Perception of teachers and students on the introduction of satellite development in the physics curriculum.

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Abstract

The study evaluates the perceptions of physics teachers and class 12 science students on the introduction of satellite development into the Bhutanese curriculum in 2021. The mixed research method was used for the study. The data collected with a purposive sampling from 12 physics teachers and 301 grade 12 science students using a survey research design were analyzed with descriptive statistics, two samples paired t-test, and one-way ANOVA. The teachers and students possessed a very high positive perception of the introduction of satellite development into their syllabus. Students expressed high positive perceptions while teachers had low positive perceptions of the content of satellite development. The male students possessed significantly higher positive perceptions and motivation compared to female students at $p<0.05$. No significant variance was observedin the perception of content and motivation based on the region.

Recommendations are suggested to the curriculum developers and implementers based on the findings and feedback from the respondents.

Keywords: Perception, Physics curriculum, Satellite development, Students, Teachers.

Introduction

It is deemed necessary to come up with innovation and changes in the education system to have advancements in science and technology, as education plays a key role in societal development(Ulu&Kiraz, 2012). The change in curriculum will help in shiftingthe focus of learners from one area to another broadening prospect of knowledge, moreover, it will help in equipping students with the latest information and knowledge based on societal needs with the change of time.

Individuals who are highly skilled in their field of specialization with good knowledge of science, and technology is needed to enhance the economyof the country in the 21st century (Yildirim, 2016). Bhutan, being one of the developing nations with a meager economy, is crucial to update and adapt the best technological tools to enhance its developmental processes and to prepare its youth to use technology effectively. Updating the curriculum based on need and with the advancement of technology is one of the ways to educate our future leaders with cutting-edge technology so that they can easily adapt to and embrace the change. Teaching the same old astronomy based on numbers and position is not enough (Bretones, 2019). ThereforeBhutanese education system, especially the science curriculum, has been undergoing rapid evolution since 1961 (Childs Ann et al, 2012)to enable our youth to grow at the pace of technological advancement.

With the royal vision of developing and launching a satelliteand growing capabilities of developing its satellite with the help of neighboring countries, it was felt the right time to introduce the concept of satellite development into the Bhutanese curriculum, so that students will be informed, motivated, and be prepared to take up the future job related to space and satellite development. The concept of satellite development was added into the curriculum of class 12 where students learned about the process of satellite development, orbital mechanics and satellite launch, satellite subsystem, space environment, and space laws and regulations. Akhter, Khan, and Din (2019) claimed that the perception of learning outcomes of students wasfield-dependent, conversely, we do not have enough equipment and space observatory to motivate students to learn and take up space physics-relatedcareers.

Problem statement

The Science curriculum in Bhutan is implemented from key stage II to key stage III general science where all the concepts of physics, chemistry, and biology are provided in a single textbook. Whereas students in key stages IV and V learn physics, chemistry, and biology as separate textbooks. The students of classes 9 to 12 were taught astrophysics till 2020. It was with the beginning of academic session 2021, the concept of space physics got added into the curriculum from classes nine to twelve at one go, although they had their share of content as per the level. Class twelve being a terminal class among secondary schools, had to learn about satellite development abruptly without learning its basics in class eleven which gave researchers a notion that students of class twelve will find it difficult to learn the content as a result develop negative

perceptions of the subject affecting their level of motivation.

As an educator,it was felt necessary to understand the perception of the students and teachers on the newly introduced chapter 'satellite development' so that the findings from the study will work as feedback for curriculum developers and curriculum implementers.

Literature Review

According to Dendup, Utha, and Pema (2021) astrophysics is defined as the study of heavenly bodies in the universe and how things evolve from a minute to a very large. To comprehend and validate the systems and functioning of space, it is important to recognize and observe the cosmos first (Subasi, Aydin&Kocak, 2015). To foster the level of interest in the learners and to achieve their career options, the study of space physics may include in the curriculum considering the learner'sneeds and interest in the ever-changing world of technology (Majid et al., 2018).

Straub and Whalen (2013) stated that the student's attention to learning and acquiring skills enhance interest in designing spacecraft that would help in discovering new ways and approaches. According to Zangmo (2015);Marusic and Hadzibegovic (2017),students' perceptions of space physics proved a significant level of interest in learning, acquiring skills, and knowledge of space physics as well. In Bosnia and Herzegovina, studies performed to analyze students' attention and aptitude toward learning space physics turned out more females compared to males with higher aptitude (Marusic&Hadzibegovic, 2017); Barlett et al.(2018).Dewitt

and Bultitude (2020) stated that depending on an individual difference, culture, traditions, and type of curriculum implemented, the perception level for the students to learn and explore space physics was moderate, however, (Majid et al., 2018); Panou et al., (2019) stated that development of positive attitude in learning space physics had the significant relation to the achievement of space physics. Dewitt and Bultitude (2020), also stated that the majority of the students exhibit a high level of enthusiasm showing energy to learn and relearn.

Impact of space physics on student's motivation was carried out to critically analyze how students change their mind and thoughts, study culture, and their values, the result came out to be reliable, and promising as (N=18) 66.7% of students agreed to take up space physics as their career in future (Straub & Whalen, 2013). According to Subasi, Aydin, and Kocak (2015), students seek to learn and explore not what is already discovered but what is yet to be discovered. Creating career opportunities for students is one factor found to be a promising avenue to motivate and advance scientific knowledgeand skills, and other required aptitudes for them to learn and explore space physics (Marusic&Hadzibegovic, 2017). Reading, continued learning, and exploring more motivate them to critically think, and develop hypotheses, and ways to move analytically forward (Majid et al., 2018). According to Kulegel and Topsakal (2020), working together motivate students to aspire and learn further to gain their scientific knowledge and skills. Particularly in Bhutan, students are found difficult to cope with and see real-life applications in space physics (Dendup, Utha, &Pem, 2021).

The future career aspiration of the students was one area that they searched to study, and analyze, and was foundthat 66.7% out of 18 undergraduate students strongly agreed that they were highly motivated to take up astronomy as a future career (Straub & Whalen, 2013). On other hand, students of Bhutan do not have adequate knowledge and ideas of space physics as their career opportunities. Students perceived no relevancein their choice of career opportunities (Dendup et al., 2021).

Vidayanti, Abdurrahman, and Suyatna (2018) suggested that learning and exploration of space can be enhanced through the use of relevant teaching-learning materials, realistic visual recording, and anything that would assist the purpose of learning.

Dendup et al., (2021) has conducted a study on the previous curriculum (Astrophysics) with the student of classes nine to eleven to understand their perception of astrophysics, but no study so far has been conducted with the students of class twelve science after the introduction of a new chapter into their physic curriculum. This study, therefore, aims to fill this research gap.

Objective & Research Questions

When any curriculum is enforced into the syllabus, students are compelled to learn and reproduce them in the exams. But it is equally important to understand how the students feel about the contents that they study. Whether they are learning the concepts for fun or under compulsion and if the content being introduced is useful to students in their future. Thereforethis study is conducted to understandthe perception of students and teachers on the newly introduced chapter ‘Satellite Development’ into the

Bhutanese curriculum. To get the feedback on the chapter Satellite Development and inform the same to the curriculum developers. The study is intended to seek answersto the following questions through this research:

Q. What is the perception of students and teachers on the introduction of a new chapter (Satellite development) into the Bhutanese curriculum?

Sub questions:

- What is the perception of students and teachers on the introduction of Satellite Development?
- What is the perception of students and teachers regarding the content of Satellite Development?
- How has the new chapter motivated students to take up a career related to space technology?
- Is there any significance of gender difference among students in their perceptions and motivation?
- What is the significance of variance of perceptions of students based on the region?
- What are the challenges faced by teachers and students in teaching and learning the new chapter?

Hypotheses

- H1: Teachers and students have negativeperceptionsof the introduction of satellite development into the class 12 physics curriculum.
- H2: There is no gender difference in their perception and motivation for the introduction of the new chapter into their curriculum.
- H3: There is no variation in perceptions based on the region.

Methodology

Both the qualitative and quantitative research methods are used for the study. The qualitative method is used as the study involves the collection of perceptions of teacher-participants through open-ended questions. The quantitative research method provides an opportunity for individual respondents to express concepts or phenomena based on their experiences (Guler, Halicoglu&Tasgin, 2013). The quantitative methodwas used, as the study involves analysis of quantified numerical data (Apuke, 2017) to evaluate their perceptions expressed in the form of numerical data.

Research instruments:

Internal consistency is not affected by choice of scale (Chang, 1994); (Croasmun&Ostrom, 2011). Therefore questionnaires were designed with the 4-Point Likert scale (Taherdoost, 2019) to collect data from teachers and students. The researchers deliberated on the questionnaires designed to assure their reliability. Cronbach's alpha of 0.89 was obtained during pilot testing with 15 randomly selected students of class twelve for students' questionnaires, while the Teachers' questionnaire obtained the Cronbach's alpha of 0.92 affirming the reliability of the research tools.

Sampling:

Purposive sampling was used for the study where 301 class twelve science students from nine different higher secondary schools consented and responded to the survey questionnaires as represented in table 1a. The student respondent consists of (N=116) 38.5% male and (N=185) 61.5% female ranging from age 16 to 22 years. There was a total of (N=77) 25.6% of participants representing

Thimphu municipal, (N=94) 31.2% from Paro district, and the largest number of respondents (N=130, 43.2%) from Punakha district. The data was also collected from 12 physics teachers (10 male and 2 female) who taught the new curriculum across the country, as depicted in table 1b.

Table 1a: Students respondents based on region.

Region	Male	Femal e	Total	Percen t
1. Thimphu	33	44	77	25.6
2. Paro	30	64	94	31.2
3. Punakha	53	77	130	43.2
	116	185	301	100

Table 1b: number of teachers

Years in service	Number
1 to 10 years	6
11 to 20 years	5
above 20 years	1
	12

Data analysis:

There were two different sets of data being collected for the study. The first set of data was collected from class twelve students of nine different schools from three different regions during their vacation. The second set of data was collected from teachers teaching class twelve physics through a google form. The data collected wereanalyzed using descriptive analysis to find out the mean and standard deviations. Two samples paired t-test was carried out to observe the significance of gender difference and one-way ANOVA was used to observe the variation in perceptions based on regions. All the analyseswere carried out in data analysis tools present in Microsoft Excel 2013.

The mean score interpretation represented in table 2 is adopted from the works of Orlanda and Ventayen (2017). The qualitative data was analyzed thematically.

Table 2: Mean score interpretation

Mean score	Interpretation
3.26 to 4	Strongly agree/ Very high
2.6 to 3.25	Agree/ High
1.76 to 2.5	Disagree/ Low
1 to 1.75	Strongly disagree/ Very Low

Findings

This section contains the findings of the perception of students and teachers on the introduction of satellite development into the Bhutanese curriculum, the content introduced, and the motivation of students to take up a future career related to space physics. The study also analyses variationin perception based on gender and region.

Table 3 consists of four items related to students' perception ofthe introduction of satellite development. Overall, there is a significantly high positive response in the perception of the student's on the introduction of satellite development (with M = 3.4± 0.72), however, depending on their perception, responses vary slightly among these items. The introduction of space physics in the Bhutanese curriculum is highly significant and strongly agreed upon (M = 3.6±0.65). One can also conclude (M = 3.3±0.74) that given the opportunity students are highly interested in learning space technology and astronomy. The student participants also strongly agreed (M=3.4±0.7 and ±0.74) that they liked the introduction of space technology into the physics curriculum and they also enjoyed learning the content introduced respectively.

Table 3: Perception of students on the introduction of Satellite Development.	Mean	SD
1. I liked space technology being introduced into the Bhutanese curriculum	3.4	0.71
2. It was high time for Bhutan to introduce space technology into the curriculum	3.6	0.65
3. I enjoyed learning the content of Space technology	3.4	0.76
4. I am highly interested in space technology and astronomy.	3.3	0.74
Average	3.4	0.72

Table 4 describes the perception of students on the content of satellite development. Out of four items, included, students strongly agreed (M = 3.2±0.77) that the contents included in the chapter on satellite development are interesting, followed by the statement to which, they agreed (M = 3.1± 0.74) that contents are not that difficult to learn. The respondents agreed (M = 2.9±0.83) that the content of space technology introduced is not that vast. There was the lowest mean = 2.7±0.85) agreeing that they can learn the content on their own. On an average (M = 3.0±0.8) students' perception ofthe content of satellite development was found to be positive.

Table 4: Perception of students on the content of Satellite Development.	Mean	SD
5. Content of space technology included in physics is interesting.	3.2	0.77
6. Content of space technology introduced for class XII is not that lengthy.	2.9	0.83
7. The contents are not that difficult to learn.	3.1	0.74
8. I can clearly understand the content when I read on my own.	2.7	0.85
Average	3.0	0.8

As represented in table 5, students strongly agree (M = 3.4±0.78) that they were motivated to take up a career related to space physics, because they got basic ideas and information on satellite development. Participants strongly agreed (M = 3.6±0.69) that they would loveto visita space

observatory to learn more about space. Similarly, they also strongly agreed (M=3.6±0.71) that they would readily take up any scholarship related to space physics to carry out further studies. They agree (M=3.2±0.82) that those who take up space technology havea bright future in Bhutan. The respondents were highly motivated (M=3.0±0.84) to take up a course related to space technology.

Table 5: Motivation of students related to their future career.

	Mean	SD
9. There is a bright future in the field of Space technology in Bhutan.	**3.2**	**0.86**
10. It has motivated me to take up a course related to space technology.	**3.0**	**0.84**
11. I love to visit a space observatory to learn more about space.	**3.6**	**0.69**
12. If I am offered a scholarship on space technology, I would take it readily.	**3.6**	**0.71**
Average	**3.4**	**0.78**

Table 6 representsa summary of paired t-tests for two samples assuming unequal variance to find out the significance of gender difference in their perceptions towards the introduction of a new chapter (satellite development) into their physics curriculum, the content of satellite development, and the motivation of new chapter to take career-related to space physics. The finding showed significant gender differences in all three aspects of the study. Male students had a greater positive perceptioncompared the female (at $P<0.05$). Similarly, a Larger number of male students were satisfied with the content of satellite development compared to their counterparts (at $P<0.05$). The study also found that a significant number of male students were interested to take

up a future career related to space physics compared to females (at P<0.05).

Table 6: Paired T-test for two samples assuming unequal variances.

Significance of gender difference.	Male	Female	P-value	Significance (at P= 0.05)
1. Perception toward satellite development	3.53	3.36	0.018	Significant
2. perception of the content of satellite development	3.1	2.9	0.006	Significant
3. Motivation to take a career related to space physics	3.4	3.2	0.015	Significant

Table 7: ANOVA single factor for the variance of perceptions on the introduction of satellite development into curriculum based on region.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Thimphu	77	270.25	3.510	0.317
Paro	94	325.75	3.465	0.364
Punakha	130	436.5	3.358	0.405

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.287248	2	0.6436	1.7416	0.1770	3.0260
Within Groups	110.1226	298	0.3695			
Total	111.4099	300				

Table 8: ANOVA single factor for the variance of perception of students on the content of satellite development based on region.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Thimphu	77	236.25	3.068	0.374
Paro	94	281.75	2.997	0.306
Punakha	130	386	2.969	0.415

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.478374	2	0.2391	0.6456	0.5250	3.0260
Within Groups	110.3933	298	0.3704			
Total	110.8717	300				

Table 9: ANOVA single factor for the variance of motivation to take future Career-related to space physics based on region.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Thimphu	**77**	**259.75**	**3.373**	**0.338**
Paro	**94**	**317**	**3.372**	**0.313**
Punakha	**130**	**430.25**	**3.310**	**0.371**

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	**0.294957**	**2**	**0.1474**	**0.42815**	**0.652**	**3.026**
Within Groups	**102.6465**	**298**	**0.3444**			
Total	**102.9414**	**300**				

Tables 7 represents the result of ANOVA single factor variance of perception of students on introduction of the new chapter "satellite development" into the physics curriculum, table 8 represents the variance of perception of students on the content of satellite development, and table 8 shows the result of variance of motivation of students to take future career related to space physics based on the three regions. The results found no significant difference in their perceptions and motivation to take up a future career based on the region with P> 0.05.

Table 10: Perception of teachers on the introduction of Satellite Development	**Mean**	**SD**
1. I liked satellite development being introduced into the Bhutanese curriculum.	**3.7**	**0.89**
2. It was high time for Bhutan to introduce space technology into the curriculum.	**3.6**	**0.9**
3. I enjoyed teaching the content of Space technology/satellite development.	**3**	**0.85**
4. Students will gain enough ideas about space technology.	**3.1**	**0.9**
	3.4	**0.89**

Table 10 represents the perception of teachers on the introduction of satellite development into the physics curriculum for class 12. The participants responded with the highest mean (M=3.7±0.89) strongly agreeing that they liked the introduction of satellite development, a concept of space technology into the curriculum. This was followed by the second statement that it was high time for Bhutan to introduce the concepts of space technology into its curriculum (M=3.6±0.9). The participants agreed (M=3±0.85) that they enjoyed teaching the content of space technology. They also agreed (M=3.1±0.9) that students will gain enough ideas about space technology.

Table 11: Perception of teachers on the content of Satellite Development	Mean	SD
5. The content introduced into the space technology is adequate for their level	2.9	0.79
6. The content introduced in this chapter is not that lengthy.	2.8	0.86
7. Contents introduced in the chapter were easy to prepare and teach.	2.1	0.99
8. Students and teachers had access to appropriate TL materials for the chapter.	1.9	1.08
	2.4	0.93

Table 11 shows the perception of teachers on the content included in the chapter on satellite development where respondents agreed (M=2.9±0.79) that the content introduced in the chapter on satellite development is adequate for the level of students and contents are not lengthy (with the mean of 2.8±86). The teacher participants disagree that, the content introduced was easy to prepare and teach and that students and teachers had access to appropriateteaching-learning (TL) materials (with a mean of 2.1±0.99 and 1.9±1.08) respectively.

Discussion

What is the perception of students and teachers on the introduction of Satellite Development?

The high positive perceptions of teachers and students in the introduction of the new chapter indicate that the respondents are happy with the move of the government and they welcome the change, which contradicted the hypothesis of the study. The respondents liked the new chapter being introduced into the curriculum as they felt it was high time for Bhutan to introduce space technology to their new generation. The other reason for the students to readily accept the change is that they enjoyed learning the content of satellite development and it also ignited their curiosity to learn more about it. The teacher respondent (R2) stated that the chapter introducedwas interesting and realistic and also mentioned "It provides more platform for students to instigate their curiosity toward space technology and carry out research related to space physics". The other respondent (R1) also stated that some students who are deeply motivated by this chapter will build space crafts and satellites for Bhutan in near future. Similarly,Barlett et al., (2018); Panou et al. (2019); Dewitt &Bultitude (2020); Straub and Whalen (2013) found positive perceptions of students on learning space physics. In another bi-country study conducted by Marusic and Hadzibegovic (2017) in Bosnia and Croatia, students expresses a high degree of interest in learning astronomy although they had limited knowledge and experience about it as astrophysics was not part of their curriculum. On the other hand, the result of the study contradicts the findings of Dendup, Utha, &Pem (2021) wherenegative perceptions were expressed by the teachers and studentsnine to eleven

on astrophysics. The variation in the result shows that the newly introduced chapter, satellite development is better than the earlier chapter on astrophysics where children had to learn lengthy theoretical concepts.

What is the perception of students and teachers regarding the content of Satellite Development?

There were mixed responses from students and teachers responding to the content of satellite development. Although students agree that the content introduced was interesting, not that vast, and not that difficult to learn on their own, teachers disagree with the same. Teachers having to surf through the internet and prepare the content of the lesson by referring to the given framework could have faced difficulties while students faced no difficulties as they were taught the curated and well-summarized content in the class. Three teacher respondents stated that the content of the chapter was vast, not specific and that contained too many theoretical concepts. On contrary, the teacher respondent (R5) stated that the content was interesting and useful for the learners as it widened the students' knowledge of space technology increasing their future scope. The other respondent (R6) found the content on the development of rockets, and satellite subsystems to be most useful than other topics. Mixed perceptions were observed among teachers and students regarding the content of satellite development, where students were more satisfied than teachers.

How has the new chapter motivated students to take up a career related to space technology?

The introduction of the chapter on satellites not only widened the intellectual horizon of students but also has

greatly motivated them to learn more and take up their careers related to space. Student participants strongly agreed that they would readily take up a future career related to space technology, which is a positive indication that they were motivated to take up future jobs related to space given the opportunity. The finding of the study is similar to the result of Straub and Whalen (2013); Marusic and Hadzibegovic (2017); Kulegel and Topsakal (2020). Similarly, a teacher respondent(R11) stated that the introduction of the chapter gave students, ideas on the process of satellite development which would have motivated them to take up career-relatedina satellite in the future.

Is there any significance of gender difference among students in their perceptions and motivation?

Significant gender differences were observed in the perception of students toward satellite development, perception of the content of satellite development, and motivation to take up a career related to space technology, at $P<0.05$ respectively, with male students showing greater interest in learning about space and working in the field related to space technology compared to their female counterpart (Dewitt &Bultitude, 2020); Dare and Roehrig (2016).One of the purposes of introducing the chapter into the Bhutanese curriculum was to create awareness among the students on space technology, which the country is just venturing into. The high positive perception of the students indicates the fulfillment of the purpose.

What is the significance of variance of perceptions of students based on the region?

The study was focusedon three regions under which nine schools were included for data collection. The ANOVA

results show no variation of views among the respondents based on the region, which indicates that children of all the three regions are of similar positive perceptions.

What are the challenges faced by teachers and students in teaching and learning the new chapter?

Students responded that they faced challenges in accessing teaching-learning materials as all the materials were provided as soft copy, they were too bulky to print, while access to phone or computer was limited to read in soft. While one teacher respondent too expressed difficulty faced in providing reading materials to the students due to lack of printing facilities. Two teacher respondents expressed that they faceda challenge in content curation and filtering to provide concise and right materials to the students to save their time.

Limitations

Many factors can lead to variation in the perceptions of students and teachers on the curriculum matter. Different countries will have variations in the content introduced into their syllabus, and the way teachers prepare and deliver will greatly vary which will influence the interest of students in learning the content that will directly impact their perception of the subject. Teaching-learning facilities can be the other factors that limit the result of the perception of students. Schools with better facilities are likely to deliver the contents better which may give better perceptions to students.

Conclusion

The study found positive perceptions of teachers and students on the introduction of a new chapter “satellite

development" into the Bhutanese curriculum despite having to encounter several challenges.

The content introduced has opened new challenges and opportunities for students where a few highly motivated students have the opportunity to work and contribute to the use of space technology. There were mixed feelings regarding the content of satellite development, where, students had greater satisfaction compared to the teachers. Teachers saw the room for providing better content to the students in the future, through better aligning of contents with the framework and proper content curation.

Students responded that the chapter has highly motivated them to learn more about space and take up a future career related to space technology. The finding of the study saw significant gender differences where male students had higher positive perceptionsofthe introduction of the chapter, the content of satellite development, and their motivation to take up a future career related to space technology compared to female students. There were no significant variations of views based on the region observed.

The study provides good feedback to the curriculum developers and implementers which will, in turn, be useful in enhancing and implementing the curriculum.

Recommendations

Following commendations are made to the curriculum developers and subject teachers based on the findings of the study.

- The respondents felt it necessary to further align the curriculum framework and Instructional Guide, and

incorporate the use of more relevant Teaching-Learningmaterials.

- Assessment structures presented to schools by the Royal Education Council have to be followed in the Bhutan Council for Secondary Examination and Assessment. Most of the respondents expressed the gap between chapter-wise weightage and the board exam question papers for the satellite development.
- The majority of the respondents expressed that training and workshop on satellite development would further enhance their teaching competence enabling them to deliver the content better.

Consent and ethical clearance

Consent from all the individual participants was sought through google form before collecting the data. The researchers also sought approval to carry out the study from the various stakeholders involved.

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