SITUATION ANALYSIS - BHUTAN

Samtse College of Education
Bhutan

The Connected Learning for Science, Technology, Engineering, and Mathematics (CL4STEM) project aims to pilot an innovation and research its effectiveness and potential scaling for building capacities of secondary school teachers in Science and Maths for fostering higher-order thinking with inclusion and equity in their classrooms. The CL4STEM pilot engages teachers in curated OERs based modules in Science and Maths and participation in online communities of practice. It is a South-South collaboration among higher education institutions to adapt and pilot the Connected Learning Initiative (CLIx, https://clix.tiss.edu) in Tanzania, Nigeria, and Bhutan. CLIx has been successfully implemented at scale in India.

The associated research studies focus on two broad areas. First, the Impact Study, analyses the impact of innovation on teachers Knowledge, Attitudes, and Practice for higher-order teaching and learning of science and maths in an inclusive and equitable manner. Second, the Innovation Diffusion Study, generates knowledge on the processes of adoption of the innovation for specific local contexts and the conditions that support scaling.

Knowledge generated from this project would be disseminated to stakeholders in federal/provincial ministries of education and relevant regulatory and professional bodies to seed it into the policy agenda of these countries. Further, key insights from this project would be shared with other researchers and opinion leaders in the spirit of creating global public goods.

This study is funded by IDRC under the Global Partnership for Education Knowledge and Innovation Exchange (https://www.gpekix.org). Centre for Applied Sciences and Technology Research, Ibrahim Badamasi Babangida University, Lapai, Nigeria, is the lead of the CL4STEM project consortium which includes Samtse College of Education, Bhutan and Open University of Tanzania as the country partners. Tata Institute of Social Sciences, India is the technical consultant to the project.

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Report is available for download at https://www.connectedlearningforstem.org/

Any questions, suggestions or queries may be sent to us at: info.cl4stem@clixindia.org

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List of Abbreviations

BCSEA	Bhutan Council for School Examination and Assessment
BPST	Bhutan Professional Standards for Teachers
CA	Continuous Assessment
CASTER	Centre for Applied Sciences and Technology Research
CDC	Curriculum Development Centre
CETE	Centre of Excellence in Teacher Education
CFA	Continuous Formative Assessment
CS	Central Schools
CTAB	Curriculum Technical Advisory Board
DAHE	Department of Adult & Higher Education
DNT	Druk Nyamrup Tshogpa
DoS	Directorate of Services
DPT	Druk Phuensum Tshogpa
DSE	Department of School Education
DYS	Department of Youth & Sports
DYT	Dzongkhag Yargay Tshogdu
ECCD	Early Childhood Care Development
EIE	Education in an Emergency
EMO	Education Monitoring Officer
FYP	Five Year Plan
GNH	Gross National Happiness
HSS	Higher Secondary Schools
IBBUL	Ibrahim Badamasi Babangida University, Lapai
ICT	Information and Communication Technologies
IDRC	International Development Research Centre
IEP	Individual Educational Plan
INSET	In-Service Education of Teachers
KAP	Knowledge, Attitudes, and Practice
KIX	Knowledge and Innovation Exchange

MoE	Ministry of Education
MSS	Middle Secondary Schools
NGO	Non-governmental Organization
NNC	New Normal Curriculum
NQT	Newly Qualified Teacher
OECD	Organization for Economic Cooperation and Development
OER	Open Educational Resources
OUT	Open University, Tanzania
PISA	Program for International Student Assessment
PPP	Public-private Partnerships
REC	Royal Education Council
RGoB	Royal Government of Bhutan
RUB	Royal University of Bhutan
SA	Summative Assessment
SCE	Samtse College of Education
SEN	Special Education Need
SIM	Self-Instructional Materials
STEM	Science Technology Engineering and Mathematics
SWOT	Strength Weakness Opportunity Threat
TEDB	Teacher Education Development Board
TISS	Tata Institute of Social Science
TPSD	Teacher Professional Support Division
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
US	United States
VLE	Virtual Learning Environment

1 Introduction

This document provides country-specific background information to plan, design, and execute the activities of the Connected Learning for STEM (CL4STEM) pilot in Bhutan. This report is collated from secondary literature and through key informant interviews with education functionaries. Participant information was collected through a survey of participating districts, secondary schools, and teachers in the country.

1.1 About CL4STEM

CL4STEM aims to pilot an innovation and research its effectiveness and potential scaling for building the capacities of newly qualified teachers (NQTs) of middle and secondary school in science and mathematics and for fostering higher-order learning in their classrooms inclusively and equitably. It is a South-South collaboration among higher education institutions to adapt and pilot the Connected Learning Initiative (CLIx) (https://clix.tiss.edu), which is already developed and scaled in India, to new contexts in Bhutan, Nigeria, and Tanzania.

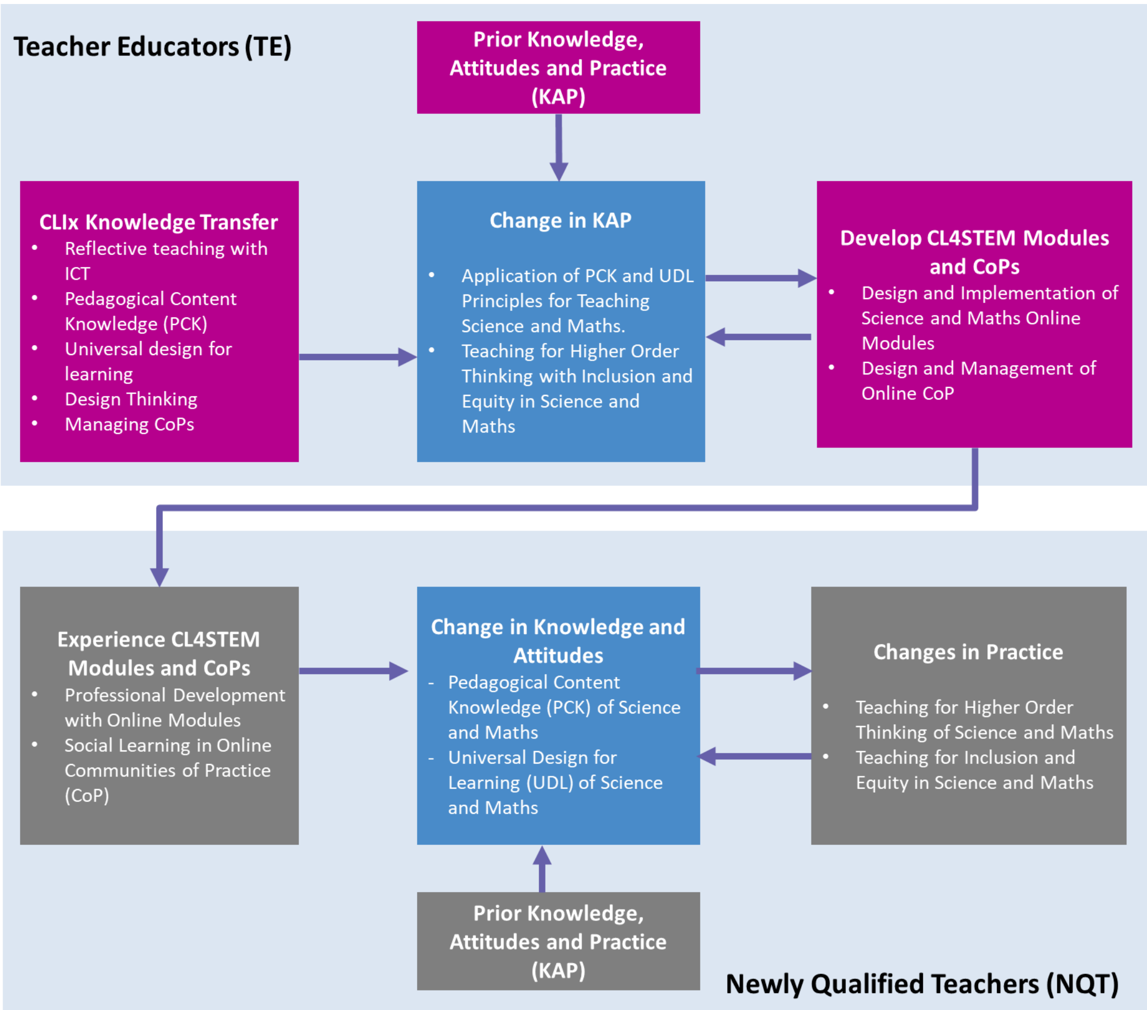

Figure 1.1: Theory of Change

The pilot involves the building of teachers' professional capacities through their engagement with curated modules based on Open Education Resources (OER) and through their participation in online communities of practice. It also involves a knowledge transfer of CLIx to teacher educators in partner institutions to build their capabilities to design and curate OERs and to design and manage online communities of practice.

The associated research studies focus on two broad areas. First, the Impact Study, analyses the impact of innovation on teachers Knowledge, Attitudes, and Practice for higher-order teaching and learning of science and maths inclusively and equitably. Second, the Innovation Diffusion Study, generates knowledge on the processes of adoption of the innovation for specific local contexts and the conditions that support scaling.

Knowledge generated from this project would be disseminated to stakeholders in federal/provincial ministries of education and relevant regulatory and professional bodies to seed it into the policy agenda of these countries. Further, key insights from this project would be shared with other researchers and opinion leaders in the spirit of creating global public goods.

1.2 Project Partners

The present study is funded by the International Development Research Centre (IDRC) under the Global Partnership for Education Knowledge and Innovation Exchange (GPE-KIX). Centre for Applied Sciences and Technology Research (CASTER), Ibrahim Badamasi Babangida University, Lapai (IBBUL), Nigeria is the lead of the CL4STEM project consortium, which includes Samtse College of Education, Bhutan (SCE) and Open University, Tanzania (OUT) as country partners; and the Tata Institute of Social Sciences, India (TISS) as the technical consultant.

The Ibrahim Badamasi Babangida University Lapai (ibbu.edu.ng) is registered and accredited higher education institution with a mandate to train teacher educators, student-teachers, and in-service teachers within and outside Nigeria. IBBUL is involved with the process of Vision 2020 policy on education and collaborates with the state government viz. the State Ministry of Education (SMOEs), Science and Technical School Boards, Secondary Education Boards, Education Resource Centre, and Teachers' Registration Council of Nigeria.

Samtse College of Education, Royal University of Bhutan (www.sce.edu.bt) is the only teacher education college that trains teachers for secondary schools in the Bhutanese education system. SCE plays a strategic role in building quality STEM teachers (including ICT-enabled approaches) that are academically sound and professionally competent enough to prepare the younger generation of Bhutanese children to brace the challenges of the 21st century.

The Open University of Tanzania (OUT) (www.out.ac.tz) is an autonomous and accredited public University, which offers certificate, diploma, and undergraduate and postgraduate degree programs through open and distance learning in Tanzania. OUT is the key site for the delivery of ICT based pre and in-service teacher education in Tanzania and has an extended mandate through the UNESCO Chair on teacher education and curriculum. OUT has existing relationships with key stakeholders in the teacher education space in Tanzania, such as the Tanzania Institute of Education that develops and oversees curricula and learning materials for secondary schools, other teachers' training institutions, and the two ministries of the central and local government that deal with education at secondary school level.

Tata Institute of Social Sciences, Mumbai, India (www.tiss.edu) is among South Asia's premier research and teaching universities in social sciences. The Centre of Excellence in Teacher Education (CETE), an Independent Centre on the TISS Mumbai Campus, engages in teaching, research, and field action, and it has multidisciplinary expertise in the use of ICT in Education for quality reform at scale. CETE was awarded the UNESCO King Hamad Prize for Excellence for using ICTs in education in 2018 for its flagship 'Connected learning initiative'.

The leadership team for the CL4STEM project is as follows:

- Principal Investigator: Prof. Nuhu George Obaje, IBBUL
- Principal Technical Consultant: Prof. Padma Sarangapani, TISS
- Lead Investigator – Bhutan: Prof. Rinchen Dorji, SCE
- Lead Investigator – Tanzania: Dr Edephonce Nfuka, OUT
- Lead Technical Consultant – Knowledge Transfer: Prof. Mythili Ramchand, TISS
- Lead Technical Consultant – Innovation Diffusion Study: Dr Vikas Maniar, TISS
- Nodal Officer: Mr. Abdullahi Abubakar Kawu, IBBUL
- Advisor: Prof. Steve Nwokeocha, IBBUL.

1.3 Importance Of CL4STEM In Bhutan

In the 21st century, scientific and technological innovation has become increasingly important in our daily lives. STEM education is crucial for the technological advancement and economic growth of the nation. Bhutan is a developing country and human resources that can contribute to the social and economic development of the nation are required in the field of science and technology.

Although the increasing need for STEM education was felt by the nation, the development of the STEM education curriculum is in its nascent stage. Teaching and learning take place in the absence of technology in Bhutanese classes even though students are exposed to numerous technologies in this digital age. Moreover, resources are notably limited in the field of STEM education. These limitations have resulted in a traditional method of teaching and learning, which is attributed to rote learning wherein the students were not able to apply their knowledge in a real-life situation (Utha et al., 2021). Further, Rai (2019) reported that Bhutanese students were unable to understand the core concepts and apply knowledge to real-life situations across grades and subjects. Moreover, the students' performance was average in Mathematics and Science (BCSEA, 2020).

His Majesty, The Fifth King of Bhutan, issued a Royal Decree (Royal Kasho) on 17 December 2020, echoing the nation's vision to accelerate its technological advancement and globalization in the field of education. His Majesty also stated that STEM should be prioritized in education and available technologies should be used optimally. His Majesty commanded that Bhutanese teachers should adopt global best practices by using information and media literacy as well as technological skills to promote learning that involves self-discovery, exploration, and the creation of new knowledge. STEM education is necessary for achieving this. Therefore, the participation of Bhutanese STEM educators in the CL4STEM project is relevant and timely. The project intends to provide teachers' capacity building programs and ensure robust STEM education in the nation. Further, the project aims at developing Open Educational Resources (OER) for STEM education, thereby addressing the need for STEM teachers in the nation.

1.4 CL4STEM In Bhutan: A SWOT analysis

Strengths

- STEM faculty experience in module development at the college level and textbook development at the school level
- Qualified STEM faculty with many years of teaching experience in respective subjects
- Experience in offering online teaching
- Physics and Biology have ICT experts
- STEM faculty has undertaken numerous ICT-related PD to enhance teaching, learning, and assessing
- STEM faculty has experience in organizing and facilitating PD, workshops, and training at the school, college, and national levels
- ICT technical experts

Weaknesses

- ICT knowledge on customization of simulation
- ICT knowledge of school teachers and students
- Development of OERs
- Resources (devices, software)
- Faculty time constraint (due to regular teaching)

Opportunities

- Policy level support at the government level and the recognition of the importance of technology-enhanced educational practices
- The Royal Decree for Reform in Education with a special emphasis on improving ICT facilities to align with a 21^{st}-century education
- Support from MoE and CDEOs
- Establishment of linkages with schools and other stakeholders
- TISS expertise in developing and offering OERs
- Most of the school Principals and teachers are in favour of CL4STEM

Threats

- ICT infrastructure and connectivity
- COVID-19 situation (frequent lockdowns)
- STEM faculty time and workload
- Seriousness of school teachers and managers in implementing the OERs
- STEM laboratory resources in the schools

1.5 Brief Background On Data Collection

The situation analysis is mostly based on the data collected from the survey, interviews, and other secondary sources. There are 20 Dzongkhags (Districts) in Bhutan. Out of this, five Dzongkhags, namely, Thimphu (West), Zhemgang (Central), Paro (West), Trashigang (East), and Samtse (South), were selected according to the region for the present study. The northern region was not selected owing to its remote location and climatic condition. Under Thimphu Dzongkhag, the schools were broadly classified into two divisions, viz., Thimphu Dzongkhag and Thimphu Thromde. The former is located within the city and the latter is located in the periphery. Each division has its own administrative and management systems.

All Middle Secondary Schools (MSS), Higher Secondary Schools (HSS) and Central Schools (CS) of these five Dzongkhags participated in the study. The survey participants included 165 STEM teachers and 24 (out of 33) Principals for collecting the school information.

The interview participants included six Principals, five Lead Teachers, four Chief District Education Officers (CDEO), and six Academic Heads of the school from five Dzongkhags. The secondary data mostly included policy-related documents and a few research articles.

In order to facilitate easy reference, coding is used as reflected in Table 1.1.

Table 1.1: Participants' code

Dzongkhag		Dzongkhag code	Principal code	Academic head code	LEAD	CDEO
Zhemgang		D1	P1	A1	L1	C1
Thimphu	Thimphu Dzongkhag	D2a	P2a	A2a	L2a	C2a
	Thimphu Thromde	D2b	P2b	A2b	L2b	C2b
Paro		D3	P3	A3	L3	C3
Samtse		D4	P4	A4	L4	C4
Trashigang		D5	P5	A5	L5	C5
	Total		6	6	5	4

Table 1.2: Socio-economic profile of students, STEM teachers and status of ICT in six districts

School district		Name of the school	No. of full-time teachers	No. of teachers teaching STEM subjects	School Status	School Location	% of teachers who owns a smart phone (approx.)	% of students who have access to a smart phone (approx.)	Type of Internet connection	Data Speed(mbps)	No. of Students with special needs	No. of Kidu Students (Economically disadvantaged)
Thimphu	Thimphu Dzongkhag	Kuzhugchen MSS	31	5	DS	Semi-urban	100	90	Fiber Optic	14	1	1
		Yangchen Gatshel MSS	26	9	BS	Semi-urban	100	40	Fiber Optic	11	36	12
		Wangbama CS	28	12	BS	Semi-urban	100	50	Fiber Optic	15	1	14
		Khasadrapchu MSS	48	13	BS	Semi-urban	100	85	Lease – line traiff	3	17	5
	Thimphu thromde	Babesa HSS	32	11	DS	Urban	100	40.7	Lease line	11	NA	7
		Zilukha MSS	50	5	DS	Urban	100	90	Fiber Optic	20	NA	13
		Yangchenphug HSS	62	24	DS	Urban	100	95	Fiber Optic	13	1	5
Zhemgang		Sonamthang CS	44	12	BS	Semi-urban	100	30	Fiber Optic	6	0	21
		Buli CS	29	8	BS	Semi-urban	100	34	Dial up	132	43	15
Paro		Shari HSS	33	11	DS	Semi-urban	99.9	90	Fiber Optic	11		
		Drukgyel CS	39	17	BS	Semi-urban	100	1	Fiber Optic	23	3	16
		Khangkhu MSS	44	11	DS	Urban	100	98	Fiber Optic	5	0	1

School district	Name of the school	No. of full-time teachers	No. of teachers teaching STEM subjects	School Status	School Location	% of teachers who owns a smart phone (approx.)	% of students who have access to a smart phone (approx.)	Type of Internet connection	Data Speed(mbps)	No. of Students with special needs	No. of Kidu Students (Economically disadvantaged)
	Lamgong MSS	53	6	DS	Urban	100	80	Fiber Optic	11	1	23
Tashigang	Gongthung MSS	25	7	BS	Semi-urban	100	0	Broadband	7	2	2
	Dungtse CS	25	10	BS	Semi-urban	100	50	Fiber Optic	12	37	2
	Bartsham HSS	30	11	BS	Semi-urban	100	0	Fiber Optic	14	0	17
	Tashitse HSS	26	8	BS	Semi-urban	100	NA	Leases line	7		
	Dungtse MSS	23	9	BS	Rural	100	0	Fiber Optic	12		
Samtse	Yoeseltse HSS	30	7	DS	Semi-urban	100	10	Fiber Optic	7		1
	Peljorling HSS	66	12	BS	Semi-urban	100	80	Fiber Optic	7	NA	5
	Gomtu HSS	68	30	DS	Semi-urban	100	60	Fiber Optic	6	1	7
	Tendruk CS	81	19	BS	Semi-urban	100	30	Fiber Optic	11	79	16
	Dorokha HSS	33	11	BS	Semi-urban	100	50	wifi		NA	NA
	Samtse HSS	32	10	DS	Semi-urban	100	80	Fiber Optic	10	0	0

Table 1.3: STEM teacher qualification, teaching experience and age category

Dzongkha		School	Qualification					Teaching Experience			Age Category		
			BED	PGDE/ PGCE	MED	MSC	PhD	less than 5 years	5-10 years	Above 10 years	Below 30 years	30-39 Years	above 40 years
Thimphu	Thimphu Dzongkhag	Kuzhugchen MSS	1	2					6	2		2	1
		Yangchen Gatshel MSS		1	1				1	1	1		1
		Wangbama CS	0		5				2	4	0	6	0
		Khasadrapchu MSS	2	2					1	3		3	1
	Thimphu Thromde	Babesa HSS		1					1			1	
		Zilukha MSS	3	2	2				4	3	2	4	1
		Yangchenphug HSS	2	2	3			1	3	3	1	5	1
		Changzamto MSS	3	1	2				2	4		4	2
		Luntenzampa MSS		1	1			1		1	1		1
		Loselling MSS	2	2		1	1		4	2	2	3	1
Zhemgang		Sonamthang CS	2	4	1			1	6		2	5	
		Zhemgang CS	1	4				2	2	1	3	2	
		Buli Central School	1		2			1	2		1	2	
Paro		Shari HS		2	1	3		2	2	4	1	3	2
		Drukgyel CS		2						2			2
		Khangkhu MSS	1		1	1				3		2	1
		Lamgong MSS	1							1			1
Tashigang		Gongthung MSS	2	1	1			1	2	1	1	3	
		Rangjung HSS	2		1	3		1		5	1	4	1
		Jigme Shrubling CS		1					1		1		
		Radhi MSS	2	1				3			3		
		Thrimsing CS	1							1			1
		Tashigang MSS	2		2				1	3	1	2	1

Dzongkha		Qualification					Teaching Experience			Age Category		
	School	BED	PGDE/ PGCE	MED	MSC	Ph D	less than 5 years	5-10 year s	Abov e 10 years	Belo w 30 years	30- 39 Year s	abov e 40 years
	Bartsham CS	2	4	1			4	1	2	3	3	1
	Tashitse HSS	1	1						2			2
	Dungtse CS	1							1		1	
Samtse	Yoeseltse HSS	4	2	1			2		5	1	5	1
	Peljorling HSS	5	3	1			3	2	4	3	1	4
	Norbugang CS			1				1			1	
	Gomtu HSS	6	3		1		2	2	6		2	6
	Tendruk CS	5		1			3	2	1	2	2	1
	Dorokha CS	2	4	2			4	3	1	5	3	
	Samtse HSS	2	4	3	1		1	1	9	1	3	7

2 Mapping The Context

2.1 Country Context

2.1.1 Geography, demography, politics, and administration

Bhutan is a small landlocked kingdom nestled deep in the Eastern Himalayas and bordered by the world's two populous nations, India to the south and China to the north. The country has a population of over 754,000 and a territory of 38,394 square kilometres (14,824 sq m). Bhutan is characterized by steep mountains and deep valleys, which has led to scattered patterns of settlement. The official language is Dzongkha but the medium of instruction in schools is Dzongkha and English. Other dialects, such as Lhotsamkha, Sharchopkha, Kurtoepkha, Khengkha, Mangdepkha, and Bumthapkha, are also widely spoken. Buddhism and Hinduism are the most followed religions. However, other religions are also practised.

The country is known for its unique developmental philosophy – Gross National Happiness (GNH) – that guides its development. Abundant water resources create ideal conditions for hydropower development, which has given impetus to economic growth. Revenue generated from hydropower has helped finance large investments in human capital, which has led to significant improvements in in-service delivery, education, and health outcomes.

Bhutan’s political environment has been stable and economic conditions have improved in recent years. Since Bhutan has shifted to a democratic constitutional monarchy in 2008, the country has developed a solid development management system founded on the principle of GNH.

As Bhutan’s developmental philosophy is GNH, this study will investigate the factors responsible for the development of STEM subjects in the schools of Bhutan. STEM Education is vital to the realization of this philosophy, as the quality of Mathematics and Science education is central in building human capital, especially in the case of Bhutan, where science and technology are still in infancy. The way in which STEM subjects are currently taught in the schools and colleges of Bhutan needs to be challenged.

The knowledge of STEM subjects has gained more attention with rapid advancements in information and communication technologies (ICT). It has become a necessity for people of all ages to attain and apply scientific knowledge effectively and efficiently to be successful citizens. In particular, students need to be well equipped with higher-order STEM knowledge, as the lack of understanding of basic STEM principles can result in an inability to solve numerous scientific problems.

The government in Bhutan has been a constitutional monarchy since 2008. The King of Bhutan is the head of state. The executive power is exercised by the council of ministers, headed by the Prime Minister. It has a two-house Parliament, namely, National Council (Gyalyong Tshodey) - the upper house and National Assembly (Gyalyong Tshodue) - the lower house.

Bhutan is divided into 20 Dzongkhags *(*districts/state). Dzongkhags are the primary subdivisions of Bhutan. The day-to-day administration of the Dzongkhag is carried out by Dzongda (District Magistrate) with the support of the Dzongkhag staff. As a part of the decentralization process, Dzongkhag Yargay Tshogdu (DYT) was established to formulate, approve, and implement the Dzongkhag plan activity. The members of DYT comprise local leaders, such as Gups (village head), Mangmi (village representative), and elected members from thromde (municipality). DYT is chaired by one of the elected Gups. D*zongkhag* is responsible for maintaining law and order and for enforcing the rules for disciplined behaviour.

This study is situated in five Dzongkhags (districts) in Bhutan. A brief profile of each of these five Dzongkhags, namely, Thimphu, Paro, Trashigang, Zhemgang, and Samtse, is presented to provide the study context.

Thimphu is the capital of Bhutan and is located in Western Bhutan. It has a population of 0.14 million scattered within an area of 1,794.87 km^2 (National Statistics Bureau [NSB], 2020). It is well connected with the road and it is a 45-minute drive from the Paro International airport. Thimphu experiences a cold and dry winter with temperatures ranging from -3°C to 15°C and mild summer with a temperature range of 12°C to 25°C. Thimphu receives moderate rainfall of 55 inches. Dzongkha and English languages are predominantly spoken by residents of Thimphu. Other dialects, such as Lhotsamkha, Sharchopkha, Kurtoepkha, Khengkha, Mangdepkha, and Bumthapkha, are also spoken.

Samtse is one of the four Dzongkhags located in the south of Bhutan. It has a population of 63000 (NSB, 2020). Although Lhotshampkha is the dominant language spoken by the heterogeneous Lhotshampa community, Dzongkha, English and other dialects are also spoken.

Samtse experiences hot and humid summer with an average temperature of 17°C in winter and 35°C in summer. It receives moderate to heavy rainfall of about 1500-4000 mm annually. It is connected with roads and shares an international border with the Indian states of Sikkim to the west and West Bengal to the south. SCE is situated in Samtse.

Paro is located in the northwest of Bhutan. It is a historic town with many sacred sites and historical buildings scattered throughout the area. It is also home to Paro Airport, Bhutan's only airport. It has a population of 35,000 (NSB, 2020) and Dzongkha is the predominant and official language. English and other local dialects are also widely spoken. Paro enjoys a cool and warm summer with temperatures ranging from 14°C to 26°C. However, winter can be severe with temperatures ranging from -5°C to 14°C.

Trashigang Dzongkhag is in the east of Bhutan. It has a population of 71,768. The main language is Sharchopkha. However, English, Dzongkhag, and other dialects are also spoken. It is one of the few Dzongkhags to have domestic airports. The district enjoys a pleasant winter (24°C-12°C) and moderate summer (34°C-22°C) with annual rainfall between 1000 mm and 2000 mm. Sherubtse College is one of the oldest colleges in Trashigang.

Zhemgang Dzongkhag is located in the South Central region. It has rich biodiversity and is home to numerous endangered animal species including the golden langur. It has a population of 17,763.

Khengkha is the dominant language, but other dialects are also spoken. Although much of the district has warm and humid climatic conditions, its northern regions have moderately cool temperatures.

2.1.2 Country-specific project risks

Country-specific risks affect education with respect to climate change, rural-urban migration, election, and currency fluctuations.

Climate change

Bhutan has three climatic zones: (a) the southern plains, which are subtropical and characterized by high humidity and heavy rainfall; (b) the central belt of flat valleys characterized by cool winters and hot summers with moderate rainfall; and (c) high valleys with cold winters and cool summers (Royal Government of Bhutan [RGoB], 2006). The southern plains experience monsoon from June to September during which flash floods and landslides are common occurrences. Snowfall is observed most of the time in the year in the high valleys.

Like other countries in the world, Bhutan is prone to climate change that will not only have a negative impact on its environment but also pose a threat to its sustainable development and the livelihoods of its people. This is because approximately 80% of the country's population depends on subsistence farming for their livelihoods (RGoB, 2014), which are prone to increasing climate change hazards. Further, many existing settlements are situated in increasingly hazard-prone areas, such as steep slopes or flood-prone riverbeds, which pose high degrees of risk.

Both monsoon and snowfall have an impact on education. In the southern plains, classes are often cancelled, as students are not able to travel to schools when the river is swollen or when bridges are washed away by incessant rain. In the high valleys, some of the schools remain open from April to September only (CDEO verbal communication). Further, some sections of students stay as day students. They have to walk long distances crossing rivers and mountains to reach schools (Pelden, 2019). They are exposed to the challenges of landslides, floods, swollen rivers, and other hazards. This concern raises the issue of equal access to education, as schools in Bhutan follow one common curriculum and practice. The students are also required to follow the same board examination both at the Dzongkhag level and at the national level.

The school infrastructure and facilities have not adapted to the climatic condition of the country. For example, schools in the high valley do not have a classroom heating system. Similarly, schools in southern plains might have fans installed to overcome the summer heat, but whether all fans are functional and whether the fans can keep the classroom temperature conducive for learning is a question.

Rural-urban migration

Many types of migration take place in Bhutan. According to the National Statistics Bureau of Bhutan (2018), migration is broadly classified as lifetime migration (Table 2.1) and resident migration (Table 3). The resident migration is a temporary migration.

Table 2.1: Migration status by gender

Lifetime migration status	Thousands			Percentages		
	Male	Female	Total	Male	Female	Total
Non-migrant	173.5	178.3	351.9	24.4	25.0	49.4
Internal migrant, rural-rural	61.6	57.7	119.3	8.7	8.1	16.8
Internal migrant, rural-urban	70.3	70.7	141.0	9.9	9.9	19.8
Internal migrant, urban-rural	13.3	12.8	26.1	1.9	1.8	3.7
Internal migrant, urban-urban	17.3	18.0	35.3	2.4	2.5	5.0
Immigrant, urban	13.4	1.8	15.1	1.9	0.3	2.1
Immigrant, rural	21.2	2.1	23.3	3.0	0.3	3.3
Total	370.5	341.4	712.0	52.0	48.0	100.0

It is evident from Table 2.2 that compared to other types of migration, rural-to-urban is the largest category of migrants with 141 thousand people, which is 19.8 per cent of the total population.

Table 2.2: Recent migration status by gender

Lifetime migration status	Thousands			Percentages		
	Male	Female	Total	Male	Female	Total
Non-migrant	255.7	262.2	517.9	35.9	36.8	72.7
Internal migrant, rural-rural	27.7	23.5	51.2	3.9	3.3	7.2
Internal migrant, rural-urban	23.4	23.2	46.7	3.3	3.3	6.6
Internal migrant, urban-rural	15.5	13.1	28.7	2.2	1.8	4.0
Internal migrant, urban-urban	16.4	16.2	32.6	2.3	2.3	4.6
Immigrant, urban	12.5	1.8	14.3	1.8	0.3	2.0
Immigrant, rural	18.9	1.4	20.3	2.7	0.2	2.9
Total	370.2	341.5	711.7	52.0	48.0	100.0

It is evident from Table 2.2 that nearly 7% of Bhutan's population falls under the recent rural-to-urban migration status. As per the report, Thimphu, the capital city of Bhutan has a 27.5% in-migration rate. Recent migration is by young adults, who seek employment, education, and marriage, with marriage being the least status. The male migration rate is higher when compared to females.

The migration practice leads to fallow agricultural land and empty households in villages. 4800 empty houses were reported in the 2017 census. Some of the reasons were the unsuitability of land for agriculture, human-wildlife conflict, lack of infrastructure like roads, poor access to drinking water and electricity, and shortage of employment opportunities in rural areas (Gelmo, 2020). The migration practice has an impact on education at both rural and urban levels. A number of rural primary schools are closed due to a lack of the required number of school-going children, resulting in the infrastructure being unused. Due to school closure, the remaining children travel long distances to attend a school or live in hostels at a very young age (current central school practice). Migration has increased pressure on the existing resources and infrastructure in urban areas.

Election: In Bhutan, the labour force considers education as a gateway where employability takes precedence over the value of education and prepares future citizens. Since the advent of democracy in the country, education has been given prominence on the political agenda of successive elected governments. The change in governments has impacted education policy, school curriculum, teacher preparedness, and infrastructure support, bringing many positive changes and enhancing the quality of education. However, some of the initiatives undertaken by the preceding government may not be given priority by the next government because of the party's own pledges. The specific examples are described in the following paragraphs.

Druk Phuensum Tshogpa's (DPT), the first elected government (2008-2013), established an *Education City* to raise the standard of education and to create knowledge centres through public-private partnerships (PPP). However, this initiative was not taken forward by the succeeding government.

The second elected government, the People's Democratic Party (PDP) (2013-2018) initiated a network of central schools (having boarding facilities from pre-primary) to provide an equitable education to economically disadvantaged communities. However, the succeeding government's priorities on these initiatives are yet to be studied.

The current Druk Nyamrup Tshogpa (DNT) government (2018-2023) has promised many initiatives in enhancing educational practices. The results are yet to be ascertained since the government is in force.

Currency fluctuation: The average income per person per day in Bhutan is Ngultrum (Nu) 40, which is less than a dollar a day, and the average income in rural areas is even lower at Nu 33 per day (SNV, 2017). More than one-third of the population lives below the poverty line. This may have implications for parents in educating their children. However, education is free in Bhutan up to higher secondary school (class XII) for all citizens of the country. This has helped many parents to educate their children in government schools or private schools.

Many parents in rural communities have difficulties in supporting their children and lack adequate resources. For instance, parents find it difficult to provide smartphones and laptops to their children for accessing online resources and learning. However, currency fluctuation in the country has a minimal impact on student learning for parents and children.

2.1.3 Impact of the COVID-19 pandemic

Since the outbreak of COVID-19, education has been hit hard like any other sector. Students, schools, colleges, and universities have been affected deeply. Following the outbreak of COVID-19, educational institutions were closed due to frequent lockdowns. Teaching and learning shifted from face-to-face to online virtual mode. Students and teachers faced a lot of problems during online sessions. Some of the key problems were parents' financial issues in providing smart phones for online learning, access to reliable and fast internet services, and their inability to subscribe 3G/4G data packages to support their children's online learning, as they reported such services to be expensive and unaffordable.

The Ministry of Education (MoE) initiated and offered online learning through radios, such as Bhutan Broadcasting Service, for the benefit of students who did not own smartphones or were located in remote areas. Further, Self-Instructional Materials (SIM) were developed for the benefit of the same group of students. Mobile classes were offered by subject teachers to lower grade students from PP-III. MoE initiated education in an emergency (EIE), which prioritized and adapted a curriculum from the existing one during the COVID-19 crisis (REC, 2020).

Students from high-risk areas were relocated to lower-risk areas. For instance, class X and XII students of Phuntsholing (southern Bhutan) were relocated to the central part of Bhutan. The 'New Normal' curriculum was developed by the Royal Education Council (REC) of Bhutan and was implemented in schools from the academic year of 2021. The examination was postponed in higher and middle secondary schools. However, examinations in lower secondary schools were replaced by continuous assessment components online. In the colleges of the Royal University of Bhutan (RUB), online examinations were conducted through a virtual learning environment (VLE).

Teachers in schools and colleges use various ICT tools to develop and deliver online lessons. However, they face numerous challenges due to a lack of adequate skills and knowledge about ICT tools and techniques (Tamang et al., 2021). Lack of adequate resources is one of the challenges faced by teachers during online sessions. Further, teachers are continuously engaged in preparing and developing online lessons, which resulted in a heavy workload and more time consumption. Monitoring students' online learning was found to be challenging and ineffective.

Besides academic constraints, COVID-19 poses challenges to school managers. P4 stated that plans and activities could not be carried out especially during the lockdown. However, he said that some of the activities could be completed with proper planning and contingency plans. P4 asserted that COVID-19 made a tremendous impact, as it disturbed the whole education system and complicated the management of human resources and curriculum.

COVID-19 continues to pose tremendous challenges in teaching and learning in the nation. However, teachers got opportunities to explore various online teaching and learning tools and techniques. The pandemic helped teachers to upscale and enhance their competencies to teach online classes effectively by using various ICT tools and social media apps. For instance, P3 said, "the role of ICT was exceptional in the sense that it kept everyone on toes and even the most digitally backward got awakened. Had it not been for COVID-19, ICT would have remained a dream for many teachers". Despite the continuous effort put in by teachers, the status of quality of teaching and learning is not known.

2.2 Education System

2.2.1 Education administration

Figure 2.1 shows the organogram of the MoE, Bhutan.

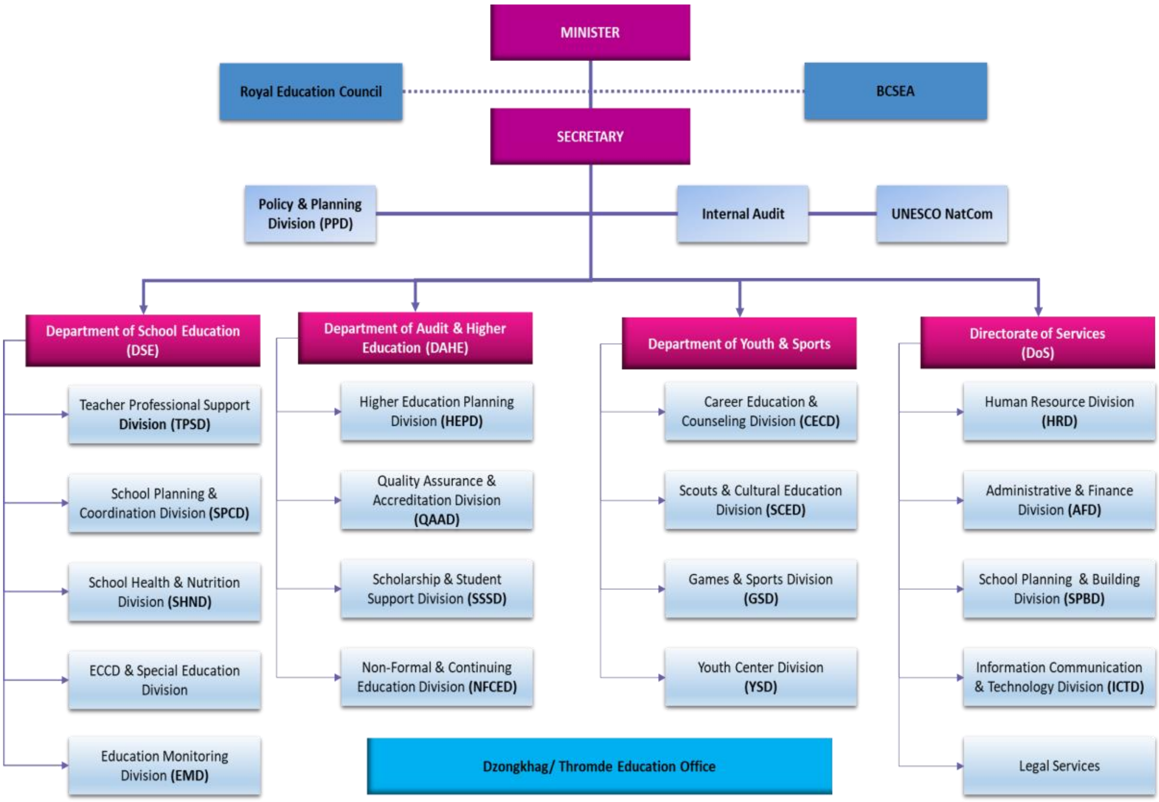

Figure 2.1: Organogram

(MoE, 2021)

The Education Minister is the head of the ministry. The MoE has four departments: Department of School Education (DSE), Department of Adult & Higher Education (DAHE), Department of Youth & Sports (DYS), and Directorate of Services (DoS). Besides, the ministry has two bodies, namely, REC and Bhutan Council for School Examination and Assessment (BCSEA). REC looks after the curriculum matters of the school and BCSEA takes care of examinations and assessments.

The organizational structure of Dzongkhag education (school included) is shown in Figure 2.2.

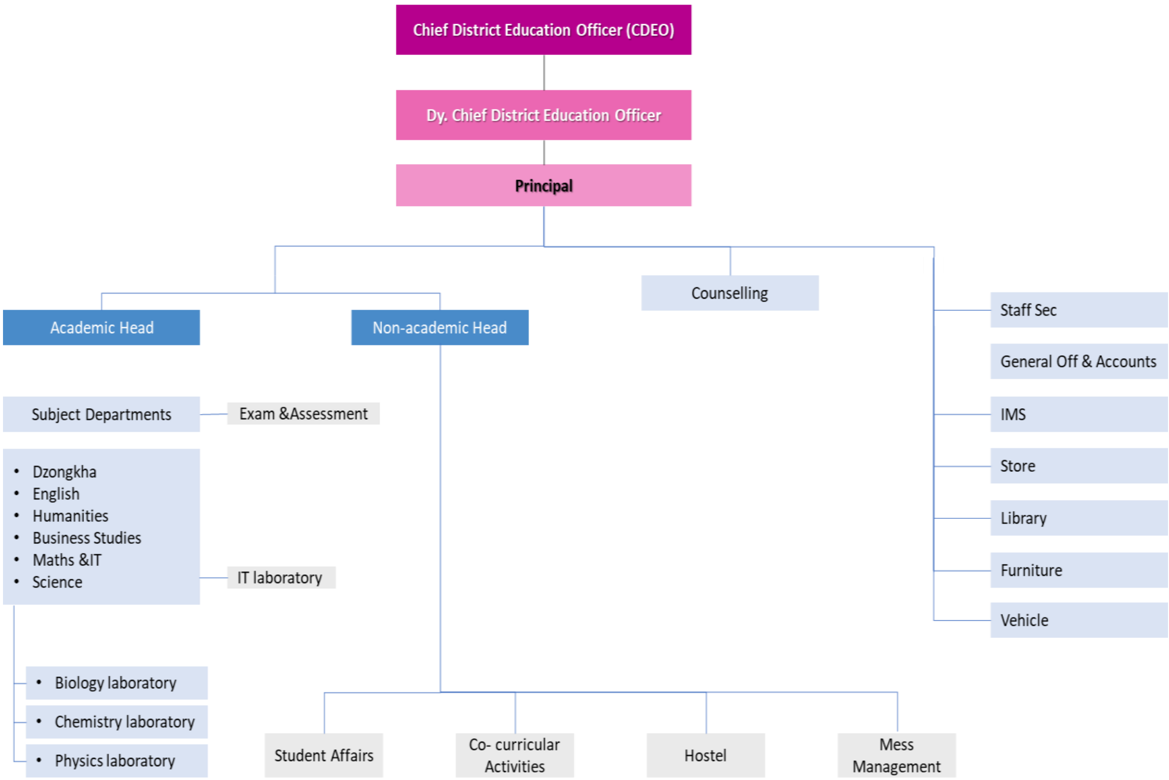

Figure 2.2: Organizational structure of Dzongkha education

The Academic Head looks after academic matters and supervises the subject departments and exam and assessment committees. Lead teachers, though not reflected in the organogram, support the Academic Head.

2.2.2 Education policy and funding

Policy: The state education policy (MoE, 2019 draft) states that:

a. The State shall endeavour to provide education for improving and increasing knowledge, values, and skills of the entire population and direct education towards the full development of human personality.
b. The State shall provide free education to all children of school-going age up to the tenth standard and ensure that technical and professional education is generally available and that higher education is equally accessible to all based on merit.

However, the current government DNT has started offering free education to all school-going children up to the twelfth standard from the 2019 academic year. Students who opt to study in private schools are financially supported by the government (Drukpa, 2021).

Out of the many policies on education, this study focused on the allocation of instructional hours, ICT, students with special needs, and teachers' professional development.

On the instructional hours, the policy states, "The annual school academic calendar shall ordinarily consist of 800 instructional hours delivered over 150 instructional days. Variations to this will consider class cohorts, seasonal conditions, and other relevant factors. Details on instructional hours shall be maintained and reviewed periodically in school management and operational guidelines" (MoE, 2014, p32). Schools are mandated to follow a period of 50 minutes to achieve the instructional hours required per academic year for each subject. However, some schools follow instructional hours of 45 minutes to 1 hour, but care is taken to meet the total instructional hours. The total instructional hours in secondary schools (middle) is divided among the various subjects (current practice), as reflected in Table 2.3.

Table 2.3: No of periods allocated per subject

Sl. No.	Subject	No of periods (50 minutes) allocated per week
1	English	6
2	Dzongkha	6
3	Mathematics	5
4	All other subjects	3

However, Classes XI and XII get an almost equal number of instructional hours for all subjects. Extra classes are carried out beside the instructional hours to cover the syllabus (MoE, 2014).

On ICT, the education policy states that ICT shall be promoted in schools through adequate resources to leverage the power of ICT in teaching and learning (MoE, 2019). Until 2019, ICT was offered only in classes IX to XII as an optional subject. However, understanding the importance of ICT, the MoE has started offering ICT as a compulsory subject from classes PP to XII in various years (REC, 2021), as reflected in Table 2.4.

Table 2.4: ICT classes

Sl. No.	Start year	Classes
1	2017	IV - VI
2	2018	VII-VIII
3	2019	IX
4	2020	PP-X
5	2021	XI-XII

However, some schools started offering ICT as a subject later than the stated year due to a lack of infrastructure and equipment.

On children with special needs, the policy states, "Schools shall put in place appropriate measures for all students, including children with special educational needs, across all grades to ensure equitable access to and participation in school. This includes support with specialized, appropriate educational services and facilities, including trained personnel" (MoE, 2019, p5). Some schools in Samtse, Thimphu, Paro, and Trashigang Dzongkhag cater to special children especially. Paro College of Education is mandated to train teachers to teach students with special needs. However, diverse learners' needs are catered to in every school. Teachers undertake professional development (PD) programs to upscale their pedagogical practices and knowledge on subject content. Each teacher is mandated to undertake 80 hours of PD in a year (MoE, 2014).

Education funding: The capital budget layout for the 7th to 12th 5-year plan for MoE and RUB (GNHC, 2016, p.47; MoE, 2014, p.116)) is reflected in Table 2.5 and Table 2.6.

Table 2.5: Education budget outlay for 5-year plan in million ngultrums for MoE

Budget	7th Plan (1992-1997)	8th Plan (1997-2002)	9th Plan (1997-2007)	10th Plan (2007-2013)	11th Plan (2013-2018)	12th Plan (2019-2023)
Total Government Budget	15,590.70	34,981.70	70,000.00	73,611.76	92,000.00	1,15,364.00
Education Budget	1,738.00	3,292.70	10,209.40	9,489.10	7438.74	3,500.00

The total education budget outlay is divided among the 20 Dzongkhags schools.

Table 2.6: Education budget outlay for 5year plan in million ngultrums for RUB

Budget	11th Plan (2013-2018)	12th Plan (2019-2023)
Total Government Budget	92,000.00	1,15,364.00
Education Budget for RUB	1086.45	1000

The total education budget outlay for RUB is divided among the colleges.

2.2.3 Academic structure

The present education system is an outcome of decades of planned development and has always played a central role in the pursuit of political, cultural, environmental, and socio-economic development of the country as a unique, progressive, peaceful, and sovereign nation. The school education system consists of seven years of primary education (PP-VI), two years of lower secondary education (VII-VIII), two years of middle secondary education (IX-X), and two years of higher secondary education (XI-XII).

The REC (2021) adapted the UNESCO-IBE module with eight stages of the curriculum cycle starting from curriculum dialogue and formulation, curriculum design, system management and governance, development of textbooks and teaching-learning materials, capacity building for curriculum implementation, processes of curriculum implementation, and curriculum evaluation and student assessment.

The 21st-century education elucidates the study of core subjects where interdisciplinary themes of global awareness, financial, economic, business and entrepreneurial literacies, and civic, health and environment literacies are integrated. It should foster the learning of innovative skills, life and career skills, and information, media, and technology skills. It should be diversified to accommodate the study of many current and emerging learning areas (REC, 2021).

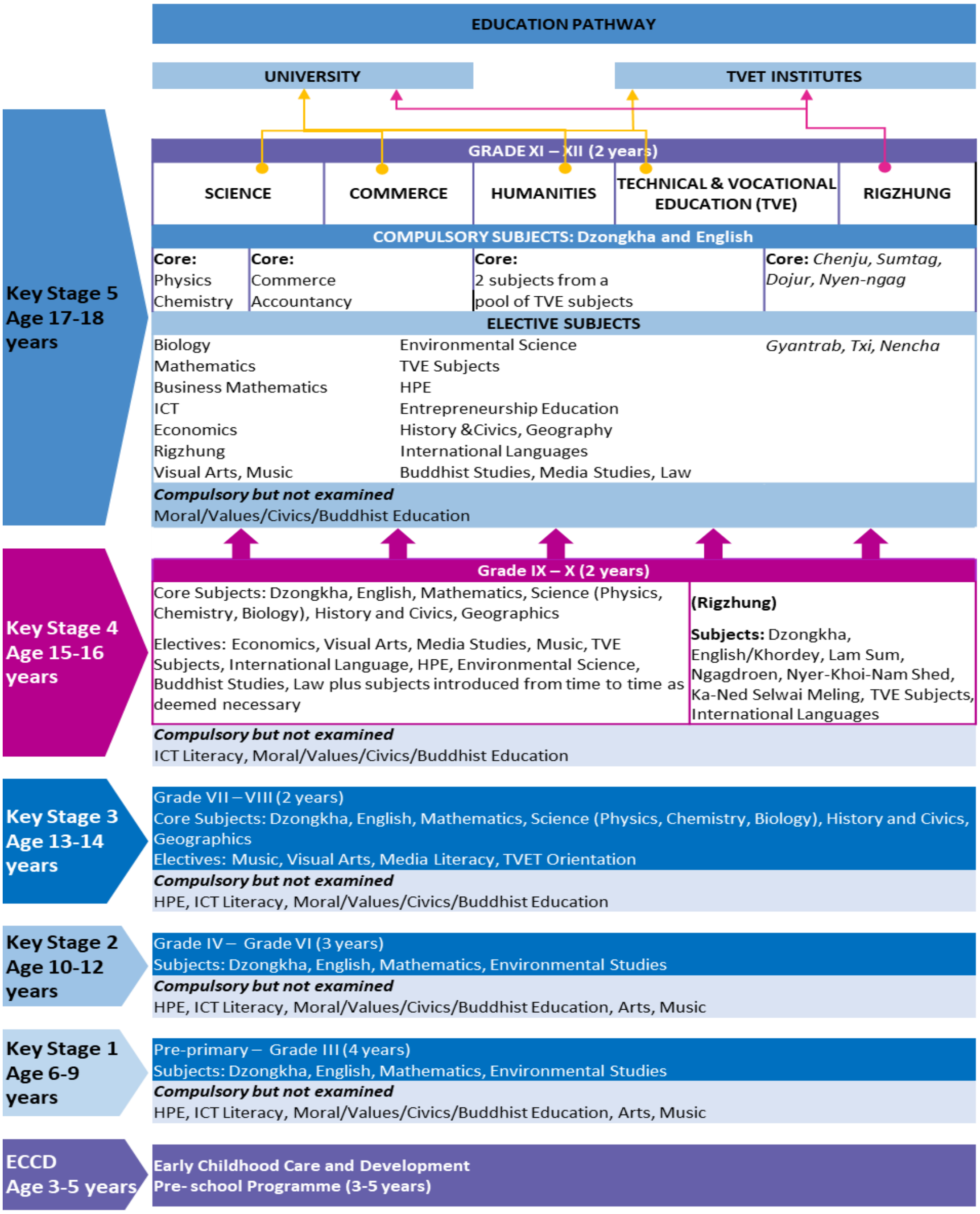

Figure 2.3: Education pathway and the core and elective subjects at different levels

(Adopted from MoE, 2014)

Note: ICT education begins from class PP to X as a compulsory subject.

The STEM education in Bhutan has undergone many changes to suit the emerging needs of learners in Bhutan. The subjects follow a spiral curriculum as shown in Figure 2.3. Science as a subject is not included in key stage 1, but Mathematics is included. In key stages 2 and 3, students study General Science consisting of Physics, Chemistry, and Biology content. In key stages 4 and 5, Science is bifurcated into Physics, Chemistry, and Biology. However, in key stage 5, students can choose between Mathematics and Biology whereas Physics and Chemistry are compulsory.

2.2.4 Teacher education and service conditions

The government has accorded the highest priority to education since the inception of modern education in the early 1960s. In Bhutan, secondary teachers are trained at the SCE of RUB. The college offers courses on B.Ed. (Secondary), PgDE, and M.Ed. After the completion, of course, they are placed in secondary schools of Bhutan by the MoE.

Bhutan considers teachers as the cornerstone of the education system and they need to be constantly updated with the latest knowledge and teaching strategies. This can be done through continuous professional development to result in effective classroom delivery. Considering the importance, the Human Resource Policy (THRP) 2014 and In-Service Education of Teachers (INSET) Master Plan mandated that every teacher receive a minimum of 80 hours of need-based PD program in a year. The MoE has established the Teacher Professional Support Division (TPSD) under the DSE in 2016 to oversee the PD process and monitor its effectiveness.

The analysis of survey data revealed that STEM teachers attended on an average of 22.3 - 28.3 hours of PD in a year, which is much lesser than the actual requirement of 80 hours, as evidenced from Table 2.7.

Table 2.7: Information on PD attended by STEM teachers in the last three years

PD	2018		2019		2020	
	Average no. of PD	Average no of hours of PD	Average no. of PD	Average no of hours of PD	Average no. of PD	Average no of hours of PD
Focused on STEM content	0.3	5.9	0.4	6.7	0.4	6.6
Focused on ICT-enabled teaching	0.5	1.4	0.5	2.3	0.9	5
Area others than STEM	1.1	15.2	1.4	19.3	1.5	10.7
Total	1.9	22.5	2.3	28.3	2.8	22.3

As per the MoE (2014), teachers are required to teach a maximum of 18-22 hours per week, which approximately calculates to 5 periods of 50 minutes every day. Further, the Bhutan Education Blueprint 2014-2024 recognizes the need to ensure a conducive classroom environment by equipping classrooms with dynamic teaching-learning resources, maintaining an ideal class size of 24 for primary schools and 30 for secondary schools. However, in reality, most schools in the urban areas are overcrowded and schools located in remote areas have few students in the class (Kaka, 2017). Further, the teacher survey data of this study revealed that most teachers in the schools have more than 30 hours of teaching workload per week.

In terms of monetary remuneration, teachers are one of the highest-paid civil servants in the country. They also get the opportunity to opt for in-country and ex-country training or conduct a study related to teaching and learning with the government's funding support. Further, they are promoted to the next higher level after serving for a certain number of years at a particular level.

2.2.5 Quantitative indicators of schooling

Quantitative indicators of schools show the ICT facilities, the number of STEM students, and students who own smart phones in the schools of five districts.

Table 2.8: Dzongkhag wise information about schools

School district		Name of the school	The lowest class in school	Highest class in school	Number of full-time teachers	Number of teachers teaching STEM subjects	Number of full-time non-teaching staff
Thimphu	Thimphu Dzongkhag	Yangchen Gatshel MSS	PP	X	26	9	26
		Wangbama CS	IX	XII	28	12	28
		Khasadrapchu MSS	PP	X	48	13	23
		Kuzhugchen MSS	PP	X	31	5	6
	Thimphu Thromde	Babesa HSS	VII	XII	32	11	11
		Zilukha MSS	PP	X	50	5	5
		Yangchenphu HSS	VII	XII	62	24	11
Zhemgang		Sonamthang CS	VII	XII	44	12	25
		Buli CS	PP	X	29	8	11
Paro		Shari HSS	IX	XII	33	11	8
		Drukgyel CS	IX	XII	39	17	47
		Khangkhu MSS	PP	X	44	11	7
		Lamgong MSS	PP	X	53	6	8
Trashigang		Gongthung HSS	PP	X	25	7	10
		Dungtse CS	VII	X	25	10	10
		Bartsham HSS	VII	XII	30	11	11
		Tashitse HSS	IX	XII	26	8	12
		Dungtse MSS	VII	X	23	9	20
Samtse		Yoeseltse	PP	X	30	7	8
		Peljorling HSS	PP	XII	66	12	12
		Gomtu HSS	PP	XII	68	30	9
		Tendruk CS	PP	XII	81	19	10
		Dorokha HSS	IX	XII	33	11	20
		Samtse HSS	IX	XII	32	10	14

Table 2.9: ICT facilities available in the schools of six districts, as per the analysis of Principals' survey

School district		Name of the school	Number of devices in school											
			Laptops	Desktops	Projectors	Printers	Photocopiers	generator/Inverter/UPS	Tablets	Smart boards	Smart TVs	Scanners	Web Cameras	Sound system
Thimphu	Thimphu Dzongkhag	Yangchen Gatshel MSS	12	35	16	6	2	2	36	1	5	2	4	2
		Wangbama CS	11	68	18	5	2	3	0	0	2	1	2	2
		Khasadrapchu MSS	6	55	16	8	1	0	0	0	0	1	20	1
		Kuzhugchen MSS	33	56	17	5	2	0	0	0	8	1	0	0
	Thimphu Thromde	Babesa HSS	0	40	9	6	2	0	0	0	0	0	0	2
		Zilukha MSS	6	77	12	5	1	4			3	1		3
		Yangchenphug HSS	10	60	32	6	1	0	0	0	0	0	0	2
Zhemgang		Sonamthang CS	5	45	12	3	1	1	0	0	0	0	3	1
		Buli CS	5	42	17	6	0	1	0	2	3	2	9	3
Paro		Shari HSS	3	60	6	5	2	0	0	1	1	2	0	2
		Drukgyel CS	0	50	12	11	2	1	0	2	2	2	0	1
		Khangkhu MSS	3	60	9	3	1	0	0	1	1	3	0	1
		Lamgong MSS	4	90	3	4	1			1	2			
Trashigang		Gongthung HSS	1	30	4	4	1	0	0	4	2	0	0	1
		Dungtse CS	0	23	1	5	1	0	0	0	4	1	20	
		Bartsham HSS	22	43		5	2	0	0	0	1	0	0	1
		Tashitse HSS	0	40	2	3	0	0	0	0	1	3	0	1
		Dungtse MSS	4	30	1	6	1	0	0	0	5	2	0	0
Samtse		Yoeseltse	0	22	7	2	0	0	0	0	0	0	0	1

School district		Number of devices in school											
	Name of the school	Laptops	Desktops	Projectors	Printers	Photocopiers	generator/Inverter/UPS	Tablets	Smart boards	Smart TVs	Scanners	Web Cameras	Sound system
	Peljorling HSS	1	18	1	4	2	0	0	0	0	1	0	1
	Gomtu HSS	1	35	3	5	1	0	0	0	3	1	0	3
	Tendruk CS	4	85	5	5	2	0		0	0	1	1	2
	Dorokha HSS	4	40	0	1	0	0	0	0	0	1	0	1
	Samtse HSS	0	40	2	2	1	0	0	0	17	2	0	2

Table 2.10: Total % of students who own smartphones

School district		Name of school	Students who own a smartphone (%)	Total No. of students in school											
				Class IX			Class X			Class XI			Class XII		
				M	F	T	M	F	T	M	F	T	M	F	T
Thimphu	Thimphu Dzongkhag	Yangchen Gatshel MSS	40	31	30	61	27	41	68						
		Wangbama CS	50	35	44	79	45	45	90	73	85	158	38	73	111
		Khasadrapchu MSS	85	123	73	196	87	33	120						
		Kuzhugchen MSS	90	24	21	45	14	16	30						
	Thimphu Thromde	Babesa HSS	40.7	31	35	66	39	49	88	28	52	80	41	48	89
		Zilukha MSS	90	88	88	176	54	51	105						
		Yangchenphug HSS	95	56	71	127	95	105	200	171	255	426	191	230	421
Zhemgang		Sonamthang CS	30	68	73	141	73	69	142	41	62	103	54	73	127
		Buli CS	34	34	38	72	43	55	98						
Paro		Shari HSS	90	39	37	76	40	38	78	97	83	180	59	70	129
		Drukgyel CS	100	72	89	161	62	107	169	87	92	179	67	107	174
		Khangkhu MSS	98	69	61	130	47	61	108						
		Lamgong MSS	80	35	33	68	33	30	63						
Trashigang		Gongthung MSS	0	15	33	48	26	31	57						
		Dungtse CS	50	50	73	123	49	61	110						
		Bartsham HSS		49	66	115	61	75	136	62	75	137	59	66	125
		Tashitse HSS		41	37	78	29	44	73	76	76	152	71	72	143
		Dungtse MSS		50	73	123	50	61	111						
Samtse		Yoeseltse MSS	10	35	35	70	31	40	71						
		Peljorling HSS	80	123	129	252	86	109	195	57	55	112	44	49	93
		Gomtu HSS	60	73	78	151	43	51	94	21	55	76	20	28	48
		Tendruk CS	30	126	125	251	143	118	261	57	51	108	42	61	103
		Dorokha HSS	50	123	139	262	111	130	241	42	32	74	40	33	73
		Samtse HSS	80	126	52	178	137	71	208	134	68	202	145	77	222

Table 2.11: Number of students taking STEM subjects

School districts		Name of school	Total No. of students taking STEM Subjects											
			Class IX			Class X			Class XI			Class XII		
			M	F	T	M	F	T	M	F	T	M	F	T
Thimphu	Thimphu Dzongkhag	Yangchen Gatshel MSS	31	30	61	27	41	68						
		Wangbama CS	35	44	79	45	45	90	13	13	26	4	9	13
		Khasadrapchu MSS	50	73	123	54	33	87						
		Kuzhugchen MSS	24	21	45	14	16	30						
	Thimphu Thromde	Babesa HSS	31	35	66	39	49	88	39	52	91	41	48	89
		Yangchenphug HSS	56	71	127	95	105	200	42	60	102	52	71	123
Zhemgang		Sonamthang CS	68	73	141	73	69	142	11	12	23			
		Buli CS	34	38	72	43	55	98						
Paro		Shari HSS	39	36	75	40	38	78	12	13	25	8	11	19
		Khangkhu MSS	69	61	130	47	61	108						
		Lamgong MSS		46	46	63	30	93						
Trashigang		Gongthung MSS	15	33	48	26	31	57						
		Dungtse CS	50	73	123	49	61	110						
		Bartsham CS	49	66	115	61	75	136	11	12	23	11	14	25
		Tashitse HSS	78	37	115	73	44	117	60	30	90	60	30	90
		Dungtse MSS	50	73	123	50	61	111						
Samtse		Yoeseltse HSS	35	35	70	31	40	71						
		Peljorling HSS	123	129	252	86	109	195	20	15	35	17	10	27
		Gomtu HSS	73	78	151	43	51	94	12	19	31	8	8	16
		Tendruk CS	126	125	251	118	118	236	18	16	34	19	12	31
		Dorokha HSS	123	139	262	111	130	241	0	0	0	0	0	0
		Samtse HSS	74	52	126	66	71	137	38	18	56	21	17	38

2.2.6 National assessments of literacy, numeracy, and STEM skills

The national assessment status of the country is discussed under three headings, viz. Programme for International Student Assessment for Development (PISA-D) Report, BCSEA result, and Analysis of Survey Questionnaire – specifically the pass percentage of classes X and XII.

PISA-D National Report 2019: More than 2000 Bhutanese students aged between 15 and 16 years attended the PISA-D test in 2007 (Zangmo, 2017). PISA-D was conducted by the Organization for Economic Cooperation and Development (OECD). The assessment focused on three areas, namely, numeracy, literacy, and science.

Mathematics/numeracy: In PISA-D, the numeracy skills of students were assessed on four parameters, namely, quantity, change and relationships, space and shape, and uncertainty and data. Bhutan's students achieved an average solution rate of 38.84% in the PISA-D 2017 mathematical literacy assessment, which was significantly higher than the PISA-D average solution rate of 30.65%. Boys performed better than girls in Mathematics (BCSEA, 2019). PISA-D findings also revealed that students in Bhutan performed significantly better in comparison to top PISA-D countries, but slightly (2% to 4%) below students in Sweden, and significantly below students in Singapore.

Further, the PISA-D highlighted the strengths and weaknesses of Bhutanese students. The students were good at interpreting, applying, and evaluating mathematical outcomes when compared to students of most of the PISA-D countries. However, they found it difficult to formulate situations mathematically, and with tasks related to the content area.

Scientific literacy: In PISA-D 2017, students were assessed on three areas, namely, scientific competencies, scientific knowledge, and attitude towards science. The results revealed that the students achieved an average solution rate of 45.10% in scientific literacy assessment, which was significantly higher than the PISA-D average solution rate of 38.28%. The findings also revealed that boys performed better than girls in science. Students in Bhutan performed significantly better than those of top PISA-D countries. The results highlighted that Bhutan's solution rates were better than low performing PISA reference countries and almost at par with the OECD average while considering the common PISA items (BCSEA, 2019).

Although Bhutan performed better than most PISA-D countries, a huge performance gap was found between Bhutan and PISA countries. Bhutan's performance is about 23 to 35 points (% points) below OECD averages. Moreover, Bhutanese students' weaknesses were identified primarily in items that require interpretation of data.

Table 2.12: Dzongkhag wise pass percentage in STEM for classes X and XII

School District		Name of school	Class X overall pass %			Class X pass % in STEM			Class XII overall pass %			Class XII pass % in STEM		
			2018	2019	2020	2018	2019	2020	2018	2019	2020	2018	2019	2020
Thimphu	Thimphu Dzongkhag	Yangchen Gatshel MSS		83.05	95.16		83.05	95.16						
		Wangbama CS	94.40	96.23	98.97	94.40	96.23	98.97	92.60	94.40	98.97	92.64	94.38	98.97
		Khasadrapchu MSS	96.94	94.06	100.00	96.90	94.40	100.00						
		Kuzhugchen MSS	100.00	100.00	100.00	100.00	100.00	100.00						
	Thimphu thromde	Babesa HSS	95.80	98.70	93.54	78.90	86.50	82.90			92.31			83.33
		Zilukha MSS	96.10	93.80	95.90									
		Yangchenphug HSS	96.76	99.1	99.00	95.00	98.00	97.00	88.45	95.02	96.91	86.50	95.47	92.60
	Zhemgang	Sonamthang CS	100.00	0.88	100.00		88.28	100.00						
		Buli CS	100.00	96.00	88.00	100.00	96.00	63.00						
	Paro	Drukgyel CS		98.00	100.00						100.00			
		Khangkhu	100.00	100.00	100.00	65.00	74.00	75.00						
		Lamgong MSS	92.00	98.60	91.30									
	Trashigang	Gongthung MSS	100.00	100.00	100.00	100.00	100.00	100.00						
		Dungtse CS	100.00	95.8	100.00	100.00	95.50	100.00						
		Bartsham HSS	100.00	97.40	96.50	99.00	94.60	93.00			91.00			81.90
	Samtse	Peljorling HSS	92.6	94.30	94.12				100.00	90.40	95.80			
		Gomtu MSS	96.10	89,05	97.10	94.60	88.00	70.80			94.70			87.50
		Tendruk CS	84.00	83.00	89.70	15.00	13.00	8.00	85.00	94.00	93.67	80.00	90.00	90.00
		Dorokha HSS		89.00	95.96		85.00	92.00						
		Samtse HSS	88.40	91.87	98.50	70.65	83.34	82.00	86.71	90.38	97.60	94.00	96.00	97.00

**Black cells indicate missing data or not applicable.*

Table 2.12 depicts the overall pass percentage and STEM pass percentage for classes X and XII for the last three consecutive years in six districts. Overall pass percentage showed a linear progression from 2018 to 2020 for classes X and XII. Similarly, the pass percentage in STEM subjects showed the same kind of progression over the years for classes X and XII.

Table 2.13: showing Grade X and XII pass percentages for 2018, 2019, and 2020

Grade	Subject	2018			2019			2020		
		Gender			Gender			Gender		
		Male	Female	TOT	Male	Female	TOT	Male	Female	TOT
X	Mathematics	96.97	97.04	97.01	88.44	86.1	87.16	79.45	78.34	78.94
	Physics	95.33	95.15	95.23	90.97	87.82	89.24	96.63	97.79	97.17
	Chemistry	83.78	85.20	84.55	78.26	79.96	79.19	97.26	96.83	97.06
	Biology	94.57	94.21	94.37	95.98	95.52	95.73	90.15	88.72	89.40
XII	Mathematics	91.82	94.07	92.56	79.31	81.11	79.92	87.85	88.21	87.97
	Physics	98.48	98.95	98.68	96.31	95.62	96.02	97.64	98.05	97.83
	Chemistry	92.94	94.73	93.71	95.63	97.02	96.25	96.68	98.76	97.62
	Biology	99.00	99.05	99.03	99.62	99.48	99.53	98.97	99.39	99.21

(BHSEC, 2019; BHSEC, 2020; BHSEC, 2021)

Table 2.13 shows the pass percentage for Mathematics and Science of grades X and XII for three consecutive years, viz. 2018, 2019, and 2020.

2.3 ICT In Education

2.3.1 Attitudes and practice concerning ICT in education

ICT is having an impact on the way students learn. The effect of ICT is felt more when data are exchanged over the internet of things and cloud computing to provide intelligent automation through artificial intelligence (MoE, 2019). The education system has to be responsive to such trending technologies and prepare students to participate meaningfully and productively in the digital world. In response to this, the MoE has been initiating the introduction of ICT in schools for all class levels since 2017. By 2021, it is envisioned that ICT subjects are taught across classes PP-XII. However, in practice, ICT subjects are yet to be introduced in some classes and schools. This is mainly because of the COVID-19 pandemic, schools' readiness in terms of infrastructure and equipment, and teachers' capabilities.

All interviewees of this study expressed that ICT played a vital role in continuing teaching and learning in schools during the COVID-19 pandemic. In order to cope with the online teaching, all four interviewed CDEOs reported that teachers were trained to use online teaching strategies. Nevertheless, internet speed, lack of proper infrastructure, minimal exposure of students, teachers' minimal knowledge on the use of ICT in teaching, and additional expenses by teachers and parents on data packages, are the challenges faced by all concerned (A5, A2b, A, A1, C3, C1). In schools having a large number of students, access to ICT could not be provided to every student. Hence, access to ICT was prioritized for students preparing for high stake examinations (C2a). In addition, some teachers were said to be technophobic, while few teachers were the least bothered to enhance their ICT knowledge (A2a).

2.3.2 Teacher proficiency in ICT in education

The teaching profession is not an exception in the wave of ICT-driven change. The role of teachers is unique in this context, as they have to embrace ICT as a way of life and be the agents of ICT-based human capital development (Alazam et al., 2012). The need to enhance the ICT capacity of teachers is considered a key intervention to ensure the successful integration of ICT into teaching. Bhutan Education Blueprint 2014-2024 states that teachers need to use ICT pervasively in their teaching to improve the quality of education.

Since most of the teachers have not studied ICT subjects in their school/college/teacher training period, they need to undertake PD programs focused on ICT-enabled teaching. Table 15 shows the PD programs undertaken by the teachers of five Dzongkhags.

Table 2.14: Number of PD and time spent for each PD by the teachers

Dzongkhag		No. of STEM teachers	The average number of PD attended in the year (focused in ICT)			Number of hours of PD attended in the year (focused in ICT)		
			2018	2019	2020	2018	2019	2020
Thimphu	Thimphu Dzongkhag	16	0.56	0.63	1.56	0.75	0.75	4.06
	Thimphu Throm	39	0.59	0.64	0.82	0.82	0.63	2.41
Zhemgang		16	2.06	1.13	1.94	2.13	2.00	2.38
Paro		12	0.17	0.67	1.25	0.75	2.38	10.33
Trashigang		29	0.28	0.24	0.31	0.97	0.56	1.34
Samtse		53	0.13	0.32	0.79	2.15	5.13	2.87

The above table indicates that the average number of PD in ICT undertaken by the teachers is minimal. This is in line with the interview data where all interviewees said that teachers' had minimal knowledge on the use of ICT to support teaching. The survey also revealed that many teachers did not attend any PD in three years, whereas a few teachers attended more than 80 hours in a year. Most of the NQT did not attend any PD. This is in line with the interview data. According to a lead teacher (L4), "Compared to previous years, PD at both cluster and school levels reduced due to frequent closing of schools. Despite all the challenges posed by COVID-19, PD requirements of needy schools were addressed by having face-to-face and online meetings".

2.3.3 ICT in education infrastructure and resources

Access to infrastructure and the internet are prerequisites for the successful integration of ICT in teaching and learning. Recognizing the importance of the internet and computers in enhancing the quality of education, the SDG indicator 4.a.1(MoE 2020) emphasizes the need for member countries to increase the proportion of schools with good access to the internet and computers for pedagogical purposes. Although the majority of secondary schools and a few primary schools in Bhutan are connected to the internet, the iSherig-II Review Report (MoE, 2019a) indicates that most of these schools are still challenged with inadequate bandwidth. In addition, all secondary schools have a computer lab with 10 to 32 working computers. However, the computer labs in most of these schools are adequate only for delivering the existing ICT literacy curriculum.

Equipment and digital learning resources: The information on ICT devices owned and used to support teaching by teachers in the five Dzongkhag schools is reflected in Table 2.15.

Table 2.15: Device owned and used by teachers for teaching and learning

Dzongkhag		No. of STEM teachers	ICT devices owned by the teacher (%)		ICT devices teachers frequently used in teaching (%)			
			Laptop	Smart phone	Laptop	Smartphone	Projector	Smart TV
Thimphu	Thimphu Dzongkhag	16	100.00	93.70	100.00	93.70	93.70	12.50
	Thimphu Throm	39	94.87	92.31	94.87	92.31	82.05	15.63
Zhemgang		16	93.75	81.25	93.75	81.25	93.75	0.00
Paro		12	100.00	91.67	100.00	91.67	100.00	0.00
Trashigang		29	100.00	97.44	100.00	97.44	92.31	0.24
Samtse		53	94.34	81.13	94.34	81.13	62.26	33.96

Table 18 shows that almost all the teachers own a laptop and a smartphone. They use these devices to support their teaching and learning. A small section of schools in Thimphu, Trashigang, and Samtse are said to use smart televisions. Besides, the table shows that projectors are used in classrooms during teaching. It is also revealed that only 62.26% of teachers in Samtse Dzongkhag use a projector. This could be because 33.96% of teachers use smart televisions.

The use of printers and photocopiers was not prominent in the survey data, though few teachers mentioned using them.

As per the Principals' survey data, the percentage of students having access to smartphones is reflected in Table 2.16.

Table 2.16: Students having access to smartphones

Dzongkhag		Percentage of students who have access to a smartphone (approx. %)
Thimphu	Thimphu Dzongkhag	40-90
	Thimphu Throm	40-95
Zhemgang		30-34
Paro		1-98
Trashigang		0-50
Samtse		10-80

Table 19 shows that some school students in two Dzongkhags do not have access to smartphones. One of the Principals of Trashigang Dzongkhag mentioned that students do not have access to smartphones due to the school's policy.

This study also looked at the various means of communication, the use of digital multimedia, and engagement in online teaching. The information generated from the survey is presented in Table 2.17.

Table 2.17: Communication tools used by teachers

Dzongkhag		Email (%)	Social Media (%)	News (%)	Education resources (%)	Online teaching (%)
Thimphu	Thimphu Dzongkhag	100	100	100	100	100
	Thimphu Throm	82.05	100	100	100	100
Zhemgang		87.50	100	100	100	100
Paro		100	100	100	100	100
Trashigang		89.74	100	100	100	100
Samtse		77.36	100	100	100	100

Table 2.17 shows that most of the teachers use email to communicate. Besides, all teachers use social media apps to communicate. Social media apps are mostly used to get the news.

The teachers were asked to choose the digital applications to support their teaching. All teachers selected videos as the commonly used application. This was supported by a lead teacher (L4). Besides, many teachers mentioned the usage of Google docs and PowerPoint. Only some teachers chose simulation, Kahoot, and Mentimeter. All teachers were engaged in online teaching and used online forums.

Infrastructure: The data collected on the school profile showed that all schools had a functional ICT laboratory. Besides, Table 2.18 shows other infrastructures that supported the delivery of lessons through ICT devices. All the Dzongkhags have functional laptops and desktops. However, in some Dzongkhags, the number was found to be less. One of the interviewees said that an ICT lab with 30 computers is inadequate for 600 students (C1).

Table 2.18: ICT infrastructure available in the school

Dzongkhag		Number of functional ICT infrastructure											
		L	D	P	Pr	Ph	G	T	SB	ST	S	WC	SS
Thimphu	Thimphu Dzongkhag	62	214	67	24	7	5	36	1	15	5	26	5
	Thimphu Throm	16	177	53	17	4	4	0	0	3	1	0	7
Zhemgang		10	87	29	9	1	2	0	2	3	2	12	4
Paro		10	260	30	23	6	1	0	5	6	7	0	3
Trashigang		27	166	8	23	5	0	0	4	13	6	20	3
Samtse		10	240	18	19	6	0	0	0	20	6	1	10

L=Laptop; D=Desktop; P=Projector; Pr=Printer; Ph=Photocopier; G=Generator/Inverter/UPS; T=Tablet; SB=Smartboard; ST=Smart TV; S=Scanner; WC=Web Camera, SS=Sound System

Internet connectivity and power

Table 2.19 shows the type of internet connectivity and availability of ICT infrastructure in the Dzongkhag schools.

Table 2.19: Internet and power connection

Dzongkhag		Type of Internet connection	Data speed of internet connection speed (MBps)	Availability of ICT infrastructure [Electricity]	Availability of ICT infrastructure [Internet]	Availability of ICT infrastructure [Computers]
Thimphu	Thimphu Dzongkhag	Fiber optics	11-20 Mbps	Most of the time	Most of the time	Most of the time
	Thimphu Throm	Fiber optics	11-20 Mbps	Most of the time	Most of the time	Most of the time
Zhemgang		Fiber Optic	6-132	Most of the time	Some time	Some time
Paro		Fiber Optic	5-23mbps	Most of the time	Most of the time	Most of the time
Trashigang		Fiber Optic, broadband	7-14mbps	Most of the time	Most of the time	Most of the time
Samtse		Fiber Optic	7-11mbps	Most of the time	Most of the time	Most of the time

According to Table 2.19, all schools in the selected Dzongkhags had fiber optic broadband connections with varying speeds. However, all schools had electricity, internet, and computer access.

Digital equity and inclusion

Braille is the main method of teaching students with visual impairments at the Muenselling Institute in Khaling. However, with the advancement of technology, braille is being replaced by the screen reader. Education for the deaf relies heavily on visual teaching strategies. Technological interventions, such as projectors, BSL videos with English, and Dzongkha captions, are used to facilitate learning for deaf students (MoE, 2019).

The Department of School Education (DSE) of MoE has received support from ‘Save the Children’, an NGO, for buying smartphones for 104 students in Wangsel Institute in Paro and 25 students in Muenselling Institute. However, not all students received smartphones due to a shortage in the market. DSE was also successful in getting audiovisual books (Drukpa, 2020).

The teachers incorporate the special needs approach in their IEP so that children’s educational needs are met. Various social media communication platforms, such as WeChat, WhatsApp, Telegram, and Google Classroom, are used to teach and learn in a meaningful way.

2.3.4 ICT in education initiatives

The Chiphen Rigpel Project was started in 2010 to transit Bhutan to a modern IT-enabled and knowledge-based society. The Chiphen Rigpel Project (2010-2015) was instrumental in providing basic ICT skills training to all teachers in Bhutan. During the 11th five year plan (FYP), the MoE developed and implemented its first-ever Education ICT Masterplan, iSherig-1. As a scale-up programme of Chiphen Rigphel, the iSherig-1 ICT Master Plan incorporated plans to provide digital pedagogy training to teachers.

Based on the emerging priority and progress made in the iSherig-1, the MoE developed its second Education ICT Masterplan, iSherig-2, to act as a road map while implementing Education in ICT in the 12th FY. The investments were majorly made for providing adequate ICT infrastructure to all schools, curriculum development, and capacity development of teachers. All these investments are to be covered through the flagship programs funded by Project Tied Assistance (PTA) (MoE 2020, P10 flagship).

Although the iSheri-1 Education ICT Master Plan was intended to provide digital pedagogy training to teachers, it could not be implemented due to a lack of teachers’ professional standards and a dedicated coordinating body (MoE, 2014). The MoE developed the Bhutan Professional Standards for Teachers (BPST) (MoE, 2019), keeping in line with the recommendation of the Bhutan Education Blueprint 2014-2024 and the National Education Policy. One of the focus areas of BPST is the *Positive Use of ICT*. The iSheri-2 Education ICT Master Plan (2019-2023) is implementing programs through concerted efforts to update the curriculum and upgrade infrastructure as per the changing ICT landscape. Equal priority is accorded to the capacity development of professionals delivering the curriculum and managing the ICT facilities and services.

2.4 Equity And Inclusion In Education

2.4.1 Attitudes and practices concerning equity and inclusion in education

The difference in the ability of students and accessibility of resources has a direct impact on the quality of education. The quality of education received and resources made available determine the future of students. Therefore, it is imperative to address the diverse needs of students by providing appropriate and equitable resources and a conducive learning environment. Bhutanese students come from various backgrounds, which include poverty, special needs, gender, ethnicity, and family income. The Bhutanese education system provides equal opportunities to all students, irrespective of their background.

National education policy ensures opportunities that are equitable, fair, and accessible to all students. Education policy statement 7.1 states, “All children of school-going age shall have equitable access and opportunity to free quality and inclusive basic education, as defined in the Constitution of the Kingdom of Bhutan” (MoE, 2019, p5). Further, education policy ensures that curriculum, pedagogy, and assessment should cater to the diverse needs of students. This component is highlighted in policy statement 9.1.10 which states that the curriculum and pedagogy shall be inclusive of gender, special educational needs, socio-economic circumstances, and geographic location. In addition, the policy reassures the provision of a safe, supportive, inclusive, and learner-friendly environment that is conducive to holistic learning, intellectual engagement, and growth for all diverse learners.

The RGoB’s commitment to providing education to all by making it accessible and by including children without any forms of discrimination (UNICEF and UNESCO, 2007) is explicitly proclaimed in the Constitution of Bhutan (RGoB, 2007). Specifically, Articles 9.15 and 9.16 guarantee education as one of the fundamental rights.

The BPST highlighted the diversity of learners where teachers have to respond to diversity in the classroom. Teachers are expected to create settings that are suitably responsive to the learners’ diverse needs (MoE, 2019).

There are 18 schools with Special Education Need (SEN) programs and two special institutes (Musenselling Institute in Khaling in the East and Wangsel Institute in Paro in the west) in the country. Musenselling Institute specializes in the provision of education for children with visual impairments, whereas Wangsel Institute provides specialized educational services for children with hearing impairment. There are 777 children in 18 schools with the SEN program and two special institutes, as of 2020 (Drukpa, 2021). The focus of schools with SEN programs is to assist students with mild to moderate disabilities. Muenselling and Wangsel institutes enrol children under the severe category of total blindness and deaf children, respectively (MoE, 2020). Students with mild to moderate learning disabilities are integrated into mainstream schools, whereas learning for students with severe needs and other categories of disabilities, such as those with visual and hearing challenges are offered facilities in segregated special schools (Dukpa, 2014).

Since 2007, the Special Education Program and MoE have been providing the expertise and resources needed to improve the quality and reach of special education in Bhutan in 2020. Paro College of Education has started offering a two years master's program in inclusive education for in-service teachers teaching students with special needs. Besides, the Royal Civil Service Commission sent teachers to other countries for pursuing masters in inclusive education through various scholarships and for updating their knowledge and practices. Bhutan has drafted a 10-year roadmap for inclusive and special education in 2019 with the vision to provide education to children with disabilities. According to the 10-year roadmap, the Early Childhood Care Development (ECCD) and SEN division will offer training programs on leadership in inclusive education for Principals. Schools with SEN programs will develop and deliver orientation programs for newly recruited teachers on inclusive education.

Inclusive access

In SEN schools, teachers use BBS-aired lessons and use social media and calls to provide additional explanations, notes, and converted MP3s that suit individual learning needs. In addition, teachers develop an individual educational plan (IEP) to deliver lessons to such student groups. Students with special needs learn from their homes with their family members' support.

Armirth et al. (2018) reported that many schools lack infrastructure and a suitable environment to cater to children with disabilities. Lack of ramps, inadequate number of classrooms for individual lessons, and absence of basic learning materials, such as books, computers, and printers, hinder the learning process. However, some SEN schools have the infrastructure, such as wheelchair ramp, common space to learn, SENCO offices, and library rooms.

Trained teachers in all special education schools receive enough teaching-learning materials.

Table 2.20: School wise access to inclusive education

<table>
<tr><th colspan="2">School District</th><th>Name of the school</th><th>Inclusive Access</th></tr>
<tr><td rowspan="7">Thimphu</td><td rowspan="4">Thimphu Dzongkhag</td><td>Yangchen Gatshel MSS</td><td>Yes</td></tr>
<tr><td>Kuzhugchen MSS</td><td>Yes</td></tr>
<tr><td>Wangbama CS</td><td>No</td></tr>
<tr><td>Khasadrapchu MSS</td><td>No</td></tr>
<tr><td rowspan="3">Thimphu Thromde</td><td>Babesa HSS</td><td>No</td></tr>
<tr><td>Yangchenphu HSS</td><td>No</td></tr>
<tr><td>Zilukha MSS</td><td>Yes</td></tr>
<tr><td colspan="2" rowspan="2">Zhemgang</td><td>Sonamthang CS</td><td>No</td></tr>
<tr><td>Buli CS</td><td>Yes</td></tr>
<tr><td colspan="2" rowspan="4">Paro</td><td>Shari HSS</td><td>No</td></tr>
<tr><td>Drukgyel CS</td><td>No</td></tr>
<tr><td>Khangkhu</td><td>No</td></tr>
<tr><td>Lamgong MSS</td><td>No</td></tr>
<tr><td colspan="2" rowspan="5">Tashigang</td><td>Gongthung MSS</td><td>No</td></tr>
<tr><td>Dungtse CS</td><td>Yes</td></tr>
<tr><td>Bartsham HSS</td><td>No</td></tr>
<tr><td>Tashitse HSS</td><td>Yes</td></tr>
<tr><td>Dungtse MSS</td><td>Yes</td></tr>
<tr><td colspan="2" rowspan="6">Samtse</td><td>Yoeseltse MSS</td><td>Yes</td></tr>
<tr><td>Peljorling HSS</td><td>No</td></tr>
<tr><td>Gomtu HSS</td><td>Yes</td></tr>
<tr><td>Tendruk CS</td><td>Yes</td></tr>
<tr><td>Dorokha HSS</td><td>No</td></tr>
<tr><td>Samtse HSS</td><td>No</td></tr>
<tr><td colspan="3">Total</td><td>10</td></tr>
</table>

The analysis of the principal survey questionnaire revealed that 10 out of 24 schools have access to inclusive education, as shown in Table 2.20.

2.4.2 Educationally marginalized socio-economic groups

During the COVID-19 lockdown, students in the SEN program learning through online classes were provided with self-instructional materials and teachers visited them at their homes. For instance, C2A shared that 200 additional SIM materials were printed and made available to students who did not have television. He also said that 28 students were provided with MP3 speakers loaded with radio lessons. Similarly, C4 shared that the SIM was prepared and distributed to students who did not have access to internet facilities. This initiative helped students who could not participate in online classes because their parents could not afford to buy smartphones. Further, mobile classes were initiated to facilitate learning for students from class PP to class III. One of the CDEOs (C2A) conducted a study in one of the urban areas of Bhutan and found that only 62% of parents provided academic support, such as helping children in completing assignments and homework activities. On the contrary, it was found that a little more than 8% of parents did not assist their children.

Bhutanese students belong to different family backgrounds. One of CDEOs (C3) based in an urban area expressed that students in the district come from different economic and family backgrounds. It was shared many students had single parents due to which they did not receive adequate guidance and support, resulting in low academic performance. C4 added that students with special needs, rural students, and students with poor family backgrounds were affected more. In addition, P3 pointed out that factors like poverty, distance from school, distractions in the town, lack of parental guidance, and family problems affect students' academic performance. P2a added that nutritional deficiency is an important factor contributing to low academic performance. Analysis of the survey questionnaire illustrated the total number of special needs and Kidu students (economically disadvantaged students supported by His Majesty) taking STEM subjects.

Table 2.21: Number of special needs and Kidu students taking STEM subjects

School district		Name of the school	Students with special needs		Kidu Students (marginalized)	
			Total	Taking STEM subjects	Total	Taking STEM subjects
Thimphu	Thimphu Dzongkhag	Kuzhugchen MSS	1	1	1	0
		Yangchen Gatshel MSS	36	36	12	12
		Wangbama CS	1	0	14	0
		Khasadrapchu MSS	17	17	5	5
	Thimphu Thromde	Babesa HSS	0	0	7	7
		Zilukha MSS	0	0	13	0
		Yangchenphu HSS	1	1	5	3
Zhemgang		Sonamthang CS	0	0	21	12
		Buli CS	43	43	15	3
Paro		Drukgyel CS	3	0	16	6
		Khangkhu MSS	0		1	1
		Lamgong MSS	1		23	
Trashigang		Gongthung MSS	2	0	2	1
		Dungtse CS	37		2	
		Bartsham HSS	0	0	17	15
Samtse		Yoeseltse HSS			1	1
		Peljorling MSS	0	0	5	2
		Gomtu HSS	1	1	7	4
		Tendruk CS	79	56	16	10
		Dorokha HSS	0	0	0	0
		Samtse HSS	0	0	0	0
		Total	222	155	183	82

**Blank indicates missing data*

Table 2.21 shows 222 students with special needs out of which 155 students opted for STEM subjects. There were 184 Kidu students, out of which 82 students opted for STEM subjects. Information about these students' academic performance is missing in the survey data.

2.4.3 Initiatives for equity and inclusion in education

The US Special Education Advisory Committee assisted MoE to come up with a special project to address the needs of learners through teacher training, capacity building, and the creation of resources in the country, specifically in SEN schools. The focus of the SEN school projects is to assist students with special needs with mild to moderate disabilities, as they comprise the largest percentage of students with learning disabilities (Bhutan Special Education Foundation, 2009).

A project titled 'A quality inclusive education for children with disabilities in Bhutan' was started in partnership with the Ministry of Health and National Commission for Women and Children in 2018.

The project was sponsored by UNICEF. The main aims of the project were: enrol all children with disabilities in schools or other learning centres; train at least 100 teachers to teach children with disabilities; ensure that at least one district has SEN school; and bring a positive change in the society's KAPs about children with disabilities (UNICEF Bhutan, 2017).

2.5 Science And Maths Teaching And Learning In Secondary Schools

2.5.1 Science and maths education practices

Since scientific knowledge and education are critical for the development of any country, Bhutan emphasizes STEM education (REC, 2012). An overhaul of STEM curriculum, development of Science laboratories, provision of equipment and in-service training for teachers and laboratory assistants are some of the initiatives that are undertaken. However, in general, students find it difficult to learn Science and Mathematics. For example, BCSEA (2020) reported a mean score of 46.8 in Mathematics, 54.04 in Physics, 54.88 in Chemistry, and 50.67 in Biology in the class X board examination. Similarly, a mean score of 64.18 in Mathematics, 66.42 in Physics, 66.15 in Chemistry, and 69.18 in Biology was reported in the Class XII board examination.

The qualitative data too revealed that students' performance in STEM subjects was not encouraging. The performance of students in STEM subjects was average in Thimphu (L2a, L2b), while it was reported below average in other Dzongkhags (L6, L1, L4). It was also revealed that economically disadvantaged students and students with special needs face more difficulties (A6, L3, L1, P2, C3, L6). Special needs children (visually impaired) have difficulty in STEM subjects, as they are unable to conduct experiments in the laboratory (A6). Further, most of the students' parents were uneducated and a majority of the community people was illiterate. As a result, such students hardly receive any motivation from their parents and community to focus on STEM subjects (L1).

Some of the major challenges faced by STEM teachers include students' low interest in the subjects (A2, L3, L1, P4, A5) and lack of resources to conduct practical classes (L1, P6, A2, L4). Students find it difficult to connect the concept of STEM content with the real situation (P3, P6). Lack of access to computers, poor net connectivity, and poor family background are some of the other challenges faced during learning (L4, L1, P5).

The analysis of interview data revealed that some of the strategies employed by schools to help students perform better in STEM subjects are: creating awareness through advocacy talk and reminding constantly on the importance and future scope (P6, L1, A2); employing different teaching strategies (L2, L3 & A2); and equipping the Science laboratory adequately (L3, P6 & P5). Some of the schools in rural areas improvise laboratory equipment to facilitate the teaching of STEM subjects (L1). Remedial classes are initiated to help students who are weak in STEM subjects (L5, L2 & L3).

Language

English and Dzongkha are the medium of instruction in schools. Dzongkha is used only in teaching Dzongkha as a subject, whereas English is used as an instructional language to teach the other remaining subjects. Though English is used in teaching right from class PP, students get to converse in English only in classrooms in most of the cases (students in rural areas and students with illiterate parents). The interview data revealed that some of the students have poor English language competency making it difficult for them to understand the concepts being taught in the classroom (L1). One of the Principals also expressed that teachers find it difficult to make concepts understandable to such students as it involves scientific procedures (P5). Hence, most teachers would resort to explaining difficult concepts in the local language, though such practice is discouraged with the intention to improve students' English language proficiency. Further, STEM subjects have concepts and scientific terms that are difficult to translate to the local language, as they may not have the relevant terms. Hence, poor language proficiency could pose a barrier in teaching and learning STEM subjects in secondary schools.

Curriculum

Schools in Bhutan follow the common curriculum. The REC takes a leadership role in the school curriculum. Curriculum Development Centre (CDC) is one of the four centres under REC. The CDC is mandated to review, innovate, and develop the relevant curriculum for school education.

As per the old Science Curriculum Framework (REC, 2012), the Science learning experiences are organized into four strands: one process strand (Strand 1) and three conceptual strands (Strands 2, 3, and 4), as reflected in Table 2.22.

Table 2.22: Strand and learning experiences

Strand	Learning experiences
One	Working scientifically
Two	Life processes
Three	Materials and their properties
Four	Physical processes

The aforementioned four strands run across all classes.

In order to set the standards, the learning experiences are organized into five key stages, as shown in Table 2.23.

Table 2.23: Key stages and classes

Key stage	Classes
One	Classes PP-III
Two	Classes IV-VI
Three	Classes VI-VIII
Four	Classes IX-X
Five	Classes IX-XII

Each key stage is elaborated with learning outcomes for all strands.

As per the old Mathematics Curriculum Framework (MoE, 2005), the Mathematics learning experiences are organized into seven strands, as reflected in Table 2.24.

Table 2.24: Strand and learning experiences

Strand	Learning experiences
A	Numeration
B	Operations
C	Patterns and Relations
D	Measurement
E	Geometry
F	Data
G	Probability

Each of the strands is spread across the Key Stages: Classes III, VI, VIII, X, and XII.

The New Normal Curriculum (NNC) is initiated by REC in 2021. However, the strands and key stages in Science and Mathematics have not changed. The selection of topics for teaching is not flexible because a common curriculum is followed across schools (C3, C4, P5, P4, P2b).

Pedagogy

The NNC mandates Science teachers to adopt five pedagogical practices to help students learn as personal and social enterprises. The pedagogical practices are:

i. Active hands-on learning
ii. Assessment for learning
iii. Classroom environment
iv. Effective use of ICT
v. Gender-sensitive

Besides, teachers are expected to use role-playing, games, simulations, talking, reading, writing, and experimentation to enhance students' learning.

Similar to Science, the NNC mandates Mathematics teachers to adopt the following pedagogical practices to achieve the expected competencies by students, as they complete their school education.

i. Establishing a safe and positive learning environment
ii. Designing lessons that focus on knowledge construction and transfer
iii. Making provisions for mathematical connections, representations, and communication
iv. Encouraging divergent thinking
v. Encouraging differentiated instruction, design thinking, inquiry-based learning, etc.
vi. Encouraging reflective practices
vii. Embedding assessment and feedback into the lesson
viii. Adopting competency-based education and learning approaches, location-based education approaches, pedagogies for developing and advancing 21st-century skills, blended learning approaches to use both face-to-face teaching as well as electronic and online media.

According to the Lead Teachers and Academic Heads, varieties of pedagogical practices are followed by teachers to enhance students' learning. Some of the examples are as follows:

i. Demonstration, problem-solving, and lecture method (L4)
ii. Active learning practices, such as concept mapping, flipping classrooms, and peer instruction practices (L3s)
iii. Project-based experiments (L2b)
iv. Experiential learning, activity-based learning, demonstration, 5E model, scientific inquiry methods and differentiated instruction (A2a)
v. Inductive, deductive, project method, demonstration, activity-based method, questioning, problem-solving, and creative teaching method (A2b)
vi. Inquiry-based learning, reflective learning, integrative learning, collaborative learning, and constructivist learning (A5)

Assessment

The assessment of a STEM subject has two components: continuous assessment (CA) and summative assessment (SA). The old weighting for each component is reflected in Table 2.25.

Table 2.25: Old assessment framework

Curriculum	Subjects	Classes	CA (%)	SA (%)	Remarks
Old	Physics, Chemistry, Biology	IX	20%	80%	
		X	20%	80%	SA is Board Exam
		XI	20%	80%	
		XII		100%	SA is Board Exam
	Mathematics	IX	30%	70%	
		X	30%	70%	SA is Board Exam
		XI	40%	60%	
		XII		100%	SA is Board Exam

The assessment in the NNC for Science and Maths is reflected in Table 2.26 and Table 2.27.

Table 2.26: Science Assessment

Subject	Key stage	Assessment						Continuous Assessment (CA) Weighting and Breakup for Each Term
		Term I			Term II			
		CA	Mid Term Examination	Total	CA	Mid Term Examination	Total	
Science	II	35	15	50	35	15	50	**Term I:** CA breakup: Assignment = 8, Class Activity=13, Test=4, Project=6, Scrap=4
								Term II: CA breakup: Assignment = 8, Class Activity=13, Test=4, Project=6, Scrap=4
	III	30	20	50	30	20	50	**Term I:** CA breakup: Assignment = 8, Class Activity=12, Test=2, Project=4, Journal=4
								Term II: CA breakup: Assignment = 8, Class Activity=12, Test=2, Project=4, Journal=4
	IV	20	30	50	20	30	50	**Term I:** CA breakup: Assignment = 6, Class Activity=8, Test=2, Project=4
								Term II: CA breakup: Assignment = 6, Class Activity=8, Test=2, Project=4
	V	15	35	50	15	35	50	**Term I:** CA breakup: Assignment = 4, Class Activity=5, Project=3, Practical=3
								Term II: CA breakup: Assignment = 4, Class Activity=5, Project=3, Practical=3

Note: CFA means continuous formative assessment

Table 2.27: Maths assessment

Subject	Key stage	Assessment						Continuous Assessment (CA) Weighting and Breakup for Each Term
		Term I			Term II			
		CA	Mid Term Examination	Total	CA	Mid Term Examination	Total	
		CFA			CFA			
Maths	II	35	10	40	30	30	60	For both Term I and Term II assess each competency through appropriate performance tasks and assessment tools
	III	20	25	45	20	35	55	Performance Tasks: quiz, question and answer, presentation, making models, small projects, etc.
								Assessment Tools: checklist, rating scale or rubrics.
	IV	15	35	50	15	35	50	Assessment Areas: Formulating situations mathematically. Applying concepts, facts and procedures, and interpreting mathematical results
	V	10	40	50	10	40	50	Obtain CA marks using the relation given in the curriculum framework and the instructional guides

Academic calendar and assignment of teaching responsibilities

The school curriculum is to be delivered in 180 instructional days of 1080 hours in an academic year. In terms of instructional hours, English, Dzongkha, and Mathematics are given more time than Science and Humanities in MSS (MoE, 2014). All teachers are engaged in professional duties from 8.20 am to 3.40 pm, including a one-hour lunch break and 30 minutes recess. Some teachers are engaged in co-curricular programs that are conducted regularly besides teaching. Teachers in boarding schools have additional responsibilities than teachers in day school (Kaka, 2017).

Concerning the school timing, instructional days, and time per subject, all schools follow the same opening, examination, vacation, and closing time in an academic year, except for a few schools in difficult terrain.

The academic session happens in two terms. The first term is from mid-February to June end. The second term is from the first week of August to November end. However, schools situated in the extreme north remain open from April to September.

Table 2.28 shows the average individual teacher time spent in classroom teaching, planning, assessing students' assignments, and administrative activities (co-curricular) or parent-teacher meetings.

Table 2.28: Dzongkhag wise teacher time spent on activities

Dzongkhag		Hours spent in:		
		Classroom teaching	Planning, teaching, and assessing students' assignments	Administrative activities / Parent meetings
Thimphu	Thimphu Dzongkha	18.4	18.6	6.07
	Thimphu Thromde	18.4	43.8	16.8
Zhemgang		16.3	10.4	3.6
Paro		16	22.5	3.83
Tashigang		18.16	13.85	3.98

The analysis of the principal survey questionnaire revealed that individual STEM teachers spent an average of 16-19 hours per week in classroom teaching. The data shows that urban teachers spent more hours (43 in a week) in planning, teaching, and assessing students' assignments when compared to rural teachers. Rural teachers spent around 10-18 hours on average. Besides teaching, STEM teachers spent 3-16 hours a week on administrative activities, such as parental meetings and co-curricular activities.

2.5.2 Teacher proficiency in science and maths education

Teacher competencies

The survey data on the experience of STEM teachers in five Dzongkhags and one Throm is quite positive, as evidenced from Table 2.29. For instance, more than 50% of the respondents have taught STEM subjects for more than ten years, followed by 29% with a teaching experience between 5 and 10 years, and 19% with less than 5 years.

Table 2.29: Number of years of teaching STEM subjects

Number of years	Number of Teachers	% of Teachers
Less than 5 years	32	19.4
5 to 10 years	48	29.1
More than 10 years	85	51.5

All STEM teachers at the least have a University degree. The split-up of STEM teachers' qualifications is reflected in Table 2.30.

Table 2.30: Number of teachers with different professional qualifications

Qualification	Number of Teachers	% of Teachers
B.Ed	68	41.2
PgDE/PGCE	51	30.9
Med	31	18.8
PhD	1	0.6

Subjects taught by teachers are reflected in Table 2.31. In some cases, teachers teach more than one subject.

Table 2.31: Percentage of teachers teaching STEM subjects

Subject taught	Number of Teachers	Number of Teachers (%)
Mathematics	47	28.7
Physics	40	24.4
Chemistry	45	27.4
Biology	48	29.3
General Science	48	29.3

The survey data reveals that NQTs (less than 5 years) were fewer in schools located closer to town. For instance, Thimphu and Paro Dzongkhags have zero NQT and Samtse has a maximum of 16 NQTs, as reflected in Table 2.32. In terms of experience, Samtse Dzongkhag has more teachers with a teaching experience of more than ten years (26), followed by Thimphu Throm and Trashigang with 22 and 15 years, respectively. Zhemgang has only one teacher with teaching experience of more than 10 years.

Table 2.32: Number of teachers with qualification and teaching experience

Dzongkhag		Qualification				Teaching Experience		
		Bed	PgDE/PgCE	MEd	PhD	Less than 5 yrs	5 to 10 yrs	Above 10 yrs
Thimphu	Thimphu Dzongkhag	5	3	9	1	0	5	11
	Thimphu Throm	15	12	3	0	2	15	22
Zhemgang		4	8	3	0	5	10	1
Paro		3	4	2	0	0	2	10
Trashigang		13	8	5	0	9	5	15
Samtse		28	16	9	0	16	11	26

Teacher training and ongoing support

Every teacher needs to attend PD to update their content knowledge and enhance pedagogical practices.

The survey data from the teachers of five Dzongkhags and one Throm indicated that the status of PDs attended by teachers from 2018-2020 is less, as reflected in Table 2.33. In terms of hours, only 3% of the school teachers attended PD for 80 hours. This is far from the MoE's mandate.

Table 2.33: Percentage of teachers who attended PD in STEM (2018-2020)

Hours of PD attended in a Year	In %		
	2018	2019	2020
80 hours and above	3	3.6	3.6
At least 1	13.9	15.8	16.4
Not Attended any	86.1	84.2	83.6

Analysis of the Dzongkhag wise PD programs attended by participating teachers in the last three years (2018-2020) indicates that teachers in the Urban Dzongkhag got more opportunities to attend PD when compared to teachers placed in other Dzongkhags. For instance, for the last three years, teachers from urban Dzongkhags, namely, Thimphu and Paro, attended an average of 15 hours and 10 hours of PD, respectively, when compared to other Dzongkhags, as evidenced from Table 2.34. Zhemgang Dzongkhag has the least average number of hours of PD attended by teachers.

Table 2.34: Number of PD and hours of PD attended by STEM teachers (2018-2020)

Dzongkhag		2018		2019		2020		The average number of PD	Average hours of PD
		No. of PD	Hours of PD	No.of PD	Hours of PD	No. of PD	Hours of PD		
Thimphu	Thimphu Dzongkhag	0.38	5.63	1.00	13.38	1.31	26.00	0.90	15.20
	Thimphu Throm	0.31	8.03	0.36	7.33	0.36	7.15	0.34	7.50
Zhemgang		0.06	1.25	0.06	1.25	0.13	0.69	0.08	1.06
Paro		0.58	10.67	0.50	6.67	0.83	12.17	0.64	10.00
Trashigang		0.34	1.90	0.52	1.72	0.31	4.28	0.39	2.63
Samtse		0.36	6.85	0.38	8.49	0.17	2.17	0.3	5.84

2.5.3 Science and maths education learning infrastructure and resources

It is imperative for all schools to have a well-equipped Science and Mathematics laboratory. Effective teaching and learning of STEM involve observing, handling, and manipulating real objects and materials. The theory learnt in classrooms may not be easily understandable unless students observe and execute the process practically.

Several scientific theories and concepts are difficult to explain directly from the books. Students must get a first-hand learning experience by performing various experiments on their own or with guidance from their teachers. It is also a known fact that school Science lab equipment and supplies make teaching and learning easy for teachers and students. Therefore, schools must have adequate infrastructure to make STEM interesting and effective for students and to encourage them to contribute significantly in the related field.

The survey data of school Principals revealed that most of the participating schools had functional STEM laboratory facilities, as reflected in Table 2.35.

Table 2.35: Dzongkhag wise functional laboratories

Dzongkhag		Number of functional laboratories				
		Physics	Chemistry	Biology	Library	Mathematics
Thimphu	Thimphu Dzongkhag (n=4)	3	4	4	4	1
	Thimphu Throm (n=3)	3	3	3	3	0
Zhemgang (n=2)		2	2	1	2	0
Paro (n*=4)		4	4	4	4	0
Trashigang (n=5)		5	4	4	5	0
Samtse (n=6)		5	5	6	6	0

**n represents the number of schools*

Table 2.36 shows that all schools from Paro and Thimphu Throm have functional Science laboratories, while other schools lack one or more functional laboratories. Further, except for one school in

Thimphu Dzongkhag, no participating schools had a Mathematics laboratory. However, all participating schools reportedly had adequate facilities and well-furnished libraries.

The qualitative data confirmed that the participating schools in Paro Dzongkhag had separate laboratories for Biology, Physics, Chemistry, and computer studies (C3). Further, the standard of Science and Computer laboratories was high in schools. The interview participants of other schools opined that despite the availability of Science laboratories, budget provision was required to replenish laboratory chemicals, equipment, and consumables on a timely basis, which was lacking (A2B, P4 & A5).

Besides laboratory and library resources, textbooks are the main resources used in the school for the teaching of STEM subjects. Moreover, teachers improvise resources themselves (A1, A2a). They also use guidebooks, reference books, past question papers, and instructional guidelines (A2b). The participants reported the use of online resources to support teaching (A2a, C3, A2b).

2.5.4 Science and maths education initiatives

In pursuit of developing STEM education, the MoE of Bhutan initiated a number of activities, such as overhauling the Science and Mathematics curriculum, upgrading the qualification of Science and Mathematics teachers to the masters' level, organizing STEM Olympiad, etc.

The National STEM Olympiad is aimed to improve the quality of STEM education. It is expected to spark students' interest in STEM-related areas, instil a positive attitude and values, and provide recognition for outstanding achievement in STEM education. The STEM Olympiad is a competition that consists of team events and individual scholastic works, which students and teachers prepare on a given theme. These challenging and motivational events are well balanced among the various disciplines of Science, Technology, Engineering, and Mathematics (REC, 2019). The STEM Olympiad is organized by REC once every year. For example, the National STEM Olympiad held at Paro from 29th to 31st May 2019 was on the theme *Artificial Intelligence for Sustainable Farming*.

The importance of STEM education is echoed in the Education Blueprint 2014-2024. It mentions that students with deep knowledge and understanding of STEM will succeed in higher education or function effectively in a competitive economy (M0E, 2014).

Besides, the Royal Society for STEM, which is an office under His Majesty's Secretariat, is set up to strengthen Bhutan's participation in scientific and technological innovations.

2.6 Stakeholders

Table 2.36 shows the details of institutions, universities, and school leaders, who are related directly or indirectly to the implementation of the CL4STEM project.

Table 2.36: Details of Institutions and University (Key Stakeholders)

Sl. No.	Organization	Division		Name of Official
1	Ministry of Education	Department of School Education	Teacher Professional Support Division (TPSD)	Ms Tashi Lhamo
			Education Monitoring Division (EMD)	Mr Sangay Chophel D
			Early Childhood Care Development (ECCD) & Special Education Need (SEN)	Mr Sherub Phuntsho
			Private School Division	Mr Dorji Wangchuk
			Bhutan Council for School Examinations and Assessment (BCSEA)	Ms Jamyang Choden
			Royal Education Council (REC)	Mr Kinga Drakpa
2	Office of the Vice-Chancellor, Royal University of Bhutan (RUB)	-	-	Ms Karma Tshering
3	CDEO of Paro	-	-	Mr. Ngawang
4	TEO of Thimphu Throm			Mr. Sangay Drukpa
5	CDEO, Thimphu Dzongkhag	-	-	Ms. Lham Tshering
6	CDEO, Samtse	-	-	Mr Karma Sonam Chophel
7	CDEO Trashigang	-	-	Ms Sonam Choden
8	CDEO of Zhemgang	-	-	Mr Sherab Jamtsho

3 About Samtse College Of Education (SCE)

SCE - CL4STEM synergies

The Royal University of Bhutan (RUB) consists of ten colleges spread across the country. Samtse College of Education (SCE) is one of the ten colleges. The RUB provides tertiary education in Bhutan. Its vision is to be an internationally recognized university steeped in GNH values. The RUB's mission is:

- To provide relevant and good quality study programs at the tertiary education level, which will fulfil the country's needs for an educated, skilled, and humane population
- To promote and conduct research to create relevant knowledge for students of Bhutan, and
- To provide training and professional services for the enhancement of knowledge, capacity building, and community development

The programs and activities developed and offered are based on the university's core values, which include: creativity and innovation, community services, and professionalism. As a constituent college of RUB, SCE is mandated to train secondary school teachers. Besides, the college is also expected to continually offer relevant PD to enhance school teachers' pedagogical and content knowledge.

The overarching aim of the CL4STEM project is to strengthen STEM education globally by building capacities of middle and higher secondary schools' NQT in Science and Mathematics. This is achieved by fostering higher-order learning in classrooms considering that no child is left behind. The STEM faculties of SCE are engaged in developing OER in STEM discipline that is aligned to achieve the aim of the CL4STEM. The aim of the CL4STEM is very much aligned with the RUB's vision to provide professional services for the enhancement of knowledge, capacity building, and community development. The community here refers to the school teachers.

ICT

STEM faculty of SCE integrates various ICT tools like Camtasia, Jamboard, Mentimeter, poll everywhere, slido, etc., in teaching, learning, and assessing. They also use Moodle, an online learning management system known as VLE, in sharing, teaching, and learning resources, uploading reading materials, preparing lessons, conducting quizzes, discussing collaboratively on forums, assessing peers through workshops, designing interactive PowerPoint, and preparing interactive video using H5P.

Faculty competencies to integrate ICT in teaching and learning processes vary from individual to individual. Some faculties were well versed in integrating ICT in teaching and learning. They facilitated in-house PD on ICT tools, such as the use of Jamboard, Padlet, slido, and online quizzes in the college. Some of the STEM faculty attended a weeklong training program on advanced python facilitated by two ICT faculty of the College of Science and Technology, RUB. Further, the college has two ICT faculties, who are the technical team of the CL4STEM project. They offered PD on basic coding to the faculty.

The college provides various professional development training on ICT. The STEM Education Research Centre at SCE organized a webinar titled "The Promise of ICTizing Education: Making Online Teaching and Learning Engaging, Interactive, and Immersive" where two senior teacher educators shared their knowledge and expertise of using a variety of digital tools and platforms for teaching, learning, and assessing to support online or remote learning.

Professional development of STEM teachers

The college organizes numerous PD for the faculty. The PD facilitators are either experts within or from outside the college. Faculties are also sent outside Bhutan to undertake PD. Of late, due to the COVID-19 situation, PDs are carried out online in a virtual mode. Numerous online webinars were conducted on various topics for the faculty. Recently, many STEM teacher educators in the college have completed a certificate course on place-based education organized by Teton Science School, USA.

Technology readiness to offer NQT online modules

The CL4STEM team of SCE is well-coordinated and determined to take the project activities forward. The SCE team headed by the President, country project coordinator, has formed different working teams headed by a leader each. The working teams are for areas like situation analysis, innovation diffusion, knowledge dissemination and scalability, subject discipline, and ICT technical support.

SCE is at an advantage in terms of online module teaching, learning, and assessing. All STEM faculties have experience in developing modules at both school and college levels. In addition, they are used to conducting online classes and using VLE. Most of the faculties are confident to use VLE features like resources, uploading, making lessons, conducting quizzes, discussing collaboratively on the forum, assessing peers through a workshop, designing interactive PowerPoint, and preparing interactive video using H5P. They also participated in PD on ICT tools like Jamboard, H5P, workshop, slido, etc. for teaching, learning, and assessing.

Physics and Biology has a faculty each with advanced knowledge, skills, and practical experience of using ICT in the class. Such expertise within the group will help the team to design the module using ICT. Mathematics and Chemistry do not have faculty or ICT experts. However, the college has a strong ICT team that can design OERs for online classes. Two ICT teams will help all STEM faculties, but some of them are especially designated to support the Mathematics and Chemistry groups.

The project team of Tata Institute of Social Science (TISS) has introduced the STEM faculty of SCE on how OERs are developed and implemented over a period of more than three months. Further, they provided a five-day 'Universal Design for Learning' workshop. This workshop enhanced the faculty's knowledge and skills to design OERs by incorporating ICT tools in teaching, learning, and assessing. Further, the TISS team is closely working with each subject discipline to develop the OERs. SCE has the capacity and capability to implement the OERs.

Relationships with stakeholders

SCE offers Postgraduate Diploma in Education to pre-service teachers with bachelor's degrees, and a Master of Education to in-service teachers who wish to upgrade their qualifications.

- The Director-General of the Department of School Education, MoE, has shown interest in the study and granted approval to undertake the need analysis of this project.
- Most of the secondary teachers, Principals, and CDEOs currently serving in the schools and Dzongkhags in Bhutan are graduates of SCE.
- One of the STEM faculties at SCE is a member of the Science subject committee at REC. Further, most of the STEM faculties of SCE are involved in developing the school curriculum, organized by REC.
- The President of SCE is a member of the Teacher Education Development Board (TEDB) and Curriculum Technical Advisory Board (CTAB) of the MoE.
- The BCSEA officials, EMOs, and officials of the private school division are mostly graduates of SCE.

Profile of teacher educators and ICT team members engaged with CL4STEM

Table 2.37: Profile of teacher educators and ICT technical team engaged in CL4STEM

Sl No	Name	Position Title	Academic Qualification	Area of Specialization
Academics				
1	Dr. Rinchen Dorji	President	PhD	Human Development/ Counselling/ Inclusive Education
2	Dr Nandu Giri	Professor	PGCE, M.Sc, PhD	Chemistry/Environmental Science/Education/Research
3	Dr Sonam Rinchen	Associate Professor	B.Ed, M.Ed, PhD	Chemistry/Education/ Research
4	Dr Karma Utha	Assistant Professor	PGCE, B.Sc, M.Sc, PhD	Physics/Assessment/Research/ Education
5	Ms Ugyen Pem	Assistant Professor	PGCE, GCES, M.Sc	Physics, Education
6	Ms. Bijoy Hungmo Subba	Assistant Professor	B.Ed, M.Ed	Mathematics, Education
7	Ms. Kezang Choden	Assistant Professor	B.Ed, M.Sc	Chemistry, Education
8	Dr Kinley	Assistant Professor	PGCE, B.Sc, M.Sc, PhD	Botany/ research/education
9	Dr Kinzang Dorji	Lecturer	PGCE, B.Sc, M.Sc, PhD	Botany/Enviromental Science/ Research
10	Mr.Ran Singh Tamang	Lecturer	PGDE, B.Sc, PGCE, M.Sc	Zoology, Education
11	Mr. Bal Bahadur Mongar	Lecturer	PGCE, B.Sc, M.Sc	Zoology, Education
12	Dr. Reeta Rai	Lecturer	PGCE, B.Sc, M.Sc,PhD	Chemistry/ Environmental Science/ Research

Sl No	Name	Position Title	Academic Qualification	Area of Specialization
13	Mr. Tandin Penjor	Lecturer	PGCE, B.Sc, M.Sc	Physics, Education
14	Mr. Lhapchu	Lecturer	B.Ed, M.Ed	Chemistry/education
15	Mr Pema Drukpa	Lecturer	B.Ed, GCTE, M.Ed	Mathematics, Education
16	Mr Purna Bdr. Subba	Lecturer	PGCE, B.Sc, M.Sc	Mathematics, Education
17	Mr Ugyen Dorji	Associate Lecturer	PGCE, B.Sc, Master	Mathematics, Education
18	Mr Tshering	Associate Lecturer	PGDE, B.Sc, M.Ed	Biology, Education
19	Mr Man Singh Singer	Lecturer	PGDE, B.Sc, M.Sc	Mathematics, Education
Technical Team				
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2	Mr Narayan Rasaily	ICT Tech.Associate	Class 12, Diploma	Diploma in Information Management System
3	Mr. Phurba Singh Moktan	Laboratory Technical	Class 12, Diploma	Diploma in Computer Hardware and Networking
4	Ms Sapna Thapa	Assistant Lecturer	B.Sc	IT
5	Mr Chenga Dorji	Lecturer	PGDE, B.Sc, M.Sc	Mathematics/IT

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