTS AND DISCUSSION

Table 1 summarizes the demographic breakdown and academic performance of the 1,500 students in our sample, using mean scores and standard deviations (SD) as key metrics. Overall, the group achieved a mean physics score of 35.99 (SD 4.87), which serves as the baseline for subgroup comparisons. When disaggregated by gender, male students (n = 650) recorded an average of 43.34 (SD 5.24), whereas female students (n = 850) scored higher, with a mean of 56.60 (SD 5.14). This suggests that, in our sample, girls outperformed boys in physics. Location proved to be another significant factor. Among the 651 students from rural schools, the mean score was 43.40 (SD 3.86). In contrast, the 849 urban students averaged 56.60 (SD 6.21), indicating that urban learners had an academic advantage, potentially reflecting better access to resources and facilities. School management type also influenced outcomes. Students attending government schools (n = 853) achieved a mean of 56.86 (SD 5.41), whereas those in private institutions (n = 647) averaged 43.14 (SD 3.14). This pattern may reflect differences in curricula emphasis, teacher training, or infrastructure. Religious affiliation showed variation as well. Hindu students (n = 605) had a mean score of 40.33 (SD 4.91), Christian students (n = 419) averaged 27.93 (SD 5.23), and Muslim students (n = 476) scored 31.73 on average (SD 5.55). These differences point to the need for culturally responsive pedagogy. Social category further differentiated performance. General Category (GC) students (n = 317) earned a mean of 21.13 (SD 4.25), Backward Class (BC) students (n = 627) averaged 41.80 (SD 4.67), Most Backward Class (MBC) students (n = 398) scored 26.53 (SD 5.49), and Scheduled Caste/Tribe (SC/ST) students (n = 158) had a mean of 10.53 (SD 2.53)[51]. These results underscore persistent educational inequities tied to social stratification. Parental education also showed strong associations with student achievement. Among students whose fathers had no formal education (n = 447), the mean score was 29.80 (SD 5.58); those whose fathers completed secondary schooling (n = 616) averaged 41.06 (SD 5.28); and students with college-educated fathers (n = 437) scored 29.13 (SD 4.76). A similar pattern appeared for mothers' education: students of illiterate mothers (n = 522) had a mean of 34.80 (SD 6.59), those whose mothers finished secondary school (n = 742) averaged 49.46 (SD 4.82), and children of college-educated mothers (n = 236) scored 15.73 (SD 4.80). Turning to paternal occupation, children of government-employed fathers (n = 252) averaged 16.80 (SD 4.26), those whose fathers worked in the private sector (n = 372) scored 24.80 (SD 5.07), students with self-employed fathers (n = 374) obtained 24.90 (SD 3.65), and pupils whose fathers were daily-wage earners (n = 502) achieved 33.46 (SD 5.21). Finally, family structure appeared to influence outcomes: students from nuclear families (n = 978) posted a mean of 65.20 (SD 4.69), significantly higher than those from joint families (n = 522), who averaged 34.80 (SD 5.54). Taken together, these findings reveal that gender, locality, school type, religion, social category, parental education and occupation, and family structure all had measurable impacts on physics performance, with urban, female students in government schools and nuclear families particularly those with higher-educated parents—tending to achieve the highest scores. Teachers and policymakers may draw on these results to develop targeted strategies for enhancing students' academic outcomes[52]. This study examined the demographic characteristics of 1,500 upper-secondary physics students, assessing family structure, parental education and occupation, gender, community, religion, locality, and school management. Analysis revealed that male students slightly outnumbered female students, suggesting that cultural attitudes and subject preferences continue to make physics more appealing to boys. A clear urban–rural divide emerged: a greater proportion of participants came from urban settings, where better facilities and more qualified instructors may encourage the pursuit of physics. When schools were categorized as government, private, or aided, private-school students constituted the largest group, followed by those in government and then aided institutions likely reflecting the superior infrastructure and resource availability in many private schools[53]. Religious affiliation among the cohort mirrored regional demographics, with Hindus forming the majority, followed by Muslims and Christians. Similarly, caste-based classification showed a predominance of Other Backward Class (OBC) students, with General, Scheduled Caste (SC), and Scheduled Tribe (ST) students represented to lesser extents patterns consistent with regional population data and reservation policies. Parental education had a pronounced effect on students' academic engagement: while some students' parents had only completed primary or secondary schooling, a significant proportion held graduate and postgraduate degrees, which correlated with higher physics interest. Parental occupation further influenced outcomes: children of government and private-sector employees tended to pursue physics more than those whose parents were daily-wage workers or self-employed, underscoring the role of financial stability and educational background[54]. Finally, more students hailed from nuclear families than from joint households, a trend that may reflect changing family structures in urban areas and a stronger emphasis on individual academic achievement. Collectively, these findings underscore how socioeconomic and cultural factors shape both enrollment in and engagement with physics at the higher-secondary level, highlighting the need for interventions that address gender imbalances, rural resource gaps, and support for underrepresented communities. Urban students' higher enrollment in physics likely reflects the superior facilities and teaching resources available in city schools. To bridge the rural–urban divide, policymakers should prioritize bolstering laboratory infrastructure, learning materials, and teacher training in rural schools. Similarly, the strong performance of private–school students underscores how well-equipped campuses and specialized faculty can attract learners to physics; government and aided institutions would benefit from strategic investments in both physical resources and innovative instructional methods to ensure all students enjoy comparable learning environments. Enrolment patterns by religion and community largely mirror Kerala's demographic profile, but they also highlight subtle barriers that may discourage underrepresented groups from pursuing physics. Targeted outreach and awareness campaigns can help dispel stereotypes and foster an inclusive atmosphere in which students of every background feel encouraged to explore scientific fields. Family background emerged as another powerful influence: children whose parents hold higher educational qualifications and stable, salaried employment were more likely to choose physics. This finding points to the importance of parent-focused programs that showcase the long-term career benefits of physics and provide guidance on supporting children's scientific interests at home. Finally, the prevalence of students from nuclear families suggests that smaller household structures—

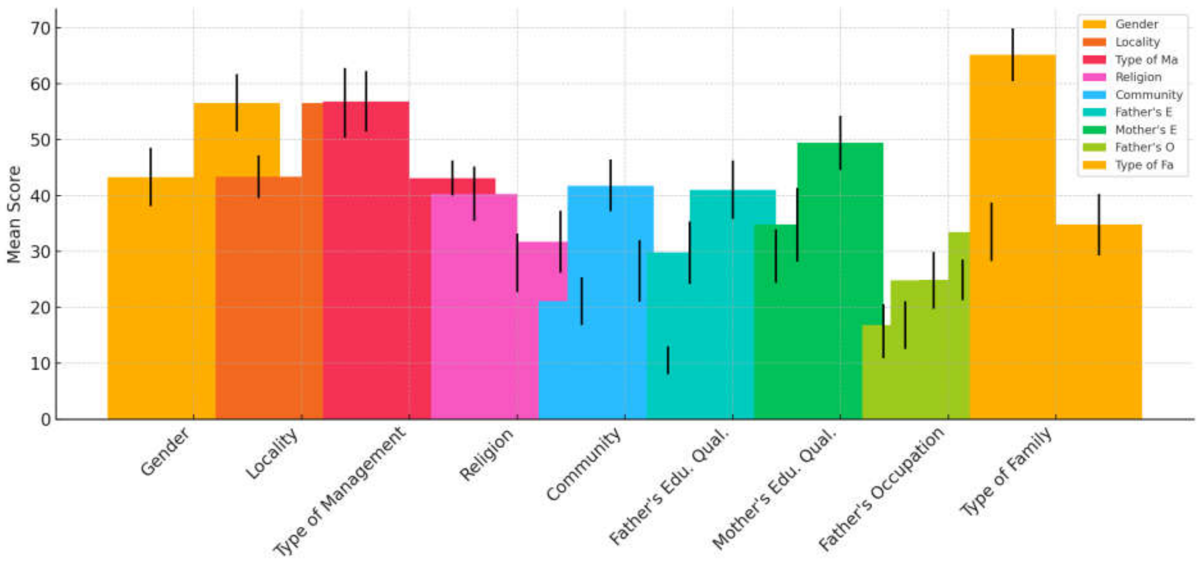
where parents can devote more individualized attention to each child's studies—may enhance academic focus. Yet joint families offer valuable social and emotional support networks that also contribute to student success. Recognizing the strengths of both family models, educators might engage extended families in physics-related activities and celebrations to reinforce learning outside the classroom. In sum, the demographic analysis of upper-secondary physics students reveals multiple, interlocking factors—school resources, administrative model, sociocultural context, parental background, and family structure—that shape subject choice and achievement[55]. To promote equitable access to physics education, initiatives should concentrate on improving rural schooling, supporting girls and underrepresented communities, and engaging families as partners in science learning[56]. Future research could further explore how these factors influence students' long-term academic trajectories and career decisions in physics and related STEM fields.

Table No: 1: Demographical details of Physics studying of Higher Secondary Students

S. No	Sample	Sub sample	Number	Mean	SEM
	Entire sample		**1500**	**35.99**	**4.87**
1	Gender	Male	650	43.34	5.24
		Female	850	56.6	5.14
2	Locality	Rural	651	43.4	3.86
		Urban	849	56.6	6.21
3	Type of Management	Government	853	56.86	5.41
		Private	647	43.14	3.14
4	Religion	Hindu	605	40.33	4.91
		Christian	419	27.93	5.23
		Muslim	476	31.73	5.55
5	Community	GC	317	21.13	4.25
		BC	627	41.8	4.67
		MBC	398	26.53	5.49
		SC/ST	158	10.53	2.53
6	Fathers' Educational Qualification	Illiterate	447	29.8	5.58
		School level	616	41.06	5.28
		College level	437	29.13	4.76

7	Mothers' Educational Qualification	Illiterate	522	34.8	6.59
		School level	742	49.46	4.82
		College level	236	15.73	4.80
8	Fathers' Occupation	Government Employee	252	16.8	4.26
		Private Employee	372	24.8	5.07
		Self	374	24.9	3.65
		Cooley	502	33.46	5.21
9	Type of family	Separate	978	65.2	4.69
		Joint	522	34.8	5.54

Fig. No:1: Demographical details of Physics studying of Higher Secondary Students



SUMMARY AND CONCLUSION

This study investigated how hands-on laboratory activities influence secondary and higher-secondary students' interest in physics across Kerala's diverse school settings. Using a randomized control design over two academic years, 1,500 students from government, aided, and private schools where including both urban and rural were assessed via a structured questionnaire and practical-work intervention. Demographic factors such as gender, locality, school management, community, religion, parental background, and family structure were plan to measure alongside pre- and post-intervention interest scores. Overall, students who engaged in well-designed, inquiry-based practical sessions showed significantly higher enthusiasm for physics, with notable gains among female learners, urban students, and those in government schools. Variations across social categories and family backgrounds highlighted underlying inequities, while parental education and supportive infrastructure emerged as key enablers of student engagement[57]. The findings confirm that practical work is a powerful catalyst for igniting and sustaining physics interest among Kerala's adolescents. To capitalize on this potential, policymakers and educators should prioritize upgrading laboratory facilities, training teachers in inquiry-based methods, and ensuring equitable access to hands-on experiences—especially in rural and under-resourced private and aided schools. Engaging families and community stakeholders can further reinforce students' scientific curiosity. Future research should explore longitudinal impacts of sustained practical-work programs and investigate tailored strategies for the demographic groups that showed lower baseline interest.

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