Exploring Students' Perceived Difficulties of Learning Physics

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Abstract

This study investigated grade 9-12 students' perceived difficulties in learning physics and how they addressed them. 124 (48 male and 76 female) students studying in one of the higher secondary schools in Bhutan participated in the study. The data initially gathered through a survey was subsequently consolidated with the individual interview to establish in-depth findings. Inductive thematic analysis was used to analyse the data. The key findings revealed that the students' perceptions of their difficulty in learning physics were associated with student, curriculum, and subject-related factors. Strategies used by the students to address these difficulties in learning physics is also explained. Implications for future research to investigate comparable challenges in other disciplines using multi-methods are also offered.

Keywords*:* Physics, perception, difficulty, secondary school

Introduction

Understanding the modern world and its technological achievements requires an understanding of physics (Baran, 2016). Despite its importance, physics is the least preferred science discipline among students (Erinosho, 2013). Various studies have been conducted to examine what makes physics challenging for students to learn (e.g., Checkley, 2010; Erinosho, 2013; Ornek et al., 2008).

Generally, students regard physics as an abstract and cognitively challenging subject. Physics is considered an abstract subject due to the lack of a colloquial meaning to connect it to ordinary real-life experiences (Bouchée et al., 2022). It is considered a less descriptive and more quantitative subject (Owen et al., 2008) which requires mathematical skills to solve physics problems (Bouchée et al., 2022; Ogunleye, 2009). Students have difficulty with the nature of the subject because of the high workload compared to other subjects, and they must engage with several representations, such as experiments, equations and calculations, graphs, and conceptual explanations, and also transform data, such as flipping between graphical and numerical representations (Angell et al., 2004; Erinosho, 2013). Physics is a cumulative subject such that if the initial concept is not clear, subsequent material will be difficult to understand (Ornek et al., 2008).

Students' negative attitudes are typically associated with more traditional approaches to science instruction (Deslauriers et al., 2019). Teaching physics through an interdisciplinary manner and constructivist approaches may help students boost self-esteem (Deslauriers et al., 2019; Saka, 2011). Ogunleye (2009) stated that the most significant component in learning physics is fostering necessary abilities through laboratory practice. Learning interest in physics will be boosted by good instructional software designed with the knowledge of applicable ideas (Esquembre, 2002; Saka, 2011). Physics learning activities at school are found dull when students could not perceive the benefit of the work necessary to study physics (Saleh, 2014).

A student's curiosity and motivation influence their decision to study physics. The mismatch between conceptual issues discussed in class and the questions on tests, and the lack of physics conceptual background results in students having less confidence and motivation causing failure in learning physics (Ornek et al., 2008). In an attempt to determine whether the perception of difficulty in physics is accurate, a study by Lavonen et al. (2007) found that students' perceptions of difficulty in physics were influenced by their friends and family. The results of a study conducted by Checkley (2010) also suggested that peers can influence students' views of the subject matter.

Due to the challenging nature of physics, students taking interest in learning physics are plummeting. For example, in the United States and Europe, the number of students pursuing scientific knowledge has decreased, creating worries about their economic future and scientific literacy in society (Trumper, 2006). The fundamental difficulty facing the education industry is how to raise the number of students who achieve the desired learning outcomes in line with global market demands. This looks to be particularly serious for physics, which plays a critical role in research and industry (Ekici, 2016).

Organisation for Economic Co-operation and Development (2020) articulates that the emphasis should be on academic success and comprehensive student well-being. It is critical to understand why students struggle in physics otherwise, students, teachers, and stakeholders would exist in different worlds. As suggested by Ornek et al. (2008), to understand what students think and how they approach physics, teachers or relevant organisations must conduct research to determine how to reach their students and assist them in grasping physics concepts.

Several studies suggested that teachers play a vital role in learning physics interestingly. For instance, according to Erinosho (2013) and Ornek et al. (2008), while learning physics, students should be given the chance to participate in regular problem-solving sessions. Basic mathematical notions that are beneficial and important for understanding physics may also need to be incorporated by curriculum developers and science teachers. Trumper (2006) suggested that content relevance needs to be scrutinised based on interest, requirement, and applicability rather than making the content too vast.

Considering the changing dynamics, the Bhutanese science curriculum is reformed to incorporate broader aspects of Science Technology Engineering and Mathematics (STEM) educational approach. The science curriculum is divided into five key stages, ranging from pre-primary to grade 12. From pre-primary till grade 8, students study integrated science. From grades 9 to 12, students learn science as separate disciplines of biology, chemistry, and physics. In Bhutan, students have demonstrated poor performance in physics during the high-stake examinations conducted by the Bhutan Council for School Examinations and Assessment (BCSEA), the assessment agency in Bhutan. As physics teachers at higher secondary schools for more than a half-decade, we have witnessed students consistently performing low in physics as compared to the other science disciplines such as chemistry and biology. Although the importance of science education is identified in the national policy and curriculum documents (Department of Curriculum and Professional Department, 2022), research on the poor performance of students in physics is limited. At the time of doing this study, no study in Bhutan explored students' perceived difficulties in learning physics. Our study fills the gap in literature by investigating grade 9-12 students' perceived difficulties in learning physics.

Research Questions

This study was guided by two research questions:

1. What are the reasons for students to perceive physics as a difficult subject?
2. How are perceived difficulties of learning physics addressed by the students?

Methodology

In this section, we discuss the study context and the research strategy (i.e. case study) applied to our study. Data collection and analysis process are also included in this section.

Study Context

The study was conducted in one of the higher secondary schools located in western Bhutan. It is a day school with grades 7 to 12. The large co-educational school caters to over 1000 students annually with a class size of 25-30 students. Although the COVID-19 pandemic challenged the schools to hold online lessons, regular classroom instruction resumed in the school at the time the data was collected.

Case Study

Case study was employed as a research strategy since the purpose of this research was to identify the phenomena under investigation by conducting an in-depth examination (Cresswell, 2013; Stake, 1995). After the administration of the survey questionnaire, individual interviews were conducted to consolidate the findings by doing detailed investigation.

Students of grades 9-12 studying in one of the higher secondary schools in western Bhutan constituted a single bounded case (Cresswell, 2007). Since case selection is one of the characteristic features of a case study (Crowe et al., 2011; Stake, 1995), this study was drawn on Stake's (1995) recommendation of choosing willing and accessible participants. After being informed of the potential merits and demerits of the study, only students who voluntarily agreed to participate in the study were included. A convenience sampling method was used to draw the sample who were easily communicated and accessible (Etikan et al., 2016). The study initially engaged 208 students (117 female and 91 male). Students who responded that physics was an easy science subject were omitted from the study after the survey questionnaire was administered because the major goal of the study was to identify students who perceived physics as a challenging science subject. As a result, we focused on 124 students (48 male and 76 female) who reported that studying physics was challenging for them.

Data Source

The data were collected in two stages. The first stage was carried out using an online survey questionnaire from 15-28 August 2022. The data obtained from the survey questionnaire was divided into two sections, A and B. The participants' background knowledge was covered in section A and the students' perceptions of physics were included in section B. The items included in the questionnaire were prepared based on relevant literature to address the research objectives, which specifically focused on identifying students' perspectives on difficulties in learning physics and strategies used for overcoming them. The survey form included the following questions:

1. How do you describe physics as a subject?
2. Why do you think physics is a difficult subject?
3. How do you manage or overcome the difficulties you face in learning physics?

The second stage of data collection involved an online interview with 20 students. Based on the initial code from the first-stage data, the researchers created interview guidelines and collected more information from the individuals through an interview which was conducted from September 6 - 15, 2022, for a maximum of 30 minutes. A minimum of 2 students were interviewed every day depending on their convenience and availability. Each participant was guaranteed confidentiality and referred to using a pseudonym.

Data Analysis

Inductive thematic analysis was used to analyse the data (Braun & Clarke, 2021) by interpreting the repeated patterns in the data set. The inductive approach enabled the researchers to identify themes that were expressed from the perspectives of the participants to answer research questions. The data analysis commenced with coding and grouping of the data obtained from the surveys and interviews followed by a discussion of all the codes and categorisations, as well as the possibilities of integrating codes to simplify the meaning. Based on their patterns, the coded data were separated into themes. Initial codes linked to the research topic were included in themes, and those lacking adequate data or being too variable were eliminated. Thematic maps were drawn to examine various approaches to combine the codes. Verbatim quotations were used (Corden & Sainsbury, 2006) to represent the interview data because direct quotations serve the readers to fully immerse themselves in the context while also capturing the opinions of the participants and reflecting the statements in their own words (Patton, 2002). The interview subjects were represented by identifiers (e.g., P1 for Participant 1) both for convenience and to protect the participants' anonymity. In the sections that follow, themes generated to answer Research Questions 1 and 2 are presented.

Findings

The findings are presented under three major themes: (1) students' perceptions of physics; (2) students' perceived difficulties in learning physics, and (3) addressing perceived difficulties in learning physics by the students. Some of the themes are further categorised into sub-themes. Survey data were presented in percentages and tables while verbatim interview data is used to present qualitative data.

Theme 1: Students' Perceptions of Physics

The summary of data obtained from the survey questionnaire is shown in Table 1. 40.4 percent (N=84) of students reported that physics was easy while 59.6 percent (N=124) indicated physics as a difficult science subject. Students who perceived physics as a difficult subject were identified when they reported physics as *challenging*, *tough*, *confusing, and puzzling*. Labels such as *comfortable, enjoyable, interesting, engaging,* and *stimulating* used by the students suggested that physics was easy for students. The analysis of this summary helped this study to focus on the students who perceived physics as a difficult subject, thereby enabling researchers to answer Research Question 1.

Table 1
Students' Perceptions of Physics as a Subject

		Students' perception of Physics		
Grade	**Gender**	**Easy % (*f*)**	**Difficult % (*f*)**	**Total**
9	Male	36.4 (12)	63.6 (21)	33
	Female	37.8 (17)	62.2 (28)	45
10	Male	44.4 (12)	55.6 (15)	27
	Female	35.9 (14)	64.1 (25)	39
11	Male	37.5 (3)	62.5 (5)	8
	Female	20.0 (1)	80.0 (4)	5
12	Male	69.5 (16)	30.5 (7)	23
	Female	32.1 (9)	67.9 (19)	28
Total		**40.4 (84)**	**59.6 (124)**	**208**

Theme 2: Students' Perceived Difficulties in Learning Physics

The reasons stated by the students were classified into 3 sub-themes: (1) student-related reasons, (2) curriculum-related reasons, and (3) subject-related reasons. Each is detailed in turn below.

Student-related Reasons

Student-related reasons in the context of this study refer to the factors that influence the study's outcome through student conduct and attitudes. In this section, 3 factors namely *motivation*, *fundamentals of physics concepts, and community influence* constitute student-related variables by describing the data obtained from students.

Motivation: Lack of motivation was identified as one reason for students' failure to understand physics. Reasons such as a lack of desire to learn physics, low self-esteem, and a high level of stress indicated a lack of motivation to learn physics as expressed by P2:

> I dislike physics because I cannot achieve the grades that my parents and teachers expected of me.

Fundamentals of Physics Concepts (e.g., mathematical skills): Knowing the fundamental concepts of physics was acknowledged as a vital necessity to understand larger concepts (e.g., theories) in physics. Students stated the need for basic mathematical skills to understand and solve complex physics problems. For instance, P9 expressed that:

> To have a good foundation in the subject of physics, the basics are required, thus I always confront a lot of challenges owing to a lack of the basics.

Similarly, P6 too expressed that "Physics is full of numerical issues, and I dislike physics since I am bad in mathematics".

Community Influence: The influence of community (e.g., senior science students) has impacted students' perceived difficulty in physics. Students who have already attended physics as their major have been instilled with the fear that physics is the most difficult science subject and that they should not study science as reported by P1:

> My seniors and my parents said to me that physics is a difficult subject where we cannot score good marks, therefore I focus on other subjects more than science as I am sure that I can obtain just a passing mark in science from biology and chemistry only.

Curriculum-related Reasons

Curriculum-related reasons are factors that impact students' performance based on the subject's curriculum type. For example, a lack of resources, real-life applications, and teaching pedagogy accounted for students' difficulty in learning physics. In this section, we present 3 pieces of evidence to illustrate curriculum-related reasons.

Resources of Learning: Resources in the school that discourages students from learning physics include not having adequate supplementary books, laboratory paraphernalia, reliable internet connectivity, and computers. This is supported by P12 when he expressed:

> Our school lacks the necessary resources. Most of the physics books in the libraries are out of date, and some equipment mentioned in the textbook is not there in the physics lab. We also don't have good internet to search for information ourselves.

Real-life Connection: Students find it challenging to link and apply physics concepts in their day-to-day activities. Some of the concepts learned in the class are irrelevant in a real-life situation as voiced by one of the participants that "some ideas used to teach physics are not relevant to the Bhutanese setting and were difficult to apply in practice" (P20).

Teacher and Pedagogy: Students' perceived difficulty in learning physics is also determined by teachers and how they teach. Teacher-centred teaching, teachers' inability to provide examples based on local contexts, and provide information additional to the one provided in the textbook influences how students perceive physics. For example, P18 opined that “my teacher’s low voice and monotonous teaching style made me lose interest in learning physics”. The above view was echoed by P19 when he expressed “with less practical the subject becomes unenjoyable, and I become fatigued to learn”.

Subject-related Reasons

Subject-related reasons refer to those variables that impact students' learning due to the nature of the subject. Students often cite physics as being cumulative, difficult and abstract. Subject-related reasons are often attributed to factors such as the need to master a multitude of concepts, the use of technical terminology, and the requirement for a strong foundation in mathematics. Four factors namely *cumulative nature, abstract nature, multiple things to learn, and computation skills* illustrate students’ perceived difficulties associated with the nature of physics.

Cumulative Nature: Students regarded physics as cumulative. Some of the students suggested the cumulative nature of physics included learning similar concepts in different grades.This is evidenced in the student’s utterance:

> If we skip any lessons in between, it is quite tough to catch up with the remaining portion because it is so closely linked (P13).

A similar view was echoed by P16:

> I discovered that most physics theories remain consistent throughout classes, although they become more advanced as we proceed to the next grade.

Abstract Nature: Learning physics is associated with understanding things that cannot be easily touched or seen. The abstract nature of physics was indicated by students as hypothetical, imaginative, and theoretical. For example, P7 expressed:

> Sometimes I get the impression that we are studying something that is not genuine. For example, we are learning about gravitational pull, yet we cannot see it, making it difficult to grasp the idea.

Similar views were shared by P18 “some ideas in physics are irrational, ridiculous, and speculative, making them abstract”.

Multiple Things to Learn: Students also reported that there are too many things to understand in physics. For example, P17 asserted:

> It contains several theories, graphical representations, computations, and an experiment that are not provided at the same time in other topics, making physics extremely difficult to understand as expressed by.

Similar concerns were also shared by P20:

> Physics is challenging because there are so many formulae, computations, experiments, graphs, and explanations that give us headaches.

Computation Skills: A huge proportion of numerical problems, formulae and equations, and things to compute demonstrate that mastering physics needs a strong mathematical foundation. This is evident when P6 asserted that:

> Physics is full of mathematics and learning physics without a fundamental mathematical background is quite difficult.

Theme 3: Addressing Perceived Difficulties in Learning Physics

Although 59.6% (N=124) of the participants believe physics is a challenging subject, they have addressed those learning difficulties. Data obtained from the interview protocol indicated that students' addressed these difficulties with the support of their friends who were good in physics, by accessing educational websites, and devoting extra time. Students are motivated to learn physics because they appreciate the stories of advancements in physics as expressed by P15 that "I try to appreciate the significance of physics all the time, which makes me want to learn advanced physics".

For some students, their future goals of becoming an engineer constantly stimulate them to concentrate on learning physics as a part to achieve their goals. This is evidenced in P1 when she expressed "because I want to be an engineer and physics is a mandatory subject, I work hard to learn although it is a difficult subject".

Learning physics requires constant revision and practice due to which students devote extra time. This is evident when P13 stated, "I usually devote more time to learning physics than to other subjects". In addition, instead of memorising the concepts, students learned to connect the concepts they studied in the class to real situations as expressed by P9:

> Memorisation does not work at all, and I always try to relate concepts by citing examples which are familiar to me which makes the concept easier to understand.

In learning concepts that required mathematical knowledge, students also referred to mathematics textbooks to understand the connection and application of mathematics. For instance, P16 expressed:

> Some numerical problems in physics required mathematics theorems like the Pythagorean Theorem and I always try to link the concept in a similar situation in both subjects to help me to understand more.

Taking notes and focusing on the key concepts was another strategy used by the students as voiced by P6: "Rather than mixing everything, I always write down the significant notes and focus on the core principles". In the school, support from both teachers and their peers is often sought as mentioned by P4 that "I always initiate the discussion with my teacher and even among my friends whenever we encounter something difficult to understand". At home, support from family and relatives is also pursued as evidenced in P3's statement "I always ask for help from my brother first and if he cannot help, then I ask my teacher".

Discussion

This study investigated students' perceived difficulties in learning physics and how they addressed them. The findings revealed that students perceive physics as abstract, complex, and content-heavy, causing them to think of it as a difficult subject. Similar claims of students' finding difficulty in learning physics are also revealed in other contexts (Erinosho, 2013; Ornek et al., 2008). In Erinsho's (2013) study that involved 830 final-grade science students and 52 physics teachers, 58 percent of students indicated physics as a difficult subject. The nature of the subject, factors related to teachers and teaching, and curriculum were regarded as reasons for the difficulty. Ornek et al. (2008) found out that students' difficulties in learning physics were associated with factors related to students, course, and the nature of physics which corresponds to student-related reasons, curriculum-related reasons, and subject-related reasons from our study.

Understanding students' perceived difficulties in learning physics was helpful for this study in addressing Research Question 1- *What are the reasons for students perceive physics as a difficult subject?* The analyses of interview transcripts consolidated with in-depth data on students' difficulties that were associated with difficult topics, lack of background knowledge, resources for learning, and need for mathematical skills. Some of the findings (e.g., motivation) that caused students to perceive physics as difficult suggest that it may be associated with students' low performance in examinations and assessments. Ornek et al. (2008) support this notion that lack of interest and motivation is a major barrier to success in physics. Student's perceptions of the difficulty of physics were also influenced by their circle of community. Lavonen et al. (2007) contend family and friends as potential variables that influence how students feel about a subject. Another factor that accounts for students' perceived difficulty in learning physics is the limited application of theories in real-life situations. Bouchée et al. (2022) assert that some of the theories' lack of common usage renders physics abstract for students. From the curriculum perspective, one approach to facilitating maximising real-life application of physics content is the inclusion of local ideas wherever possible in the curriculum materials. At the school and classroom level, outdoor education (e.g., visiting parks, and hydropower stations) to connect the concepts learned inside the classroom can be encouraged. Traditional approach to teaching where there are no or minimal practical lessons was reported as one factor linked to students' perceived difficulty in learning physics. Learning physics through experiments inside the science laboratory enables students to derive practical skills of hands-on learning and fosters the practice of learning by doing. There is evidence of students' perspectives being influenced by the views of the community (e.g., senior science students). When students have poor perspectives, it generates negative interest in learning physics (Trumper, 2006).

Research Question 2 - *How are perceived difficulties of learning physics addressed by the students?* was attended by examining how students used various strategies to mitigate those challenges. One intriguing finding of this study is that some students' motivation to learn physics despite perceiving it as difficult is sparked by their future aspirations. Saleh (2014) concurs that students put forth a great deal of effort to excel in physics because they understand the importance of continuing higher education in science-related fields. Checkley (2010) acknowledged that future considerations have a considerable impact on students' decision to enrol in physics. Consequently, it is imperative to provide students with a clear career education that may enable them to choose a vocation that matches their interests.

Although very little time is allotted for physics teaching (3 periods per week), students managed to learn multiple things. To get through the complexity of the material, students devoted extra time to study physics. Taking notes and focusing on the key concepts was another method the students used to overcome comparable difficulties. Students have put the effort into relating the ideas they learned in class to actual situations instead of memorising them. Similar assertions are made in Erinosho's (2013) study, which indicated that instead of memorising, strategies for enhancing students' assimilation of the material should be used to promote interest in learning physics.

This study also found that students use mathematics textbooks to understand the connection and application of mathematics when studying physics, which require mathematical expertise. Such findings are useful to inform both physics and mathematics teachers to understand the importance of relating the formula and concepts that are accessible in both physics and mathematics. Students will benefit from cross-curricular pedagogies by applying problem-solving skills in mathematics across physics topics (Deslauriers et al., 2019). Students in our study also considered seeking assistance from peers and teachers at school, as well as seeking support from family members at home as one the ways to address these difficulties.

Students seeking help and support from family members may demonstrate approachability, which enables students to address their difficulties in learning physics. Such situations have broader ramifications for parents and families who assume responsibility for a student's social and cognitive development.

Conclusion

This study examined grade 9-12 students' perceived difficulties in learning physics. Most of the students considered physics as a difficult subject citing reasons associated with students, curriculum, and the nature of the subject. Although students think of physics as a difficult subject, they have employed several ways to address the learning difficulties. Approaches such as discussing the contents with their peers, learning from educational websites, and spending additional time to learn solving numerical questions were applied by students to address the perceived difficulties.

To address students' learning difficulties in physics and make the subject enjoyable, studies such as this are crucial to understand why they have trouble with the subject in the first place. Based on the findings, it is suggestive that there are reasons (e.g., curriculum-related and subject-related reasons) that are beyond the control of students, making them perceive physics as difficult. Relevant stakeholders, policymakers, curriculum developers, and teachers may seek additional approaches to include local ideas to minimise students' perceived difficulties. Learning content needs to be carefully examined based on relevance, necessity, and the learner's interests. Physics instruction should include suitable remedial exercises to help students fill in any gaps in their mathematical and problem-solving abilities. If students can plan and carry out the strategies for answering questions, physics is found to be enjoyable for them (Erinosho, 2013).

Teachers must comprehend students' desires to tailor their lesson activities. Future researchers can use other techniques to investigate reasons for students to perceive physics as a difficult subject and how they address those issues as the findings of this study are limited in generalisability. Our findings suggest that initiating a similar study to understand the difficulties of students in other disciplines is imperative. This may be conducted using multi-method approaches, applying different conceptual and theoretical frameworks, or investigating in association with other influential variables (e.g., culture, motivation). In summary, the findings of this exploratory study extend the literature on students' perceived difficulties in learning physics and serve as the foundation for future studies.

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