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Exploring Factors Influencing Performance in Physics Education: A Case Study of Challenges and Interventions in Bhutanese Year XII Students

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Abstract

This research delves into the multifaceted factors impacting academic performance in physics education. Through a comprehensive investigation employing a case study approach, the study sheds light on the challenges faced by Bhutanese Year XII students in their pursuit of excellence in the National High-stake Examination in Physics. The research identifies three overarching themes that have emerged from the diverse perspectives of teachers and students. These themes encompass the performance of Grade XII students in the aforementioned examination, the hurdles encountered during high-stake physics assessment, and the implementation of targeted interventions to address these challenges. The study not only scrutinizes the quality of instruction and its impact on learning outcomes but also delves into specific aspects such as teaching methods, class duration, and teachers preparation skills. The findings underline the significant influence of teaching methods on learning outcomes, with valuable insights from students at the College of Science and Technology CST and Motithang Higher Secondary School MHSS. Moreover, the research highlights the need for innovative approaches like inquiry-based lessons to enhance the comprehension of abstract theoretical concepts. This study serves as a valuable resource for educators, administrators, and policymakers seeking to enhance physics education and mitigate the obstacles faced by students in Bhutanese Year XII classes.

Keywords: Physics education, Active learning, Physics teachers, growth mindset, etheno physics.

INTRODUCTION

Education plays a pivotal role in shaping the progress and development of a nation. It serves as a platform for individuals to acquire knowledge, skills, and capabilities, thereby contributing to their personal growth and the advancement of society as a whole. In Bhutan, as in many other countries, the pursuit of excellence in education is a key priority for the government and various stakeholders. Despite concerted efforts by the Ministry of Education to enhance educational standards, there remains a notable challenge concerning the performance of Bhutanese Year XII students in the National High-stake Examination in Physics (BHSEC).

This issue has garnered attention and raised concerns among government officials, parents, and educators alike, as evidenced by the performance data spanning multiple years (BCSEA, 2019, 2020, 2021, & 2022). This study, therefore, seeks to delve into the multifaceted factors that impact the academic performance of Year XII students in physics, a subject of critical importance in the educational landscape.

The literature surrounding this study underscores the significance of addressing the challenges faced by students in physics education. It emphasizes the need for a holistic investigation into the factors affecting performance, coupled with strategic interventions to address these challenges. With this context in mind, the research questions that guide this study emerge:

What is the current performance level of Grade XII students in the National High-stake Examination in Physics?

What are the specific challenges encountered by students in high-stake physics assessment?
What targeted interventions can be implemented to mitigate these challenges and enhance performance in physics?

Rationale for the Study

The rationale behind this research stems from the critical importance of physics education in Bhutan and its role in shaping the future of students and the nation as a whole. As the nation strives for progress and development, it is imperative to ensure that the educational system equips students with the knowledge and skills needed to excel, particularly in subjects like physics. The persistent challenges in physics education, as evidenced by performance data, necessitate a comprehensive inquiry.

Through a case study approach, this research aims to shed light on the various dimensions of the issue, considering the perspectives of both teachers and students. It will not only assess the quality of instruction but also delve into specific aspects such as teaching methods, class duration, and teachers' preparation skills. Moreover, this study will explore innovative approaches like inquiry-based lessons, which have the potential to enhance the comprehension of abstract theoretical concepts.

This study serves as a valuable resource for educators, administrators, and policymakers who are committed to enhancing physics education and overcoming the obstacles faced by Bhutanese Year XII students. By addressing these challenges, we can contribute to the educational excellence of our students and in turn, the progress of our nation.

Literature Review

These learning barriers affect students' performance. The factors that affect students' success in Physics are those that arise during instruction, such as instructional methods, as well as those that relate to students' pre-instruction preparation, such as English and Mathematics classes.

In the Bhutanese school, there are challenges to performance in learning physics. The common challenges include the need for more resources for learning physic. The learning and teaching of physics dwell to that on preparation for the examination and not on the practices of physics. The learning material needs to be more appropriate with the approach to learning physics.

Besides, some schools need infrastructures suited to teach physics. The time allocation, shortage of time for the class, and poor English language of students in comprehending the discipline and attributes of learning physics. The beliefs of students that physics is a difficult subject and the lack of teachers' skills and knowledge to prepare an inquiry-based lesson in physics. The issues of performance in physics at the global school are from the perspective of the approach that needs to be included. The Inquiry-based teaching and learning methodologies of teaching where problem-solving and critical thinking are not considered (Dusabimana & Rugema Leon, 2022). Such attributes are missing in Bhutanese schools as well.

Physics is, without a doubt, one of the most challenging studies offered in higher secondary schools. The subject matter, the instructional materials, the classroom atmosphere, the teacher factor, and the application of principles to real-life situations are all potential sources of difficulty in physics (Hofer et al., 2018).

RESEARCH METHODOLOGY

3.1 Study design

This study adopts a mixed-method approach, combining both quantitative and qualitative data collection techniques. The quantitative data is derived from the high-stakes examination scores of BHSEC Physics students, sourced from the Bhutan Council for School Examinations and Assessment database. This includes course grades based on Continuous Assessment (CA) components.
Qualitative data is collected through semi-structured interviews conducted at selected schools using survey questionnaires. Additionally, a case study approach is employed to examine performance, challenges, and interventions in detail.

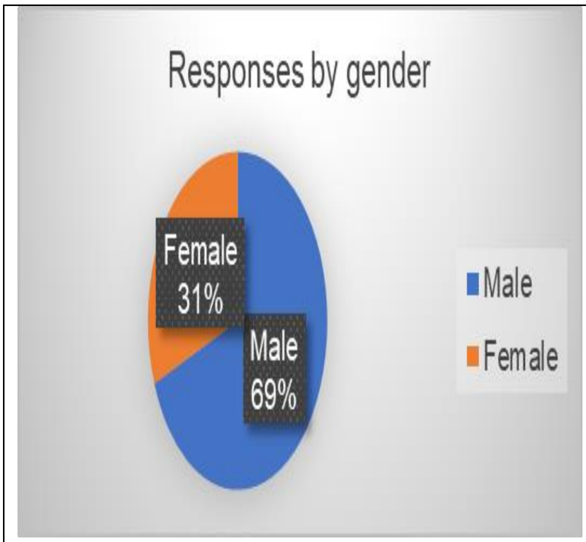
3.2 Study samples

The study focuses on past year science students from selected schools with a background in physics. Schools with varying levels of performance excellent, mediocre, and substandard are identified based on quantitative data, and a case study is developed from these categories.

3.3 Approach/Paradigm

This study adopts a post-positivist approach, encompassing both quantitative and qualitative phases. Quantitative data collection is followed by inferential analysis. The inclusion of semi-structured questionnaires, complemented by quantitative data, reflects a constructive approach.

Artifacts



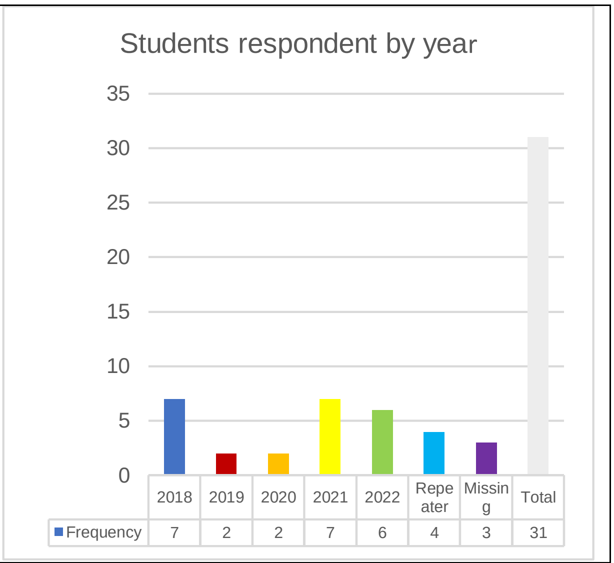


Figure 1a: Responses by Gender.	Figure 1b: Responses by Year.

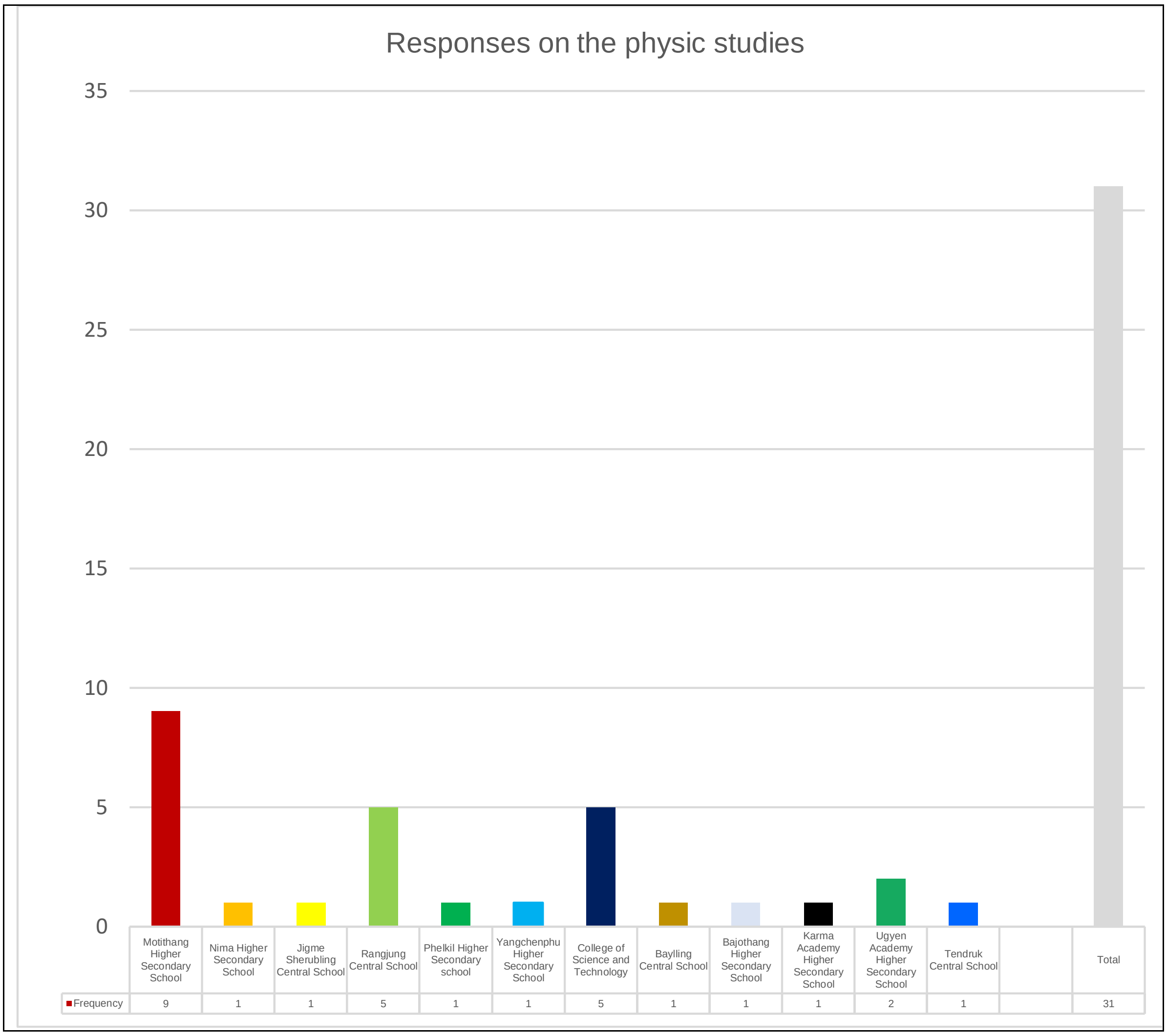


Figure 1c: Demographic study on physic study

Demographic Study: The demographic analysis includes factors such as school, gender, and students' year of completion (Grade XII). There are a total of 31 participants, with 69% male and 31% female, representing five categories of students from 2018 to 2022. Some students are categorized as "repeaters" without specifying the year. Notably, two schools and one college under the Royal University of Bhutan are focused on for data reliability. Data from 2018, 2021, and 2022 are used for statistical reports. Other years, 2019 and 2020, lack sufficient data for representation.

RESULTS AND DISCUSSION

In this section, the data analyses are presented, wherein they have been collated, merged, and triangulated to gain a comprehensive understanding of the stated issue.

Interview: Physics teacher.

A physics teacher in grade XII emphasizes the universality of scientific knowledge and its applications, advocating for a global perspective in physics teaching. He aims to create awareness of global issues and challenges in physics, promoting it as a multidisciplinary skill rather than an isolated subject. To bridge the teaching and learning gap, he emphasizes cross-cultural collaboration using technology.

The teacher highlights the significance of integrating global resources and materials to stay updated with international research and appreciate diverse scientific contributions in physics. By adopting this approach, he aims to enhance students' understanding and appreciation of physics in a broader, interconnected context.

Case study: Physics Student

The students' expectations for physics education involve addressing real-world applications of abstract concepts and a desire for a well-equipped investigation lab and increased global exposure to understand challenges better. They emphasize the importance of practical courses such as laboratory exercises, hands-on workshops, project-based and inquiry-based learning, and field visits to apply theoretical knowledge in practical scenarios. However, in Bhutanese classrooms, the focus remains primarily on exams and grades, limiting students' opportunities for innovation and experimentation.

The need for a shift towards more critical thinking and application-based learning in physics classes is crucial to preparing students for diverse career paths beyond physics, where quantitative reasoning and problem-solving skills gained through studying physics are highly valuable.

Reflection on high school physics in Bhutan

In physics education, experiments in one of the High Schools above are primarily a tool to support various goals, such as to illustrate physics phenomena and promote conceptual understanding, experimental design, or data analysis skills. The use of an experiment as a teaching and learning tool indicates that Jigme N (Name Changed) is pursuing primarily a content-related learning goal: The students should learn about the elongation of springs by quantitatively investigating the relationship between force and elongation.

The acquired content knowledge can be used in various contexts, for example, to explain the function of a spring scale. In order to achieve this content-related learning goal, Jigme N never uses an experiment as a tool by precisely specifying the setup, the performance of the measurement and the analysis of the experimental data. Jigme N, the physics teacher, teaches about experimental setup; students learn and note about the instruction and then close the lesson to prepare for the class test later in the week.

Observation 1:

While the physics teachers who were interviewed stated the global practices of teaching, learning and assessment in physics, there need to be more such practices to make the students learn hand on or to the practices of realities, just as what the force elongation of springs by investigating quantitatively the relationship between force and elongation. Newton's three laws are done the same way in one of the observations. The laws of inertia, acceleration and opposite and equal reaction are taught from the text and summed up in the text and test.

In Bhutanese schools, the observation cues provided insights into how teachers initiate scientific learning. It is essential for students to express and share interpretative ideas explicitly. To enhance the learning experience, teaching approaches need to shift from transmitting experiences to promoting active student involvement. Encouraging students to observe phenomena, collect data, and engage in scientific reasoning and inquiry-based approaches fosters a deeper understanding of concepts within the context of Bhutanese classrooms. By involving students actively in their learning, the approach emphasizes scientific exploration and encourages them to develop their interpretations and explanations.

In Bhutanese schools, teachers face challenges in preparing for physics education due to the lack of qualified teaching resources for primary schools. Existing textbooks are often confusing and focused on producing exam results rather than promoting meaningful learning. This examination-oriented approach has led to a lack of genuine interest in physics among students. To address these issues, there is a need to transition from information-based teaching to inquiry-based scientific learning. Pre-service teacher education in Paro and Samtse should equip the new generation of physics teachers with skills to foster children's curiosity, encourage scientific thinking, and engage them as active and responsible learners in an interactive educational environment.

Table 2: Resources of learning physics in the schools (Challenges).

Name of the School			There is a need for additional resources to support the practice of learning physics.	The focus of learning and teaching physics often revolves around exam preparation	Physics education in schools emphasizes practical application	The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning	Appropriate equipment is necessary for teaching physics effectively	The language used by students to comprehend the discipline of physics learning holds significance
MHSS	Total	Mean	7.77	6.00	6.44	7.77	8.55	6.66
		Last	9.00	9.00	9.00	9.00	9.00	9.00
		Maximum	9.00	9.00	9.00	9.00	9.00	9.00
		Minimum	5.00	2.00	3.00	5.00	8.00	3.00
RTC	Total	Mean	7.40	6.80	5.60	9.00	7.00	6.80
		Last	9.00	8.00	7.00	9.00	8.00	9.00
		Maximum	9.00	8.00	7.00	9.00	9.00	9.00
		Minimum	5.00	4.00	4.00	9.00	4.00	5.00
CST	Total	Mean	7.20	6.40	6.00	6.60	7.40	6.20
		Last	9.00	7.00	7.00	8.00	8.00	6.00
		Maximum	9.00	9.00	7.00	8.00	9.00	8.00
		Minimum	3.00	4.00	3.00	3.00	5.00	4.00
Total	Mean		7.58	6.80	6.29	7.67	7.80	6.54
	Last		9.00	7.00	7.00	8.00	8.00	6.00
	Maximum		9.00	9.00	9.00	9.00	9.00	9.00
	Minimum		3.00	2.00	3.00	3.00	4.00	3.00

a. Limited to first 31 cases.

The study surveyed that appropriate equipment is necessary for teaching physics effectively, with a mean of 7.80; materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning, with a mean of 7.67. There is a need for additional resources to support the practice of learning physics with the of 7.58. The focus of learning and teaching physics often revolves around exam preparation, with a mean of 6.80; Physics education in schools emphasizes practical application, with a mean of 6.29. The language students use to comprehend the discipline of physics learning holds significance, with a mean of 6.54.

The study on physics learning among grade 12 students in 2018, 2021, and 2022, including repeaters, revealed significant findings. The impact of teaching methods on physics learning outcomes was observed, with the 2021 batch showing a higher mean (7.71) compared to the overall mean of 7.35. Students' perception of physics as a challenging subject increased over time, with the 2022 batch having the highest mean (8.25) compared to the overall mean of 7.03. Implementing inquiry-based lessons was deemed beneficial, with the 2018 batch having a mean of 7.00 and an overall mean of 6.80. The study also highlighted the influence of instruction quality (mean of 6.77) and challenges related to abstract theoretical concepts (mean of 5.48), insufficient class duration (mean of 5.38), and teachers' preparation skills (mean of 4.74). These findings shed light on the challenges faced in physics education within the schools.

Students may be exceling in solving traditional textbook-style problems without grasping underlying concepts due to memorization and formulaic approaches. They may rely on pattern recognition and algorithmic problem-solving techniques, lacking a deeper understanding. This can hinder their ability to apply knowledge to unfamiliar situations or problem-solving beyond the scope of learned and textbook examples. (Teacher’s reflection).

This is because the questions given in the textbooks are direct compared to CBQs given in the examination. Also, the questions given in the textbook are similar to the concepts explained by the teacher so, it becomes easier to solve it without actually grasping the underlying concepts. (Student’s reflection)

I feel that most students expect the teaching and learning of physics to be beyond one’s classroom; that it rather be more practical than theoretical as physics is all about practicality of science in our daily lives. Practical courses such as quantum physics, electricity and magnetism, thermodynamics. (Student’s reflection)

There are practical problems with fundamental physics concepts include the difficulty of translating theoretical knowledge to actual situations, difficulties visualizing abstract ideas, a lack of access to sophisticated laboratory tools, and the requirement for exact measurements and accurate data analysis. Learning about and tackling these problems helps improve physics instruction (Teacher’s reflection).

Observation 2:
While the textbook for physics in year XII is illustrated with graphics and is convincing, what is inadequate is the textbook is taught for the text and has no connection to the field based and to the practicum.

The future of Bhutanese Schools Physics education is concerning due to low student enrollment in grade XII physics and a shortage of qualified physics teachers. This study aims to address teachers' approaches to teaching and learning physics and raise awareness of physics resources. However, even with a physics teacher professional development program, the issue of inadequate learning resources remains unaddressed.

To engage students, activities can be designed to help them understand how modern devices work, using unit-relevant physics knowledge to develop and test explanations for their operations. Qualitative investigations can lead to quantitative descriptions and testing of explanations.

Teachers play a crucial role in sparking students' interest in physics and supporting their learning. The focus in physics teacher education should be on non-cognitive qualities, their responsibilities in organizing high-quality physics instruction, and accessing resources in schools and teacher education.

In today's technological world, it is essential to ensure the relevancy of a physics teacher's role in preparing students for the future. Addressing these challenges will be vital to improve Bhutanese Schools Physics education and encourage more students to pursue physics as a subject of interest and career potential.

Table 3: Psychology Challenges of learning physics.

Name of the School			Having a fixed mindset can hinder the learning process in physics	Societal stereotypes can impact the learning of physics	Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts	Anxiety related to board examinations can affect performance in physics
MHSS	Total	Mean	6.66	5.44	5.77	7.55
		Last	6.00	4.00	1.00	9.00
		Maximum	9.00	7.00	9.00	9.00
		Minimum	2.00	4.00	1.00	5.00
RTC	Total	Mean	7.00	5.40	6.80	7.80
		Last	8.00	2.00	9.00	9.00
		Maximum	9.00	8.00	9.00	9.00
		Minimum	1.00	2.00	1.00	5.00
CST	Total	Mean	6.60	4.40	5.20	7.00
		Last	7.00	5.00	5.00	7.00
		Maximum	8.00	7.00	8.00	9.00
		Minimum	5.00	2.00	2.00	5.00
Total	Mean		6.67	4.77	6.00	7.06
	Last		7.00	5.00	5.00	7.00
	Maximum		9.00	8.00	9.00	9.00
	Minimum		1.00	1.00	1.00	4.00

a. Limited to first 31 cases.

The study revealed that Anxiety related to board examinations could affect performance in physics, with a mean of 7.06; Having a fixed mindset can hinder the learning process in physics, with a mean of 6.67; Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts mean 6.00 and Societal stereotypes can impact the learning of physics with the mean of 4.77.

The study shows that Anxiety related to board examinations can affect performance in physics 7.06 and 2022 batch of class XII and the repeater is affected; Having a fixed mindset can hinder the learning process in physics 6.67 or 2021, 2022 and the repeater. Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts 6.00 and Societal stereotypes can impact the learning of physics, 4.77 is the least.

CASE STUDY A: Mindset

These are the vignettes on the psychological challenges of learning physics as stated by the teachers on mind set.

The way I teach is always right and perfect for every student, what I say is always correct, No student should argue with me as I am always right, student should solve the numerical problems the way I want, student should not intervene while classes are on, no student should ever ask the doubts out of topic or syllabus, in minimum time frame (end of every class) every student should be able to solve physics numerical and understand the concept very clearly, a student should not explore beyond what I teach, a student should not learn beyond what I want him/her to learn, the steps that I know are always right and work under any conditions while solving any numerical, ……" such mindsets and the mentalities of a physics teacher hinders learning physics.

Student's mentality is what matters next.

The moment teacher enters the classroom and till the last minute of the class, often extra sometime, lectures go on non-stop. Someone already burdened with the previous class is now being overburdened with such lectures which in reality promotes no learning. What's the meaning of such annoying classes where there is no learning? Such classes only give bonus tension, stress, frustration, irritation and so on.

Teacher teaching physics just for the salary rather than with a mindset to teach and share a new knowledge with the students is another mentality factor of a teacher that restricts learning.

These are the vignettes on the psychological challenges of learning physics as stated by the students.

Such mindset may foster the idea that intelligence and skills are inherent qualities. This may deter learners from accepting challenges, asking for assistance, and battling through hurdles. They might refrain from taking chances, which would stunt their development and hinder their ability to comprehend difficult physics concepts.

Due to fixed mindset, the student assumes that it is very complex or difficult to master, even if the topics are understandable. As a result, the student doesn't get confidence to try also.

Observations:

The general mindset of students across 12 institutions regarding physics studies is perceived as "challenging" and "difficult." Many students opt to drop physics early, even as early as grade X. The researcher developed and assessed a physics-specific mindset questionnaire, noting that physics mindsets can change over time. However, Bhutanese physics education lacks targeted interventions, focusing solely on the syllabus and curriculum without delving into the philosophy, principles, practices, and pedagogy of learning physics.

The challenge lies in students unconsciously holding onto beliefs about their academic performance in physics. Emphasizing the psychology of a growth mindset can support students' physics learning by focusing on the learning process. Teacher colleges for physics educators need to directly connect this knowledge with the psychology of growth mindset.

CASE STUDY B: Societal stereotypes of learning of physics

Another psychological challenge are the stereotypical practices in physic which restricts proper learning. This is what is stated:

Learning environment is major cause. Physics is all about nature and its phenomenon. The problem here is that we have a greater number of theory classes than practical. A teacher explaining a physics topic on a chalk board is not that effective than a teacher taking his students out of the class, in a lab or anywhere the experiments & learning scenarios are favorable. Our stereotypical frame of mind within the physics teachers thinking that all the students in the classroom are as brilliant like Einstein or Max Planck should be eradicated. Just by lecturing in the classroom no one understands. No genius is sitting in the classroom, a teacher must understand this. Else learning is difficult with such stereotypes. (Teacher)

Another stereotypical mindset within the teachers is that they want the student to focus and concentrate on what they are teaching but the problem here is neither the students know how to focus/concentrate on what's being taught nor the teacher ever taught how to concentrate on what he/she is teaching, they themselves don't know how to concentrate forget about teaching about it to others. This type of mentality robs the learning. (Student)

Observations:
In Bhutanese schools, there is a need to explore physics beyond conventional boundaries, incorporating both convergent and divergent learning approaches. Physics education should be enriched by traditional and modern cultural contexts, associating it with fine arts to make it more relatable and accessible for learners.

Currently, Bhutanese school physics primarily follows the Western model, which can be overwhelming and complex for students. To improve learning outcomes, there should be a gradual progression from basic, simple, and native science concepts. By integrating native art and local science into physics studies, students can better understand the applications of physics and appreciate its aesthetic appeal.

Physics can be perceived as a way physicists view nature, and it shares similarities with fine arts. Connecting physics with the arts can enhance students' understanding and appreciation of both disciplines. For instance, learning about additive and subtractive color mixing can be related to artistic pigment blending, enabling students to grasp scientific concepts more effectively.

Cultural anthropology offers valuable insights into students' learning experiences, and teachers can incorporate students' "light cultures" to facilitate scientific understanding of phenomena like refraction and interference of light.

Internet access has expanded the horizons of physics teaching beyond the classroom, allowing teachers and students to access a wealth of educational resources globally. Physics teachers share common goals, such as meaningful learning, practical work, inquiry, and the development of higher-order thinking skills. Emphasizing constructivist approaches and connecting physics to real-life contexts, including daily life and the wider community, can enhance student engagement and foster scientific attitudes and values.

CASE STUDY C: Students often excel in solving traditional textbook-style problems only as one of the teachers teaching physic states:

The first thing we need to understand here is that 70-80 percent of the traditional physics textbooks are obsolete. Whatever information that a student finds in them are wrong which needs some rectifications. The irony behind the numerical being solved without understanding the core concepts is because they are designed in such a way that with memorized and crammed physics definitions including some memorized info from the textbooks, problems can be solved. A student need not have to think or analyze anything. Same like a math student solving integration problems correctly without knowing its purpose. For example, in physics we solve electricity and magnetism related numerical and we get the solutions, the problem here is that one doesn't really know why that calculation is done…. This is the problem in our system. Traditional textbooks are designed in that way which helps a student be a fool than a better thinker and more creative.

And the students who studied physics in one of the high schools' states:

This might be due to the emphasis on formulaic approaches, rote learning, and a lack of attention on deep knowledge.

Observation:
The teaching of physics in Bhutan faces several challenges, including a lack of educational resources and large class sizes. With an average class size of 30 students, managing practical work becomes difficult in overcrowded classrooms. The limited availability of low-cost or no-cost materials further hinders the learning process. Additionally, the digital era puts extra demands on teachers' skills, necessitating pre-service and in-service training to equip them for an IT-based society.

The role of trained teachers is essential for meaningful learning in physics classrooms, but untrained and underqualified teachers persist, promoting rote learning despite educational reforms. To enhance physics education, a Digital and Global Laboratory is proposed, involving collaborative science research projects that link students and teachers both within and outside Bhutan. Initiatives like Earth Lab and Global Lab allow students to interact with scientists, fostering a deeper understanding of physics concepts.

The use of microcomputer-based physics laboratory software, simulation, and interactive physics software enriches students' learning experiences and enables data analysis that may be challenging in conventional laboratory setups. These tools offer personalized learning experiences, catering to individual needs.

CASE STUDY D: Anxiety related to board examinations and performance in physics

Based on the board examination and the anxiety developed which results in the performance of physics, the physic teacher stated distinctively:

If Concepts delivered in the classroom are weak, a teacher running after syllabus completion rather than the content a student has really learned, stressing too much on derivations which confuses the student are some of the reasons that causes anxiety in a student and about his/her performance in the examinations. (Teacher)

A moving body experiencing resistive force cannot exert a good impact (force) in a similar manner a student with anxiety cannot perform better in the test. Anxiety in a student creates confusion and the concepts he or he has will all get mixed up which cannot be applied while answering the questions in the exam. (Teacher)

Observation
Performance in physics has been significantly impacted by exam-related anxiety. High anxiety levels can make it challenging to think, make it difficult to solve problems, and make it difficult to concentrate. It increases exam anxiety, undermining students' self-assurance and causes them to perform poorly despite their preparation and expertise. One of the senior students reflected:

Anxiety might be causing higher stress levels, trouble focusing, poorer cognitive performance, and test anxiety. Despite our knowledge and preparation, these factors are impairing problem-solving skills, restrict information retrieval, and result in poor performance in examinations. (Senior student)

The Bhutan Board examination holds significant importance for a student's future, leading to immense pressure and anxiety, affecting physics performance. To address this, ongoing or formative assessments such as projects, assignments, case studies, and place-based learning, as well as practical and ethnic science evaluations, could be introduced, providing a more meaningful and holistic approach to studying physics.

The anxiety seems softened when physics in the schools is intended with education.

The Bhutanese classes on physics take place in a vacuum, not the physic within a geographical, historical, and social context. If there is a transition from that ethno-physics to contemporary physics, there is no anxiety in learning physic. The anxiety sometimes leads to a physics' "culture shock". Bhutanese students are forced to challenge a "cultural border crossing" when they encounter a new culture of physicists.

A foundational and microscopic insight into culture is necessary for the physics curriculum, instruction, and support system.

The first cultural aspect is related to the renovation of the curriculum to include the 'physics culture' in balance and the eventual establishment of a new culture of physics (Ethno physics to Advanced physics and Quantum physics. The second is related to learning and teaching in a cultural context and including "cultural validity" in assessment. The third is related to the issues, approaches, and future of a multi-cultural approach, as opposed to international standardization, for Bhutan's national curriculum and science education standards.

Table 4: Perspective of learning physic and interventions.

Name of the School			It is important to incorporate a global perspective in the teaching and learning of physics	The implementation of inquiry-based teaching and learning methods should be taken into account in physics education.	Introducing Place-Based Physics in Bhutanese schools is necessary.	Physics learning should prioritize skill development followed by conceptual understanding	Introductory physics courses for students should include practical skills alongside theoretical knowledge	Practical problems of various types should be integrated with the fundamental concepts of physics
MHSS	Total	Mean	7.00	5.88	6.66	6.66	7.77	7.66
		Last	9.00	1.00	9.00	9.00	9.00	9.00
		Maximum	9.00	8.00	9.00	9.00	9.00	9.00
		Minimum	5.00	1.00	5.00	4.00	5.00	5.00
RTC	Total	Mean	6.60	5.60	8.40	7.40	8.40	6.60
		Last	9.00	7.00	9.00	9.00	9.00	9.00
		Maximum	9.00	8.00	9.00	9.00	9.00	9.00
		Minimum	2.00	1.00	7.00	5.00	7.00	1.00
CST	Total	Mean	6.40	6.00	7.20	7.20	7.60	7.40
		Last	7.00	7.00	7.00	7.00	9.00	9.00

	Maximum	8.00	7.00	9.00	9.00	9.00	9.00
	Minimum	2.00	4.00	5.00	5.00	6.00	5.00
Total	Mean	6.70	6.29	7.19	7.29	7.90	7.45
	Last	7.00	7.00	7.00	7.00	9.00	9.00
	Maximum	9.00	9.00	9.00	9.00	9.00	9.00
	Minimum	1.00	1.00	4.00	4.00	4.00	1.00

The table 4 presents students' perspectives on learning physics and suggested interventions. They emphasized the importance of including practical skills alongside theoretical knowledge (mean of 7.90) and integrating various practical problems with fundamental concepts (mean of 7.45). Skill development was prioritized over conceptual understanding (mean of 7.29). Students supported the introduction of Place-Based Physics in Bhutanese schools (mean of 7.19) and emphasized incorporating a global perspective in physics teaching (mean of 6.70). Implementing inquiry-based teaching and learning methods was also recommended (mean of 6.29) to enhance physics education.

The study indicates the perspective of learning physic and interventions. The Introductory physics courses for students should include practical skills alongside theoretical knowledge 7.90. The class XII batch of 2021 and 2022 indicated the practicality of it.

The table 4 indicates students' perspectives on learning physics. Adopting a growth mindset in physics education received significant support (mean of 7.51) from both Class XII students of 2022 and repeaters. Integrating practical problems with fundamental concepts was valued (mean of 7.45), and skill development was prioritized over conceptual understanding (mean of 7.29). Students emphasized the importance of introducing Place-Based Physics in Bhutanese schools (mean of 7.19) and incorporating a global perspective in physics teaching (mean of 6.70). Implementing inquiry-based teaching and learning methods was recommended (mean of 6.29) to enhance physics education.

CASE STUDY E: Perspective of learning physic and interventions.

Learning physics needs to build education in association with cultural activities. As such, linking physics education with cultural activities could herald significant improvements in the year XII curriculum, new ways of learning, teaching, and assessing, and new approaches to physics pedagogy, teacher education, and policies in physics education.

Accordingly, the current paper attempts to identify why students feel that physics is difficult and they do not like physics. Also, the new frontier of physics culture education is discussed, which may help overcome the limitation of Western culture-based physics science from the Bhutanese physics classroom and culture. A physics teacher who is in the higher secondary school is stated:

In Bhutanese schools, efforts are made to incorporate real-world relevance and inquiry-based learning in physics and science education. Current events in physics and global happenings are integrated into relevant topics, providing context and enhancing students' understanding. An example of "Place-Based Physics" involved students investigating energy conservation by interviewing family and school staff, proposing context-specific solutions. Connecting prior non-scientific knowledge to new concepts helps students grasp theoretical knowledge effectively and avoids misconceptions.

Abstract physical concepts are visualized using technology, but limited ICT resources pose challenges for fundamental physics education, making it time-consuming for teachers. Overcoming these obstacles is essential for promoting engaging and effective physics education in Bhutanese schools.

Observation:
Physics education needs to aim to bring up the future physicists in Bhutan. But Bhutanese physics is taught to all as a subject or a part of science subject. The evidence indicates that copying physics itself is enough. The year XII and X physics textbook states of "retrieval and use of ideas and illustrations, either in part or whole, from numerous websites and other forms of sources" (Department of Curriculum and Professional Development, 2022, p. 2)

Physics teachers in Bhutan insist on students' psychology (Growth mindset). Yet, when it is a mode of examination conducted by the Bhutan Board of Examination, we persist with the industrial mode of test and examination. Also, the origin of students' dislike of physics could be interpreted as originating from the disconnection between two cultures and between everyday life and the physicists' activities.

Table 5: One sample t test: Approaches to learning physics.

Name of the School		Test Value = 0					
		t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
MHSS	Learning in physics is influenced by the quality of instruction	9.38	8	.000	6.77	5.11	8.44
	The teaching methods employed have an impact on the learning outcomes in physics	20.28	8	.000	7.88	6.99	8.78
	The duration allocated for physics classes is insufficient	5.032	8	.001	5.22	2.82	7.61
	Students hold the belief that physics is a challenging subject	8.468	8	.000	7.33	5.33	9.33
	Teachers lack the necessary skills and knowledge to effectively prepare for physics lessons	3.84	8	.005	3.33	1.33	5.33
	Implementing inquiry-based lessons in physics can enhance the learning experience	17.71	8	.000	6.88	5.99	7.78
	Students come into introductory physics courses with theoretical concepts that are abstract	7.26	8	.000	5.77	3.94	7.61
RTC	Learning in physics is influenced by the quality of instruction	3.89	4	.018	6.20	1.77	10.62
	The teaching methods employed have an impact on the learning outcomes in physics	4.24	4	.013	6.00	2.07	9.92
	The duration allocated for physics classes is insufficient	5.01	4	.007	5.80	2.58	9.014

	Students hold the belief that physics is a challenging subject	6.51	4	.003	7.60	4.36	10.83
	Teachers lack the necessary skills and knowledge to effectively prepare for physics lessons	2.80	4	.049	4.40	.045	8.75
	Implementing inquiry-based lessons in physics can enhance the learning experience	7.83	4	.001	5.20	3.35	7.04
	Students come into introductory physics courses with theoretical concepts that are abstract	6.78	4	.002	4.60	2.71	6.48
CST	Learning in physics is influenced by the quality of instruction	8.37	4	.001	7.20	4.81	9.58
	The teaching methods employed have an impact on the learning outcomes in physics	7.82	4	.001	7.00	4.51	9.48
	The duration allocated for physics classes is insufficient	6.39	4	.003	6.20	3.50	8.89
	Students hold the belief that physics is a challenging subject	6.03	4	.004	5.60	3.02	8.17
	Teachers lack the necessary skills and knowledge to effectively prepare for physics lessons	5.19	4	.007	5.60	2.60	8.59
	Implementing inquiry-based lessons in physics can enhance the learning experience	10.85	4	.000	7.20	5.35	9.04
	Students come into introductory physics courses with theoretical concepts that are abstract	7.96	4	.001	5.40	3.51	7.28

a. No statistics are computed for one or more split files

The table 5 indicates one sample t-test: Approaches to learning physics: In MHSS, the teaching methods employed impact the learning outcomes in physics t score of 20.28 on the degree of freedom 8 with the Sig. (2-tailed) of 000 with a Mean Difference of 7.88; 95% Confidence Interval of the Difference of lower 6.99 and upper 8.78. In a One-Sample t-Test, the test variable's mean of 20.28 is compared against a "test value" of 7.88, a known value of the mean in the population.

There are seven variables in the approaches to learning physic or three schools in Bhutan. The tested values for MHSS and CST are higher than the mean difference. Their expectation is much higher than the average expectation. RCS's test value is lower than the average mean difference.

Table 6: One sample t test: Resources to learning physics.

Name of the School		Test Value = 0					
		t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
MHSS	There is a need for additional resources to support the practice of learning physics.	14.928		.000	7.77	6.57	8.97
	The focus of learning and teaching physics often revolves around exam preparation	7.50	8	.000	6.00	4.15	7.84
	Physics education in schools emphasizes practical application	8.22	8	.000	6.44	4.63	8.25
	The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning	17.928		.000	7.77	6.77	8.77
	Appropriate equipment is necessary for teaching physics effectively	48.698		.000	8.55	8.15	8.96
	The language used by students to comprehend the discipline of physics learning holds significance	8.94	8	.000	6.66	4.94	8.35
RTC	There is a need for additional resources to support the practice of learning physics.	9.10	4	.001	7.40	5.14	9.65
	The focus of learning and teaching physics often revolves around exam preparation	9.25	4	.001	6.80	4.75	8.84
	Physics education in schools emphasizes practical application	10.984		.000	5.60	4.18	7.01
	Appropriate equipment is necessary for teaching physics effectively	7.82	4	.001	7.00	4.51	9.48
	The language used by students to comprehend the discipline of physics learning holds significance	10.254		.001	6.80	4.95	8.64
CST	There is a need for additional resources to support the practice of learning physics.	6.46	4	.003	7.20	4.10	10.29
	The focus of learning and teaching physics often revolves around exam preparation	7.34	4	.002	6.40	3.97	8.82
	Physics education in schools emphasizes practical application	7.74	4	.001	6.00	3.84	8.15
	The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning	6.73	4	.003	6.60	3.87	9.32

	Appropriate equipment is necessary for teaching physics effectively	9.10	4	.001	7.40	5.14	9.65
	The language used by students to comprehend the discipline of physics learning holds significance	9.34	4	.001	6.20	4.35	8.04

a. No statistics are computed for one or more split files.

The table 6 has six variables on the resources and t-test values of the resources; it is rated higher than the mean differences. If the three institutions, CST: There is a need for additional resources to support the practice of learning physics have the t value 0f 6.46, and the average mean difference is 7.20.

Table 7: One sample t-test: Psychology Challenges of learning physic

Name of the School		Test Value = 0					
		t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
MHSS	Having a fixed mindset can hinder the learning process in physics	8.16	8	.000	6.66	4.78	8.54
	Societal stereotypes can impact the learning of physics	16.11	8	.000	5.44	4.66	6.22
	Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts	5.71	8	.000	5.77	3.44	8.10
	Anxiety related to board examinations can affect performance in physics	13.60	8	.000	7.55	6.27	8.83
RTC	Having a fixed mindset can hinder the learning process in physics	4.61	4	.010	7.00	2.78	11.21
	Societal stereotypes can impact the learning of physics	4.63	4	.010	5.40	2.16	8.63
	Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts	4.64	4	.010	6.80	2.73	10.86
	Anxiety related to board examinations can affect performance in physics	9.75	4	.001	7.80	5.57	10.02
CST	Having a fixed mindset can hinder the learning process in physics	12.94	4	.000	6.60	5.18	8.01
	Societal stereotypes can impact the learning of physics	5.04	4	.007	4.40	1.97	6.82
	Students often excel in solving traditional textbook-style problems without truly grasping the underlying concepts	5.36	4	.006	5.20	2.50	7.89
	Anxiety related to board examinations can affect performance in physics	9.89	4	.001	7.00	5.03	8.96

a. No statistics are computed for one or more split files

The table 7 indicates the psychological challenges of learning physic. The two institutions, MHSS and CST, have t values higher than the mean difference values. RCS has the exception that t values on three variables are less than the mean difference: Having a fixed mindset can hinder the learning process in physics; Societal stereotypes can impact the learning of physics. Students often excel in solving traditional textbook-style problems without genuinely grasping the underlying concepts.

Table 8: Correlation to approaches of learning.

		The teaching methods employed have an impact on the learning outcomes in physics	Implementing inquiry-based lessons in physics can enhance the learning experience	Students come into introductory physics courses with theoretical concepts that are abstract
Learning in physics is influenced by the quality of instruction	Pearson Correlation	.833**	.406*	
	Sig. (2-tailed)	.000	.023	
	N	31	31	
The teaching methods employed have an impact on the learning outcomes in physics	Pearson Correlation		.480**	
	Sig. (2-tailed)		.006	
	N		31	
Students hold the belief that physics is a challenging subject	Pearson Correlation			.530**
	Sig. (2-tailed)			.002
	N			31
Teachers lack the necessary skills and knowledge to effectively prepare for physics lessons	Pearson Correlation		.364*	
	Sig. (2-tailed)		.044	
	N		31	

The table 8 indicates the correlation of the variables in the study. Learning in physics is influenced by the quality of instruction has a correlation significance of 833** to the teaching methods employed have an impact on the learning outcomes in physics; Learning in physics is influenced by the quality of instruction has a correlation of 406** to implementing inquiry-based lessons in physics can enhance the learning experience.

Teaching methods significantly impact physics learning outcomes (correlation .480**). Students consider physics a challenging subject (correlation .530**), especially with abstract theoretical concepts. Teachers lacking preparation skills also affect learning (correlation .364**). Implementing inquiry-based lessons improves the learning experience.

Table 9: Correlation to resources of learning.

		There is a need for additional resources to support the practice of learning physics.	The focus of learning and teaching physics often revolves around exam preparation	Physics education in schools emphasizes practical application	The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning	Appropriate equipment is necessary for teaching physics effectively
There is a need for additional resources to support the practice of learning physics.	Pearson Correlation		.486**	.458**		.691**
	Sig. (2-tailed)		.006	.010		.000
	N		31	31		31
The focus of learning and teaching physics often revolves around exam preparation	Pearson Correlation	.486**				
	Sig. (2-tailed)	.006				
	N	31				
Physics education in schools emphasizes practical application	Pearson Correlation	.458**			.641**	
	Sig. (2-tailed)	.010			.000	
	N	31			31	
The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning	Pearson Correlation			.641**		
	Sig. (2-tailed)			.000		
	N			31		
Appropriate equipment is necessary for teaching physics effectively	Pearson Correlation	.691**				
	Sig. (2-tailed)	.000				
	N	31				

The table 9 indicates the correlation of the resources to learning physic. There is a need for additional resources to support the practice of learning physics has a correlation significance of 486** to the focus of learning and teaching physics often revolves around exam preparation;458** to Physics education in schools emphasizes practical application; .691** appropriate equipment necessary for teaching physics.

The focus of learning and teaching physics often revolves around exam preparation has a correlation of 486** to a need for additional resources to support the practice of learning physics. Physics education in schools emphasizes practical application has a correlation of .458** with a need for additional resources to support the practice of learning physics; .641** to the materials and instructional methods, suitable and adaptable to facilitate effective physics learning.

The materials and instructional methods should be more suitable and adaptable to facilitate effective physics learning has a correlation of 641** to Physics education in schools emphasizing the practical application; Appropriate equipment is necessary for teaching physics effectively, correlating with a need for additional resources to support the practice of learning physics is 691**.

Table 10: Correlation to global perspective of learning.

		It is important to incorporate a global perspective in the teaching and learning of physics	The implementation of inquiry-based teaching and learning methods should be taken into account in physics education physics teaching and learning to be considered	Introducing Place-Based Physics in Bhutanese schools is necessary	Physics learning should prioritize skill development followed by conceptual understanding	Adopting a growth mindset in learning physics should be given consideration	Introductory physics courses for students should include practical skills alongside theoretical knowledge	Practical problems of various types should be integrated with the fundamental concepts of physics
It is important to incorporate a global perspective in the teaching and learning of physics	Pearson Correlation							.494**
	Sig. (2-tailed)							.005
	N							31
The implementation of inquiry-based teaching and learning meth	Pearson Correlation							.550**
	Sig. (2-tailed)							.001
	N							31

Physics learning should prioritize skill development followed by conceptual	Pearson Correlation					.594**	.766**	.609**
	Sig. (2-tailed)					.000	.000	.000
	N					31	31	31
Adopting a growth mindset in learning physics should be given consideration	Pearson Correlation				.594**		.659**	.735**
	Sig. (2-tailed)				.000		.000	.000
	N				31		31	31
Introductory physics courses for students should include practical skills alongside theoretical knowledge	Pearson Correlation			.521**	.766**	.659**		.696**
	Sig. (2-tailed)			.003	.000	.000		.000
	N			31	31	31		31
Practical problems of various types should be integrated with the fundamental concepts of physics	Pearson Correlation	.494**	.550**		.609**	.735**	.696**	
	Sig. (2-tailed)	.005	.001		.000	.000	.000	
	N	31	31		31	31	31	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The table 10 indicates the correlation to the global perspective of learning physic. It is important to incorporate a global perspective in the teaching and learning of physics with the correlations of 494**to practical problems of various types should be integrated with the fundamental concepts of physics, and implementation of inquiry-based teaching and learning methods should be taken into account in physics education, physics teaching and learning to be considered the correlation of .550**with practical problems of various types.

Physics learning should prioritize skill development followed by conceptual understanding correlates with the significance .594** to adopting a growth mindset in learning physics should be given consideration; introductory physics courses for students and practical skills alongside theoretical knowledge with .766** and practical problems of various types integrated with the fundamental concepts of physics .609**.

Introductory physics courses for students should include practical skills alongside theoretical knowledge and have a correlation of 521** with the Introduction of "Place-Based Physics." Physics learning should prioritize skill development and conceptual understanding. Correlate 766**; adopting a growth mindset in learning physics with a significance of .659** and practical problems of various types integrated with the fundamental physics concepts with a significance of.696**

Recommendation

Students believe that physics is a challenging subject and implementing an approach of teaching, learning and assessment to change. The inquiry-based lessons in physics can enhance the learning experience, and for these new learning materials, a new psychology has to be placed.

ICT plays a crucial role in establishing meaningful learning in physics education, transforming students' attitudes towards the subject. Thoughtful consideration of meaningful learning approaches is essential when designing ICT-based instructional materials. Students embrace ICT, and when utilized by skilled teachers, it enhances the teaching-learning process, fosters teacher-student interactions, and enriches the knowledge resource base. However, caution is advised to prevent misuse, overuse, or dependency on ICT. The discussion emphasizes the need for ICT integration to be grounded in an understanding of ethnic, native, and indigenous physics before progressing to contemporary physics, nano, and quantum physics. Additionally, it is recommended that year XII textbooks be refined to reflect professional and disciplined physics.

The resources of learning physics in school are a challenge, and we need to prioritize scarce resources. The school science budget is limited and is used for basic science equipment and supplies. The ICT hardware and software for teaching purposes in physics is inadequate and outdated. The Bhutan students need to adopt ICT in physics education while striving to provide basic educational requirements. ICT adds dimension to the resources and learning interfaces, and educational system policymakers should be responsible for the new physic learning in Bhutan.

The psychological challenges of learning physics in Bhutanese schools revolve around examination, tests, and grading, which may hinder meaningful learning. Physics teachers have shifted from earlier individual psychological perspectives to incorporate sociological perspectives, such as social constructivism, science for specific social purposes, and situated cognition, acknowledging the impact of cultural milieu on learning. Integrating cultural perspectives can provide fresh insights into common issues related to students learning science. It is essential to develop teaching methods that incorporate content from students' cultural worlds, allowing them to construct meaningful connections. Students facing challenging physics problems may respond in two ways: negatively, questioning their abilities, or positively, enjoying the struggle as an opportunity for growth. The positive approach is linked to a growth mindset, where students believe in the malleability of intelligence through effort and hard work, as proposed by Carol Dweck's psychology of growth mindset.

Conclusion

Physics education has always been and still is the main engine of human development, including the humanities. We live in a transitional era of constant change in the content and instruments of physics education. Education, especially physical education, became a social phenomenon. In this stage, the main process was the colorization of physics education, in which the major teaching tool and information carrier have to be the physics teacher. High school physics in Bhutan and elsewhere Asian countries are characterized by the tokenization of physics education.

Bhutan school system needs to see the development of physics education as a process of creation and improvement of physical process models rather than examination, a physics laboratory rather than a classroom; resources need to be dynamic rather than stick to the model of industrial physics. In it, computer technology enabled us to make these models of physics study dynamic. Physics education is confined to the classroom, text, and tests and sinking in the quicksand of high stack examination.

Currently, we need to dwell on the network instruments for learning physics, allowing using all the Internet information resources accumulated by humanity and learning physics using personal computers, tablets and mobile phones at any place and at any convenient time. Multimedia network instruments are able to create a special physics learning space, and physics education is not only expansive, it is priceless.

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