CHAPTER 1 : INTRODUCTION

This chapter aims at providing an introduction to its readers, precisely, an orientation, for the current study. It acts as an entry point to the thesis with a brief overview of the school education system in India leading to the launching of the NEP, 2020, the relevance of the current study in the light of the NEP, 2020, the study area of Sikkim, the education system in Sikkim, a conceptual framework of the constructs being investigated, the significance and the rationale behind this study and an outline of the chapters included in this thesis.

1.1 School Education in India: A timeline

India has come a long way from being conquered by the British to being governed by the Crown for 89 years to finally gaining independence in 1947. The Indian government made education a top priority after the country was freed from British domination. On January 26, 1950, the constitution came into effect, making India a republic that operated according to its provisions. Education was added to the concurrent list of subjects in 1976, making it the responsibility of both the Centre and the States. Many educational commissions were established after the country attained independence, and curriculum frameworks and educational policies were developed. To advance India's educational system, the commissions' suggestions were put into practise (Kumar, 1998).

In a report entitled "The School Education System in India: An Overview" published in 2019, the British Council succinctly outlined the post-independence education policies and activities of India (Anderson & Lightfoot, 2019).

Figure 1.1 shows that the first commission formed immediately after independence was the Secondary Education commission, followed by the Kothari commission and several others policies and schemes like the NEP 1968, 1986, the Midday meal scheme, NCF 2005 etc. Figure 1.2 shows how India progressed further in its pursuit of improving the education system through its various guidelines, leading to the development of the latest NEP 2020, which is currently on the road to being implemented in all the states of India. For ease of comprehension, they are laid out in a timeline:

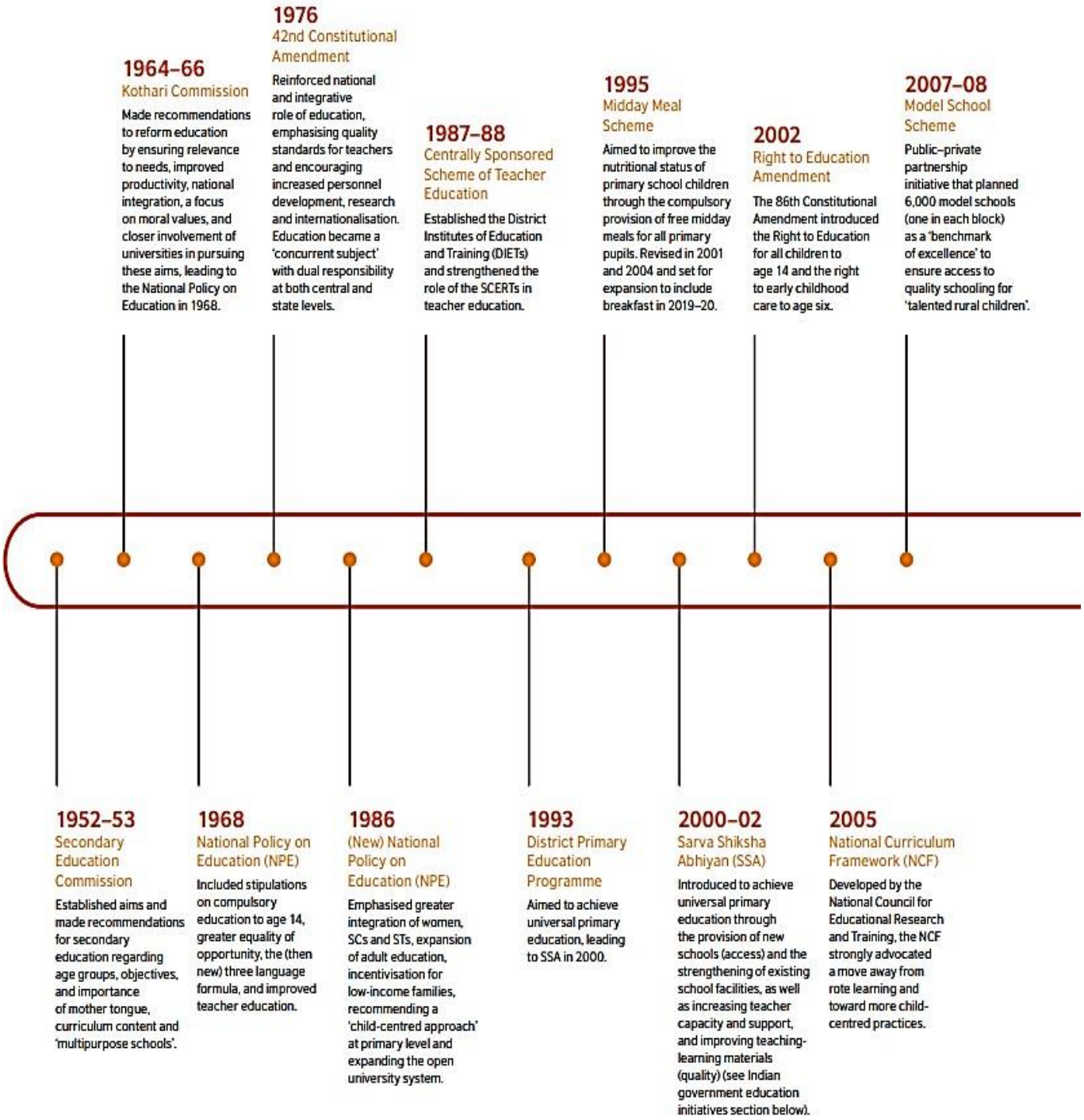

Figure 1.1 Educational policies of the Indian government (1952-2008)

(Source: British Council Report, 2019)

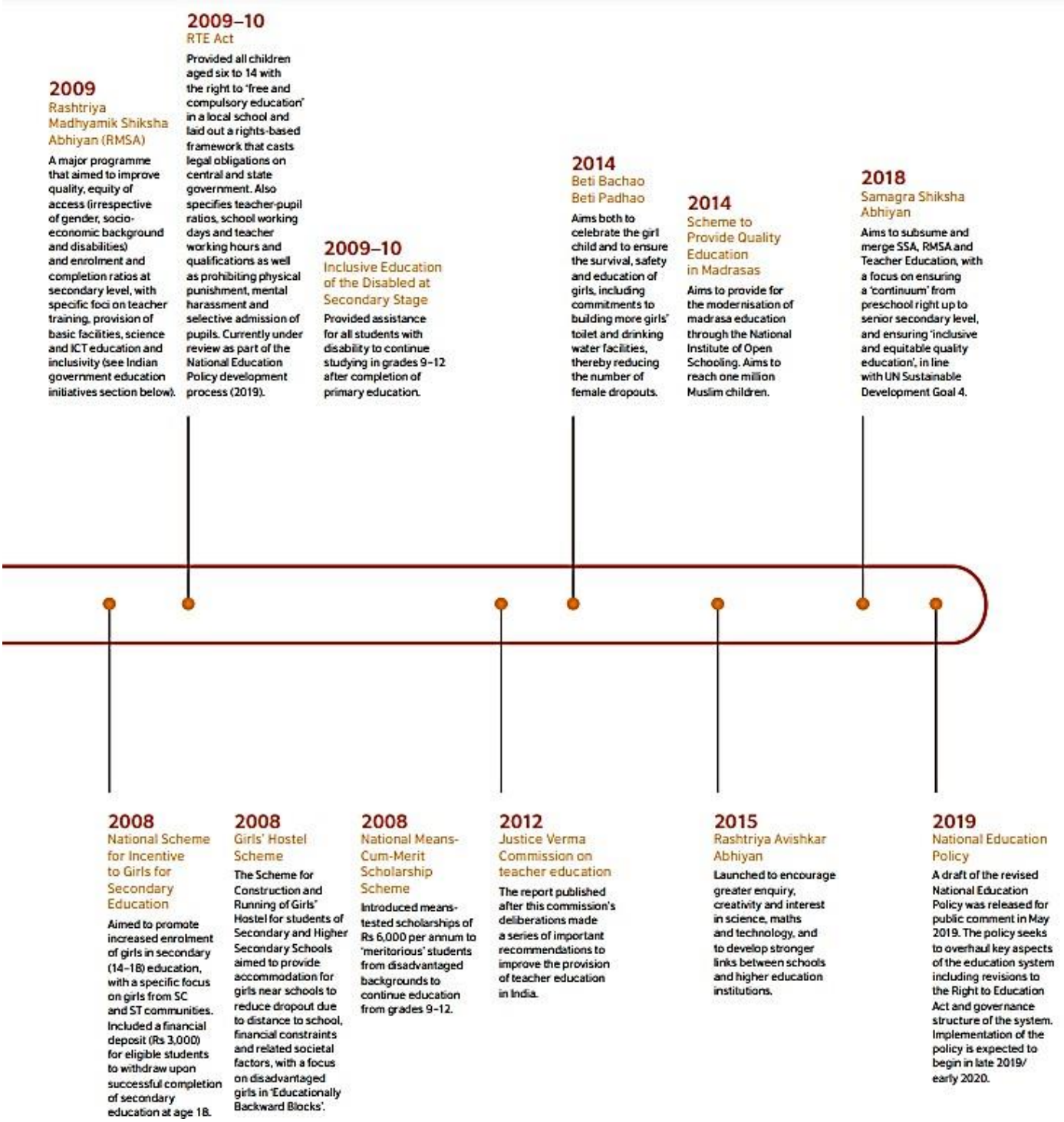

Figure 1.2 Educational policies of the Indian government (2008-2019)

(Source: British Council Report, 2019)

According to the timeline above, the National Educational Policy (NEP) 2020 marked the final significant development in India's effort to transform its educational system. The Union Cabinet adopted the NEP on July 29, 2020, with the intention of making a

number of changes to the Indian educational system at all levels, from school to college levels.

1.2 Significance of the present study: With reference to the NEP, 2020

The National Education Policy (2020) represents the third significant revision of India's educational framework since its independence. The two preceding educational strategies were introduced in 1968 and 1986, respectively. Following the replacement of the National Policy on Education, 1986, which had been in effect for 34 years, a series of reforms were implemented. Nevertheless, the researcher in this particular section will solely address the aspects that are pertinent to the present investigation.

- The main goal of the NEP 2020 is to position India as a "global knowledge superpower." The document mentions that it is essential that kids not only learn, but more crucially, understand “how to learn”, given how swiftly the employment environment and the global ecology are changing. By saying that children need to know how to learn, the NEP 2020 is demonstrating a recognition and appreciation for the significance of “metacognitive awareness” in education. The statement is suggesting that children must be taught and trained on how to regulate their learning, hence enhancing their overall learning capabilities.
- The NEP 2020 proposes that pedagogy should undergo a transformation in order to enhance education by including learner centred, holistic, adaptable and pleasurable approaches. In order to effectively cater to students' needs, it is imperative to ascertain their preferences and subsequently adapt strategies for instruction accordingly. It is imperative to acknowledge that individuals possess distinct and consistent approaches while engaging with tasks. By discerning the cognitive functions predominantly employed by students to solve problems, educators can tailor activities and classes to align with their individual learning styles. The enjoyment of students in the teaching-learning process is contingent upon teachers shifting away from the conventional teacher-centered lecture approach and prioritising the preferences of students.
- Education should play a vital role in the development of individuals' character, ethical behaviour, rational thinking, compassion, and care. Simultaneously, education should provide learners with the necessary skills and knowledge to

pursue productive and fulfilling work opportunities. Rational thinking is a left-brain function while compassion and emotion are right-brain functions. The NEP 2020, through this, emphasises the significance of both brain hemispheres in facilitating the comprehensive development of students. If educators possess the ability to construct their instructional milieu in a manner that fosters the development of not only intellectually adept persons, but also compassionate and empathetic human beings, then there exists a potential for the cultivation of well-developed human beings.

- The NEP 2020 prioritises the empowerment of teachers and suggests to provide them with all the necessary provisions and support to enhance their effectiveness in performing their duties. This encompasses, among various other facets, the provision of the necessary resources to enable effective teaching. It is imperative to provide suitable resources to accommodate the diverse needs of all kids. Students who have a strong inclination towards visual learning should be instructed using visual aids, while students who prefer hands-on activities and active participation in classroom activities should be taught using suitable materials. In essence, it is imperative that educators are furnished with the necessary materials to facilitate optimal learning outcomes.
- A good educational institution is characterised by an inclusive and nurturing environment that ensures the well-being of every student. It fosters a safe and intellectually engaging atmosphere, providing a diverse array of learning opportunities. Additionally, it possesses adequate physical infrastructure and resources that support effective learning for all students. The acquisition of these qualities should be the primary objective of any educational institution. The NEP 2020 is emphasising on keeping students at the centre of instruction and modifying teaching-learning methodologies to suit their requirements.
- The main goal of curriculum and pedagogy reform at all educational levels and in all subject areas is to shift the focus of the education system towards meaningful understanding and helping students "how to learn," while moving away from the prevalent practise of memorization.

1.3 Sikkim: The study area

Origin of the name: "Sikkim" originates from the Limbu word "Sukhim," which means "bride's new house." Sikkim had formerly gone by several names. It was referred to as "Nye-mae-el" or "paradise" by the Lepchas. The Bhutias termed it "Beymul Demazong" or "the hidden valley of rice," while the Limbus called it "Su-Khim" or "new house." According to Sikkim's history, the British further distorted the Limbu pronunciation of the term, leading to the name being changed to "Sikkim," which is being used even to this day (Subba, 2017).

Merged into India as its 22nd state: Sikkim originally existed as a little Himalayan kingdom governed by Chogyals (kings). However, the kingdom went through severe crises under the tenure of the last Chogyal (King), Palden Thondup Namgyal. As a result, the first action done at this point was to elevate Sikkim from protectorate status to associate state status with India. As a result, the tiny kingdom was merged as the State of Sikkim with the Indian Union upon the Union Parliament of India's approval of the 38th Constitutional Amendment Bill, 1975, ending the cherished feudal monarchy that had existed for more than three centuries. (Chakravarthi, 2003).

Geography and Population: Sikkim's population was 6,10,577 according to the 2011 Census of India. The Sikkim Human Development Report (2014) indicates that Sikkim is India's least populous State. With a total size of around 7,096 square kilometres in the Himalayas, it is also India's second-smallest state in terms of land area, following Goa. Sikkim is a landlocked state in the eastern Himalayas that is bordered by Nepal, Bhutan, China, and West Bengal (India) towards the west, east, north and south, respectively. The State is home to 315 glacial lakes, 84 glaciers, 10 mountain peaks that climb above 7,000 metres, and the well-known Tsomgo, Gurudongmar, and Khecheopalri lakes. The world’s third highest mountain peak, Mount Khanchendzonga, is situated on the boundary between Sikkim and Nepal.

Figure 1.3 Placement of Sikkim in India

Source: NIC, Delhi.

Figure 1.4 Outline map of Sikkim

Source: http://cgwb.gov.in/

Districts of Sikkim: Currently, Sikkim is divided into six districts: Gangtok, Mangan, Namchi, Gyalshing, Pakyong, and Soreng. Before 2021, Sikkim had just four districts: North Sikkim, West Sikkim, East Sikkim, and South Sikkim, each with its headquarters at Mangan, Gyalshing, Gangtok, and Namchi respectively. After December 2021, the districts of Pakyong and Soreng were added. The most populous district in the state and its primary administrative and commercial hub is Gangtok, formerly known as East district. The largest and most beautiful of all the districts in Sikkim is Mangan, formerly known as North Sikkim. Due to the incredibly mountainous terrain and chilly weather, it is also the least populous district. Gyalshing district is rich in history and religion and was formerly known as West Sikkim. Some of the most revered and significant monasteries in Sikkim were founded here, and it was also here where the first Chogyal of Sikkim was consecrated in Yuksum in 1642. It is a stunning landscape with several lakes and waterfalls as well as excellent hiking trails. Namchi, formerly known as South Sikkim, is home to a number of tourism destinations. This district is a land straight out of a fairy tale, with charming villages and tall hills, and a breathtaking vista of the Khangchendzonga range. The two new districts are Pakyong and Soreng. The smallest district in Sikkim is the Soreng district (https://sikkimtourism.gov.in).

1.4 School education in Sikkim

Like every other state in India, Sikkim bases its educational policies, laws, and regulations on those established by the Centre. Several initiatives, including the Right to Education (RTE) Act, the Midday Meal Programme, the Sarva Shiksha Abhiyan, and the Rashtriya Madhyamik Shiksha Abhiyan, have been launched to help Sikkim accomplish its educational goals. Through the provision of essential infrastructure, these interventions aim to provide education to all children. Sikkim's educational system is not all that dissimilar from that of other states. In Sikkim, there are four separate levels of schooling. They are the primary level (I-V), middle level (VI-VIII), secondary level (IX-X), and senior secondary level (XI-XII) stages. The upper primary or middle stage is also referred to as junior high school. However, the ongoing 10+2+3 structure has been replaced by the 5+3+3+4 system with the debut of the new NEP, 2020. The NEP, 2020 is on the road to being implemented all over the country, including Sikkim (Subba, 2017).

All of Sikkim's government schools and a small number of private schools are affiliated to the Central Board of Secondary Education (CBSE), New Delhi. The Indian School Certificate (ISC) Board, New Delhi, has affiliations with a small number of private schools. In its 2002 Annual Report, the Government of Sikkim's Department of Education stated that English is taught as the first language in schools and serves as the principal medium of instruction. As a second language, students are taught Bhutia, Lepcha, Nepali, Limboo, Gurung, Rai, and Newari, among other regional tongues. From classes IV to VIII, it is compulsory for students to learn Hindi that is taught as the third language. All the government colleges in Sikkim are affiliated to Sikkim University, a Central University, established by the Govt. of India in 2007. Prior to 2007, they were affiliated to North Bengal University in West Bengal.

The following section will present a few selected indicators of school education status in Sikkim. These are based on data collected and disseminated by the National University of Educational Planning and Administration (NUEPA), New Delhi, in their most recent publication of 2016-2017. The Census, 2011 data have also been included.

Table 1.1 Literacy rate of Sikkim

Males	87.3 %
Females	76.4 %
Overall literacy rate	82.2 %

Source: https://www.census2011.co.in

Table 1.2 Literacy rate of Sikkim compared to other North eastern states of India

State	Literacy rate
Mizoram	91.33 %
Sikkim	**82.2 %**
Nagaland	79.55 %
Manipur	76.94 %
Meghalaya	74.43 %
Tripura	74.04 %
Arunachal Pradesh	65.38 %

Source: https://www.census2011.co.in

The literacy rate of Mizoram is the highest, followed by Sikkim, which is the second highest.

Table 1.3 Number of schools in Sikkim

	Primary with Upper Primary, Secondary and Senior Secondary	**Upper Primary with Secondary & Senior Secondary**	**Primary with Upper Primary**	**Upper Primary with Secondary**	**Total**
Schools in rural areas	65	7	125	4	201
Schools in urban areas	15	0	13	1	29
Total	**80**	**7**	**138**	**5**	**230**

Source: http://udise.in/

The number of schools in rural areas is more than that in urban areas in Sikkim. There are a total of 230 schools in Sikkim. If we are to focus only on the numbers of the senior secondary schools in Sikkim, then we see that there are only 87 schools.

Table 1.4 Enrolment of students in schools

Grade	**Boys**	**Girls**	**Total**
VIII	6345	6744	13089
IX	7317	7763	15080
X	4898	5494	10392
XI	4083	4736	8819
XII	3147	4072	7219
XI-X	12215	13257	25472
XI-XII	7230	8808	16038

Source: http://udise.in/

The enrolment of students is highest in Grade IX, but the numbers show a decline in the higher secondary level. There is less enrolment of students at the senior secondary level as compared to the secondary level.

Table 1.5 Enrolment by Age and Grade (Senior secondary level)

Age	**Grade XI**		**Grade XII**	
	Boys	**Girls**	**Boys**	**Girls**
<15	16	12	9	6
15	25	39	3	3
16	243	284	19	26
17	715	929	174	282
>17	1902	2138	2108	2719

Source: http://udise.in/

Table 1.6 Enrolment by Stream and Grade (Senior secondary level)

Stream	Grade XI		Grade XII	
	Boys	**Girls**	**Boys**	**Girls**
Humanities	848	1249	511	965
Science	381	546	284	432
Commerce	284	320	197	217
Vocational	160	153	300	233

Source: http://udise.in/

Now that we have set the background for the current study by understanding a brief history of the education system of India and providing a brief overview of the study area of Sikkim, the investigator shall now delve into explaining the conceptual framework of the constructs that are being investigated in this study.

1.5 Brain hemispheric dominance

Education is a process of holistic development of an individual in mental or intellectual, physical, emotional, psychological and social spheres of life. This cannot be achieved without the brain which is central to all aspects of human development. The following sub-sections provide a more thorough explanation of brain hemispheric dominance.

1.5.1 The Brain: Basic structure

The brain serves as the nerve center and the most intricate organ among all vertebrates. It is situated within the cranial region in the head, typically situated in close proximity to the primary sensory organs governing vision, hearing, balance, taste, and smell (Kurre, 2012). The cerebral cortex, is the largest section and is thought to have billions of neurons, each of which is synaptically coupled to thousands of other neurons. These neurons communicate with each other through axons, which are long protoplasmic fibres that transmit signals to distant regions of the brain or body and target particular recipient cells (Pelvig, 2008).

From the biological perspective, the brain's role is to exercise centralised control over the body's other organs either by causing patterns of muscle activity or by secreting hormones. Rapid and well-organized responses to environmental changes are made possible by this centralised control. From a philosophical perspective, the brain is unique in comparison to other organs since it creates the physical framework for the

mind. The mind and the brain were first believed to be separate throughout the early stages of psychology. However, early scientists' investigations revealed that the mind was a part of a working brain that displayed specific behaviours based on the environment and the organism's development (Rosenberger, 2011). The brain is composed of the cerebrum, cerebellum, and brain stem.

The cerebrum is larger than the cerebellum or brain stm and is also known as the big brain. It is the most important part of the skull and stretches from the eyebrows to the middle of the skull. It carries out higher tasks such as interpreting vision, hearing, speaking, emotions, reasoning, learning, and analysis, among others (Kurre, 2012). The outer part is made up of grey matter while the inner is made up of white matter. The cortex is the term for the top layer of the cerebral grey matter. There are clusters of nerve cells nearby that come from the brain's motor and sensory regions, while the white matter creates the nerve fibres. The nerve cells are formed by the grey matter. The two hemispheres are linked by a fissure known as the corpus callosum. There is a cross-relationship between the two hemispheres and the body parts since the right hemisphere is linked to the left side of the body and the left hemisphere to the right (Gardener, 1983).

The conscious and unconscious motor commands of the cerebral hemispheres and brain stem are coordinated by the cerebellum. The cerebellum has a complex, neural cortex-based surface that is extremely convoluted. A transverse fissure divides the anterior and posterior loses. This region contains certain fissures that are deeper than those in the cerebrum. It carries out the muscle coordination, posture, and balance functions. To put it briefly, it regulates the body's motor functions (Ackerman, 1992).

The corpora quadrigemina, which are two pairs of sensory nuclei, mediates information between the spinal cord, the cerebrum, and the cerebellum (Kurre, 2012). What is of importance to us for this study is the cerebrum i.e., the two hemispheres.

1.5.2 Brain hemispheric dominance: Evolution, Meaning and Definitions

The brain is made up of two hemispheres, just as other organs like the eyes, hands, ears, lungs and kidneys, that are also two in number. Since the time of Socrates, it has been believed that the human mind is divided into two conceptual halves, one of which is responsible for reasoning and the other which lacks it (Hattie, 1992). Hobbes, Pavlov,

and Freud were among those who divided the brain into two categories: an organised, directed half and an undirected, non-concrete half (Mayer, 1977). The idea of cerebral localisation for specific functions was debated throughout the French and German scientific communities in the early to mid-1800s (Springer & Deutsch, 2001). Until quite late in the 19th century, the prevailing viewpoint among observers appeared to be that the brain consisted of two hemispheres, which exhibited a high degree of bilateral symmetry and primarily replicated each other's functions. In his book entitled "The duality of mind," British physician Arthur Wigan (1844) gave the phenomena renewed prominence and advanced the idea that "each cerebrum is a distinct and perfect whole, as an organ of thought." Researchers at the centre of the debate, such as Gall (1838), Paul Broca (1861), and Marc Dax (1865) added to the argument for the idea of localised function in the brain. It is believed that Broca's discovery of this area sparked a general revaluation of how the two hemispheres of the brain function and initiated a more methodical focus on the distinctions between them. And in a way, it did, even if the story is more complex than it initially appears. To begin with, the discovery under consideration was in fact made decades prior by Marc Dax, a French physician, although he was never appropriately credited for it (McGilchrist, 2010). The fact that Broca conducted the initial brain investigation of a person who had lost the ability to communicate demonstrates that he was an even greater proponent of the concept of brain symmetry than the majority of researchers of his generation. Upon observing a lesion in the left frontal lobe, he deduced that it was equally probable that he would also encounter a lesion in the right frontal lobe, but not necessarily in its third convolution. After several cases failed to meet his initial expectations, he reconsidered his position and eventually identified the area that is now referred to as Broca's region. Then, other scientists' focus began to change, and the hypothesis of brain hemisphericity began to take shape. Thus, brain hemisphericity had been scientifically proven for all intents and purposes by the turn of the 20th century (Scull, 2010).

In support of the early theorists, Sperry et al. (1969) objectively deduced that the human brain frequently behaves as if it were two separate things, one half possibly independent of the other. By investigating patients who had undergone surgery to divide the two brain hemispheres by severing the corpus callosum, Sperry was able to examine the effects of the interruption of communication between the right and left sides.

Sperry et al. (1969) objectively deduced that the human brain frequently behaves as if it were two separate things, one half possibly independent of the other, in support of the early theorists. Sperry was able to investigate the effects of the interruption of communication between the right and left sides of the brain as a result of the dissection of the corpus callosum through investigations of patients who had undergone surgery to divide the two brain hemispheres.

Thus, the importance of brain hemisphere dominance has increased recently in academic, professional, and occupational settings (Springer & Deutsch, 2001; Vincent, 2001; Gazzaniga, 2002). This theory, which has received considerable attention through the past decades, posits that individuals while learning may select a preferable method of cognitive processing that is associated with the activity occurring in the right or left hemisphere (Bavand, 2013). Brain hemisphericity, as defined by cognitive neuroscientists, pertains to an individual's inclination towards utilizing either one or both hemispheres of the brain during the execution of a given task (Mansour et al., 2017). Alptekin and Atakan (1990) define hemisphericity as the inclination of an individual to utilize one cerebral hemisphere more frequently than the other, irrespective of the task-related mindset and disposition. Leng et al. (1998) define it as an inclination to utilize one-hemisphere brain functions more frequently than the other. Corballis (2012), on the other hand, defined it as the propensity to execute specific and precise brain functions using either the left or right cerebral hemisphere. Hudson (2000) categorized brain hemisphericity into whole, left, and right. While there are individuals who favour using either their left or right hemispheres to process information, others have the ability to do so simultaneously, which can be beneficial for teaching methods (Dulger, 2012). Integrated/whole brained learners employ the same approaches as right and left brained learners, albeit in a more equitable and balanced fashion (Namaziandost et al., 2020). While it is critical to acknowledge that the two cerebral hemispheres do not function independently but rather collaborate, it is equally significant to note that one hemisphere exhibits a greater degree of dominance than the other (Saleh, 2001).

1.5.3 Synonyms of Brain hemispheric dominance

Brain hemispheric dominance has been represented with different synonyms in different literature. It is represented as Brain dominance by Marquez (2023); Li et al. (2022); Aburayash (2021); Ramly et al. (2021); Gholasi et al. (2020); Inad & Jabbar (2020); Joven et al. (2020); Suresh et al. (2020); Alghraibeh & Alshalawi (2019); Belecina & Ocampo (2019); Singh & Gera (2018); Suzani (2018); Vahdat et al. (2018); Wei & Sulaiman (2018); Alibeigi (2017); Wei et al. (2017); Nazemi et al. (2016); Özyel (2016); Deshmukh et al. (2014); Kok (2014); Dülger (2012); Kim & Cho (2012); Mohamed (2012); Oflaz (2011); Özgen (2011); Nofal (2007); as Hemispheric dominance by Arabmofrad et al. (2021); Ka-J & Teo (2016); Humera (2015); Weisi & Khaksar (2015); Bavand et al. (2014); as Brain hemisphericity by Nandhini & Subramanian (2021); Ayadi et al. (2019); Koju et al. (2019); Yazgan & Sahin (2018); Soyoof et al. (2014); Vlachos et al. (2013); Fernandez (2011); Oliver (2009); Saleh (2001); as Cerebral dominance by Ibrahim & Mangoud (2023); as Brain laterality by Singh et al. (2020); Szirony et al. (2008) and as Brain Hemispheric Orientation by Alvaro (2006).

Though Brain hemispheric dominance has been represented with different synonyms in different publications, their meaning and definitions do not vary. All of these terms swerve towards one definition and that is the brain is composed of two hemispheres that are lateralized into performing distinct functions.

1.5.4 Brain dominance theory: Left brain vs Right brain

One of the theoretical pillars supporting this inquiry is the brain dominance theory, which Roger Sperry and his colleagues developed. In a nutshell, this theory asserts that the two parts of the brain each have distinct tasks. Each hemisphere has a different method of information processing, and each hemisphere has a preferred or dominant hemisphere for processing cognitive information (Bavand Savadkouhi et al., 2013). For his work, Sperry was awarded the Nobel Prize in Physiology in 1981.

The way a person thinks and learns is determined by which hemisphere they use more frequently- their dominant left or right (Rowson & McGilchrist, 2013; Corballis, 2014). The left brain is the intellectual and logical hemisphere, according to the attributes assigned to it. It is the hemisphere that excels at logically or deductively processing verbal and numerical data. Accordingly, the left hemisphere analyses and separates

information into its component elements, processing it progressively in a linear and organised way. As such, there is a claim that the left hemisphere exhibits a greater propensity for detail orientation, excels at information structuring and analysis, and is most suitable for cognitive tasks involving language, writing and reading, mathematics, science, logic operations, and the processing of serial sequences of data (Prado et al., 2011; Rowson & McGilchrist, 2013; Babcock & Vallesi, 2015). According to the hemispheric dominance theory, individuals who employ the left hemisphere of their brain predominately exhibit rationality, attention to detail, logical reasoning, and analytical thinking. It is based on these thinking and problem-solving characteristics. This indicates that these individuals perform well in fields like mathematics, engineering, or the natural sciences that call on these skills (Kumar & Sharma, 2016).

On the contrary to the analytical mode of thought exhibited by the left brain, the right brain processes information in a non-verbal, visual-spatial, intuitive, emotive, holistic way which culminates in a creative or inductive mode of thinking. It seems to operate effectively through the use of images and generalizations, symbols, affective input, and artistic assertions (Brown, 2000). It looks at links and resemblances in patterns, analyses non-verbal, material, and spatial data, and takes a comprehensive approach to everything. Consequently, information is consolidated and simultaneously analyzed in the right hemisphere, which perceives the overall picture rather than individual entities. Due to its design, which focuses on similarities rather than differences in three-dimensional forms and images, it is believed to be effective for tasks requiring the simultaneous processing of diverse information and the comprehension of complex configurations and patterns, such as face recognition, pattern recognition, and spatial relationships (Babcock & Vallesi, 2015; Oaksford, 2015). Due to these characteristics, those who employ their right brain more often are perceived as artistic, intuitive, emotive, imaginative, and visually oriented. Furthermore, it is asserted that they possess exceptionally refined aesthetic and emotional sensibilities (Corballis, 2014; Viskontas, 2017). Music and graphic design are examples of other right-brain activities (Dulger, 2012; Hamid et al., 2020).

1.5.5 Why lateralization of functions?

Both an evolutionary and a mechanical perspective are needed to provide an answer to the question of why brain functions are lateralized. The brains of fish, amphibians, birds, and mammals are also lateralized in incomparable ways for processes like emotion regulation, attention, classification of stimuli, and coordination of vocalisations. This offers strong evidence that various lateralizations have proven to be beneficial for the survival of specific animals and may have genetic and physiological roots in common (Ehret, 2006). There are several justifications in the literature for why people with significantly lateralized brain functions ought to be happier than those with weak or no lateralizations. According to Levy et al. (1983), the presence of a functionally symmetric brain in mammals, including those with highly developed learning capacities like humans, would be superfluous. Since each hemisphere of the brain has its unique neuronal pathways for creating internal world representations, having identical representations would be a waste of one hemisphere. Dimond (1976) made a similar argument, saying that two complementary halves of the brain could attend to and process different stimuli while also preparing for different responses, increasing the likelihood of flexible and original solutions to new problems. Strong lateralizations of brain functions are required, according to studies on mouse-killing behaviour in rats (Denenberg et al., 1985) and human response times (Bulman-Fleming & Bryden, 1994), to produce associated behavioural outputs swiftly and unambiguously. Thus, the potential, economy, and adaptivity of the brain are increased by substantial neuronal processing lateralizations.

1.5.6 Models based on Brain hemispheric dominance

1.5.6.1 McCarthy's 4MAT teaching style model

McCarthy's 4MAT or Four Modes Application Techniques is derived from the Brain Dominance Theory and the Experiential Learning Theory of Kolb (McCarthy, 1990). According to the Experiential Learning Theory, concrete experience and abstract conception are on either sides of a reflective continuum and information processing changes along this continuum (Kolb, 2000). Based on this model, McCarthy (1990) identified four types of learners: Imaginative learners, who prefer concrete experience and reflective observation and primarily focus on the question "Why?"; Analytical learners, who prefer abstract conceptualization and reflective observation and seek

answers to the question of "What?"; Common Sense learners, who prefer active experimentation and abstract conceptualization and are concerned with the question "How?"; and Dynamic learners, who prefer concrete experience and active experimentation and pursue answers to the question "What if it happens?" (McCarthy & McCarthy, 2006). Experiential Learning Theory's cycle is organised by the 4MAT Teaching Model by taking brain dominance into account. Because of this, it divides each quadrant of the cycle into two stages that incorporate both left and rightbrained activity (McCarthy, 1990). For each of the four learning modes, the model includes both left and right brain activity. The figure given below illustrates the model better.

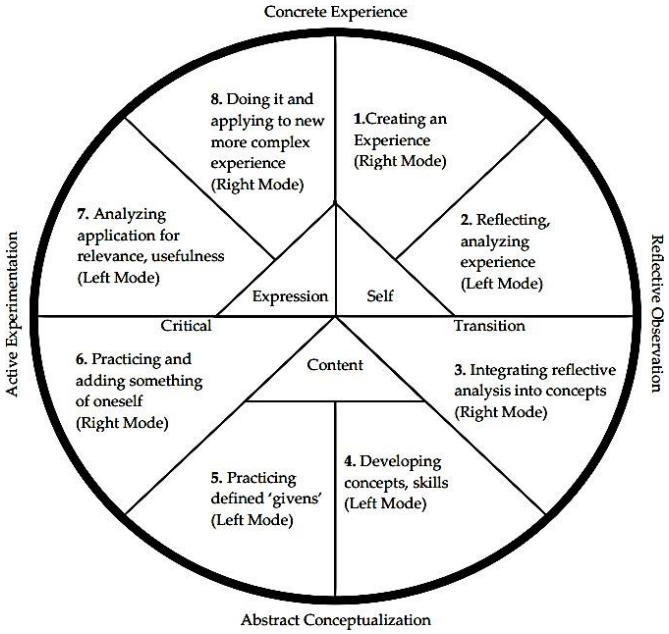

Figure 1.5 The 4MAT model (McCarthy, 1990)

McCarthy and McCarthy (2006) have explained the steps as they occur in the model as follows:

The right-brained students are exposed to an experience that can aid in their ability to form connections regarding the subject in the first step. In the second step, students are required to analyse their experiences of the first-step as part of the left-brained thinking process. In the third step, students are instructed to use their right brains to visualise the idea as they have come to comprehend it via personal experience. Here, metaphors and images are acceptable. The fourth stage, known as the enlightenment step, is designed for people who think more with the left brain. The students are given knowledge about the subject from the text books in this step. The left-brain practise phase is the fifth and

final step. By practising, teachers help students become experts in what they have learnt. The discovery stage starts in the sixth step, where pupils are required to create something by building on what they have learnt. In the seventh stage, they critique the products they and their friends created in the previous stage, which involves the left brain, in an effort to make them better. They show off the most recent version of their products in the eighth and last step, which calls for the proper way of thinking. By assimilation, students demonstrate how they relate what they have learnt to themselves and put it to use.

1.5.6.2 Herrmann's Whole brain model

The Whole Brain approach is another approach that takes students' learning preferences and preferred brain hemispheres into account. According to Herrmann (1988), differences in brain dominance lead to different learning styles. Along with dividing the hemispheres into left and right, the model also divides the limbic system into left and right (Herrmann-Nehdi, 2008). The paradigm therefore asserts that the brain is divided into four quadrants, which are designated as the A, B, C, and D quadrants. These 4 quadrants and their specialized functions are:

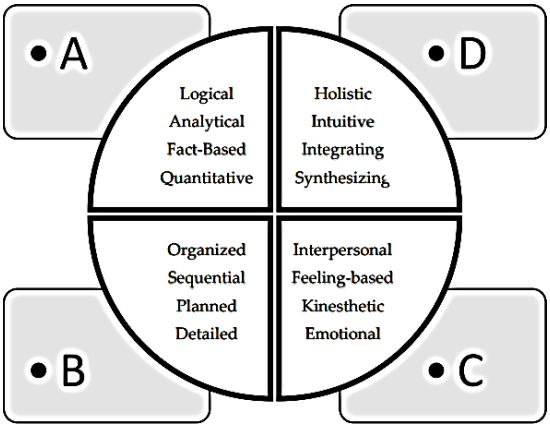

Figure 1.6 Whole brain model
(Herrmann-Nehdi, 1988)

As depicted in the illustration above, the model partitions the brain into four discrete quadrants: left upper D, upper right A, lower right B, and left lower C. Herrmann-Nehdi (2008) posits that instincts and emotional processes are associated with the lower quadrants (B and C), while cognitive and intellectual activities are situated in the upper quadrants (A and D). Individuals may utilize all or a portion of the A, B, C, and D cerebral hemispheres while learning (Herrmann, 1988). Furthermore, individuals with

a dominant D quadrant acquire knowledge primarily through observation and intuition, whereas those with a dominant C quadrant acquire knowledge primarily through experiences, discussions, feedback, and values (Lumsdaine & Lumsdaine, 1995). Individuals with a dominant A quadrant have a tendency to acquire knowledge through verbal instructions and information, while those with a dominant B quadrant learn practically and through various activities. The crucial thing to remember is that all the fundamental ideas should be taught through exercises appropriate for each of the four quadrants (De Boer et al., 2011). This gives every kid an equal opportunity to learn, regardless of how they want to learn. Additionally, pupils have the chance to employ and expand their capacity for thinking in different brain regions that they do not naturally favour. Horak et al. (2001) also discovered that the Whole Brain Model aids students' ability development in those quadrants as well those they do not exhibit dominance.

1.5.7 Determination of Brain hemispheric dominance in the present study

The researcher selected the Brain Dominance Inventory developed by Davis et al. (1994) based on the brain dominance theory, for the present study. They categorize the brain dominance of individuals into left, right or whole on the basis of the participants' tendency to utilize the functions associated with either of the two hemispheres or both. The various functions that are studied are listed in the form of 39 statements, wherein every statement has three options (a, b and c). Option 'a' represents left brain behaviour, option 'b' represents right brain behaviour and option 'c' represents whole brain behaviour.

1.6 Metacognitive awareness

1.6.1 The concept: Meaning and definitions

The meaning of Metacognitive awareness has been established by Flavell in his research paper where he says, "It is at least conceivable that the ideas currently brewing in this area could someday be parlayed into a method of teaching children (and adults) to make wise and thoughtful life decisions as well as to comprehend and learn better in formal educational settings" (Flavell, 1979, p. 910). What is this particular area that Flavell is referring to that possesses the capacity to enhance comprehension, learning, academic achievement, and above all, the capacity to make informed and purposeful life choices? Flavell was referring to the act of engaging in reflection and monitoring one's own

thoughts. He coined the word "metacognition" with his colleague Ann Brown to describe this process, and the results of their research are now being observed in classrooms around the world.

In her book "Metacognition in Young Children," Larkin (2009), very cleverly illustrates the difference between the different levels of thinking. The author claims that while it may seem like a simple notion to say, "I'll stop for a cup of tea now," if she were to pause, take a moment to ponder, and then resume her action, she might consider why she had the thought in the first place. She would then begin to ponder the following: "Is my body attempting to alert me that I am dehydrated? Alternatively, do I own a body clock that is programmed to deliver particular messages at particular periods of the day? Perhaps the idea had nothing to do with thirst, but rather with feelings of fatigue, boredom, or being stuck, or perhaps with the need for a reward for the job that had been accomplished that day. She could follow her own reasoning from any one of these ideas. She has progressed from conventional thought to contemplation of the thought itself, its origin, and the deliberate selection of an action subsequent to her realization of the multitude of possible thoughts that may have preceded the initial thought. All of this second-order thinking is metacognition. Larkin (2009) also believes that by using this example, we can see how, from one very simple concept, she was able to change her way of thinking, ponder on it, and ultimately come to a good decision, or at least one that was appropriate for her at the time. She recognized the immense potential of incorporating metacognition into educational environment wherein one simple thought like "I want a cup of tea" could trigger thoughts that could pique her curiosity about many subjects she didn't know much about, inspire her to learn something new, or keep her focused on the task she was working on. Metacognitive awareness is called by several researchers with different terms but refers to the same. Metacognitive awareness is Metacognition and vice versa (Larkin, 2009).

- Flavell (1979) described Metacognition as Knowledge and cognition about cognitive phenomena.
- Baker & Brown (1984) opined, it is the knowledge and control the child has over his or her own thinking and learning activities.

- According to Brown (1987), it is the understanding of knowledge, an understanding that can be reflected in either effective use or overt description of the knowledge in question.
- Schraw & Dennison (1994) defined Metacognitive awareness as the ability to reflect upon, understand and control one's learning.
- According to Zimmerman (1995), metacognition is defined as the awareness and control of an individual's own learning, such as an awareness of how and what he/she thinks.
- Akturk & Sahin (2011) said that, it is the information that one possesses about his cognition and ability to regulate the structure of that cognition.

Students need to develop metacognitive awareness in order to be self-reliant and creative in the twenty-first century (Margaret, 2002; Thomas, 2012; Ya Hui, 2012). According to research, learners who are able to track and improve their progress do better academically (Coutinho, 2007) and are better able to regulate their learning (Haataja et al., 2018; Schnaubert & Bodemer, 2019). Students with metacognitive skills are more self-reliant, more intentional and strategic in their learning (Listiana et al., 2016), and more mindful of their learning processes (Zhao & Mo, 2016). Throughout the acquisition process, they may also accurately evaluate their own performance and undertake a self-evaluation (Molenberghs et al., 2016). Additionally, metacognition is a significant predictor of academic achievement for students, according to Al Baddareen et al. (2015). Conner (2007) cited a number of research that demonstrated how students' learning might be enhanced by using metacognitive strategies like regulating, monitoring, and managing their own learning. It is clear, in general, that students who have strong metacognition perform well whereas those with weak metacognition struggle to manage learning activities (Conner, 2007).

Additionally, metacognition is also identified as one of the fundamental skills that students in higher secondary education need to master. According to Kemendikbud (2013), this competency links a variety of fundamental competencies to characteristics of attitudes, abilities, and information that students must master for a given school, class, and topic level. This implies that all subjects in classes XI and XII should focus on developing metacognition so that it would eventually benefit students when they pursue higher education.

1.6.2 Metacognition v/s Cognition

Metacognition and cognition go hand in hand. According to Akturk and Sahin (2011), planning, monitoring, and evaluation are examples of metacognition tasks that take place before, in the middle of, and after cognitive activities. So, metacognition is a deeper understanding of cognition that is used to control cognition during problem-solving or learning processes. If cognition is the recognition and comprehension of something, then metacognition is the comprehension of the process by which an individual acquires knowledge and comprehends concepts. Though cognition and metacognition cannot be separated, they serve different purposes. Metacognition, according to Schraw (1998) and Holton and Clarke (2006), is distinct from cognition. While cognition itself is required to complete a job, metacognition is required to comprehend how the task will be carried out (Schraw, 1998). It implies that cognition operates second, whereas metacognition operates first. Schraw (1998) went on to say that metacognition is a fundamental prerequisite for cognition to be effective. If metacognition is strong, cognition operates efficiently. On the other hand, if metacognition is weak, cognitive talents will not work well. This implies that one's success is more dependent on one's capacity for metacognition than on their cognitive abilities. Because awareness of metacognition comprises understanding of cognition and management of cognition, it will aid students in carrying out more suitable learning activities to meet learning objectives (Schraw & Dennison, 1994).

1.6.3 Theoretical foundations on Metacognitive awareness

Metacognition is one of the actively researched areas in the field of educational psychology (Livingston, 2003; Tobias & Everson, 2009). The term "metacognition" was first used in the field of psychology by John Flavell in the year 1979. Since then, a great deal of theoretical and empirical study in the field of metacognition has begun (Louca, 2008).

1.6.3.1 John Flavell's Model of Metacognition (1979)

John Flavell (1979) created a metacognition model that has four components: metacognitive knowledge, metacognitive experiences, objectives and tasks, and strategies or actions.

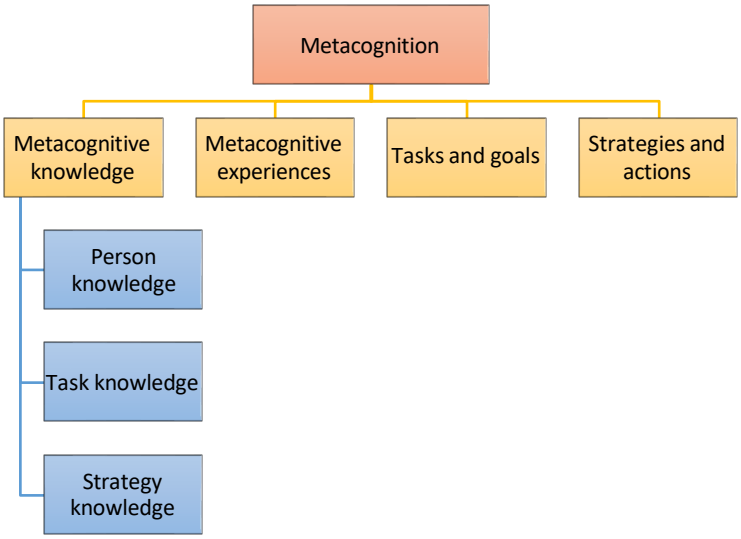

Figure 1.7 John Flavell's Model of Metacognition (1979)

i) Metacognitive knowledge lies in the understanding of how various factors can influence one's own thought processes. These diverse elements are categorized into person, task, and strategy groups.

- The person group comprises our perception of ourselves and others as rational beings, the diversity of methods in which people think, and the multitude of beliefs that exist regarding thinking, that some people may perform certain tasks better than others, and that cognitive processes like attention, concentration, and memory have an impact on performance.
- The task category takes into account our understanding of the task. It suggests how effectively a learner comprehends the purpose, nature, and requirements of learning assignments. For instance, is it comparable to any previous assignment we have completed? Do we have all the details we require to complete the task? Can we accurately forecast our success or failure on the task given this knowledge?
- Strategies include information on the methods most effective for achieving our objectives. It speaks to the learner's comprehension of the approaches or techniques one will use when carrying out a task in order to achieve cognitive objectives.

ii) ii) Flavell explains how metacognitive knowledge base is built through metacognitive experiences. These sensations may be conscious and stem

from previously learned metacognitive skills, such as recalling a method one used to handle an issue similar to the one being experienced, or they may be more emotive, such as feeling stuck on a particular aspect of the problem. These experiences must be processed and not avoided as being too time-consuming or psychologically challenging in order to be useful in building the metacognitive knowledge base. Children can only establish a solid metacognitive knowledge base by giving them the chance to practise working through metacognitive events.

iii) Metacognitive goals and tasks: The metacognitive tasks and goals describe the desired results or purposes of a cognitive attempt. Apart from broadening one's understanding of a subject, goals and tasks could include memorizing material, understanding it, or creating something, such a written composition or a mathematical answer. One can accomplish a certain goal by utilizing both metacognitive experience and knowledge.

iv) Metacognitive strategies and actions: These are deliberate processes employed to regulate one's cognitive activity and guarantee the achievement of a cognitive objective (such as comprehending a text, figuring out a math problem, or creating an effective statement) is achieved.

1.6.3.2 Ann Lesley Brown's Model of Metacognition (1987)

The metacognition model of Brown (1987) consists of two dimensions: Knowledge about cognition and Regulation of cognition.

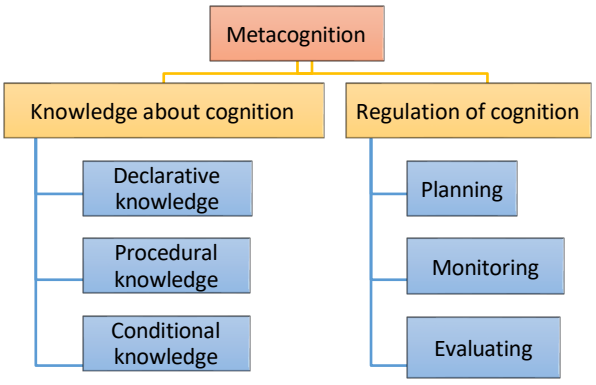

Figure 1.8 Ann Lesley Brown's Model of Metacognition (1987)

i) Knowledge of cognition: Reynolds (1992) defines this as an individual's awareness of their own cognitive processes, that improves one's ability to use different strategies and manage resources. Knowledge of cognition is composed of three subcomponents (Jacobs & Paris, 1987) are:

- Declarative knowledge is the understanding of one's own capabilities and the factors affecting performance as a learner (Schraw & Moshman, 1995). Before starting any learning activity, a person may already be aware that setting goals is an effective learning approach.
- Procedural knowledge: This term describes a learner's comprehension of how to put strategies and procedural skills into practise. More procedural knowledge leads to more spontaneously applied skills in people (Schraw & Moshman, 1995). For example, a student is aware of when and how to use proper strategies as well as how to set up efficient goals before starting any activity.
- Conditional knowledge: Conditional knowledge is the understanding of when and why to use particular cognitive actions. It denotes the blending of procedural and declarative knowledge (Garner, 1990). Before finishing a certain task, one could decide that defining goals would be a preferable course of action.

ii) Regulation of Cognition: According to Brown (1987), this is the process through which students manage and keep track of their learning. They are categorized into three strategies: Planning, Monitoring and Evaluating.

- Planning strategies: Selecting and designating resources that have an impact on performance is an element of planning. Examples include formulating predictions prior to commencing a task, employing sequential methods, and deliberately allocating time or concepts prior to commencing an activity.
- Monitoring tactics: A person's ongoing awareness of how well they comprehend and present a task is referred to as monitoring strategies. Participating in regular self-tests while learning is a great example. Studies show that the development of monitoring skills in both toddlers and adults is gradual.

- Evaluating strategies: Analysing an individual's learning results and regulatory processes is referred to as evaluating strategies. After a task is finished, it also involves evaluations of the comprehension and learning processes. For instance, reviewing the results after finishing a certain task.

1.6.3.3 Nelson and Naren's Model of Metacognition (1990)

A theoretical framework for describing a higher cognitive system was provided by Nelson and Naren in 1990. They separated the object-level and meta-level parts of the metacognitive system into two main categories. The links between the two components, which include the control and monitoring elements, show how information is evaluated from the lowest level (i.e., the object level) to the highest level (i.e., the "meta level").

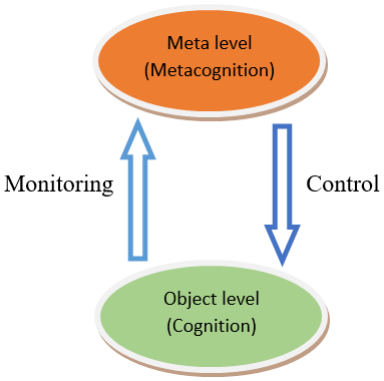

Figure 1.9 Nelson & Naren's Model of Metacognition (1990)

i) The object-level: Cognitive functions, sometimes known as "person's thinking," occur at the object level. The ability to understand is cognition, which is what this phrase refers to. For instance, one technique to reach this level is via interpreting text when reading. In order to accomplish a particular objective, such as comprehending the meaning of a given text, students employ cognitive strategies at the object level, such as decoding (Nelson & Naren, 1990).

ii) The 'meta-level': It refers to a learner's "thinking about thinking" stage. At this higher-order level, metacognitive strategies are used to make sure the learner meets the goals they have set. Keeping with the reading example, the

student would evaluate their comprehension of the most recent paragraph before going on to other subjects. The term used to describe this is monitoring. If they are content with their level of understanding, they will keep reading. Otherwise, they could decide to read the passage again or look up the word in a dictionary. In other words, it is a type of metacognition, or self-awareness (Nelson & Naren, 1990).

Hence, the term "control" refers to the information that travels from the meta-level to the object-level, thereby impacting the actions at the object level through the initiation, continuation, and termination of an activity. "Monitoring," conversely, operates under the assumption that data is transmitted from the level of the object to the level of the meta-level.

1.6.3.4 Schraw and Dennison's model of Metacognitive Awareness (1994)

According to Schraw and Dennison (1994), Metacognitive awareness has two components: Knowledge of cognition and Regulation of cognition.

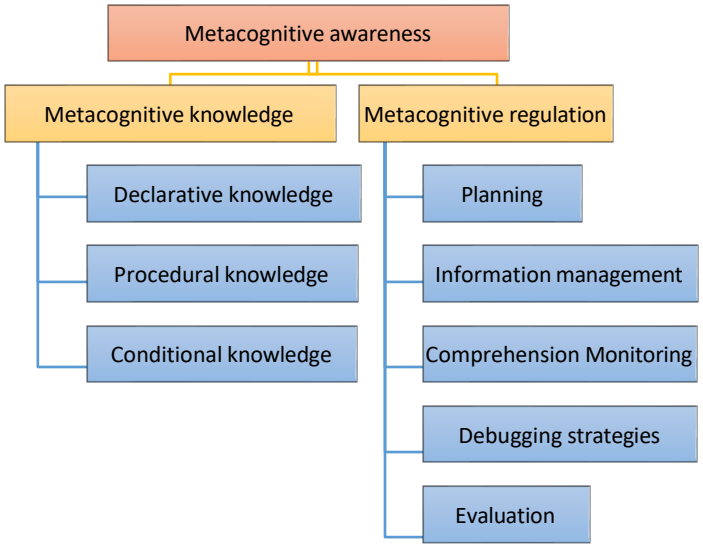

Figure 1.10 Schraw and Dennison's model of Metacognitive Awareness (1994)

i) Metacognitive knowledge includes making judgments that aid in determining the task one is currently working on as well as learning about the task. It encompasses Declarative, Procedural, and Conditional knowledge as its three subcomponents.

- Declarative knowledge constitutes the ability to comprehend one's own learning process and the relationship between oneself and the tasks
- Procedural knowledge is the capacity to decide which strategies should be used and for what purposes. Students must be aware of the methods and tools they can use to accomplish their goals.
- Conditional knowledge is the understanding of the when, why, and how learners should apply a particular method, the circumstances under which they can learn effectively. It simply means understanding when and where a particular strategy will be most helpful in assisting students in reaching their objectives.

ii) Metacognitive regulation is utilised for regulating cognitive activity. It comprises of five sub-components:

- Planning is about setting objectives, allocating resources, and managing time comprise planning. Furthermore, it addresses the essential knowledge that ought to be acquired, the optimal approach to problem-solving, and the methodology and objectives that ought to be established.
- Information management strategies point out what has to be done so that students can learn more. They must be able to process the information swiftly and effectively while also coming up with original ideas. Additionally, they must be able to elaborate on, visualise, and divide large chunks of information into smaller chunks.
- The process of continuously assessing one's learning progress and figuring out whether or not one is employing the appropriate strategies to understand the content being studied is known as comprehension monitoring.
- Determining what to do when problems develop, such as what strategies to use if a learner is having trouble understanding during the learning process, is known as debugging strategies.
- Analysis of learning outcomes and the efficiency of post-learning procedures is referred to as evaluation. Evaluation also establishes whether the aims were achieved and the learning process was successful.

1.6.3.5 Efklide's components of metacognition (2006)

According to Efklides (2006), Metacognition is categorised into: (i) Metacognitive knowledge, (ii) Metacognitive experiences, and (iii) Metacognitive skills.

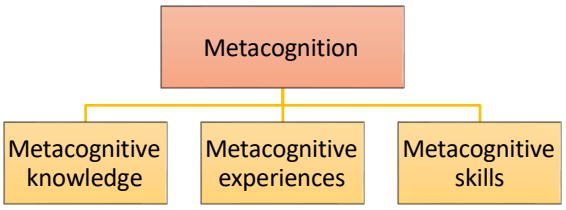

Figure 1.111 Efklide's components of metacognition (2006)

i) Metacognitive knowledge: It pertains to the students' perceptions of themselves as cognitive beings. It also suggests a relationship between a learner's self-perceptions and the tasks and methods used in the process.

ii) Metacognitive experiences: It represents the learner's feeling of knowing. When we have an experience that we believe to be familiar but cannot recall, such as having something on the tip of our tongue but being unable to express it aloud, we feel a sense of knowing. Furthermore, metacognitive experience entails the ability to assess one's own effort. Metacognitive experiences and knowledge share some parallels with the 'Knowledge of cognition' component of two-component models of metacognition.

iii) Metacognitive skills: It has to do with cognitive control, which encompasses the capacity for planning, efficient time management, and analysis and evaluation. Metacognitive skills are similar to the 'Regulation of Cognition' component found in two-component models of metacognition.

1.6.4 Determination of Metacognitive Awareness in the present study

From the review of the related literature and study of various models and tools that are related to metacognitive awareness, the researcher selected Schraw and Dennison's (1994) model for the present study. Metacognitive awareness, as stated by Schraw and Dennison (1994) comprises of two broad dimensions: i) Metacognitive knowledge and ii) Metacognitive regulation.

1.7 Perceptual learning style preferences

1.7.1 What are learning styles?

The primary focus of educational psychology is learning, and for some time now, studies of academic achievement have centred on the learner and encouraged active and engaged learning. Particularly, learning styles have provided some insightful information regarding learning in academic and non-academic settings. Individual differences occur in every social structure, and this is also true in the classroom, where students represent various social strata, ages, genders, ethnicities, and skills (Adu-Febiri, 2002). Every person has their own preferred thought and behaviour patterns (Cano-Garcia & Hughes, 2000; Haik & Moustafa, 2007). It is widely acknowledged that how students are predisposed to approach a learning scenario has a significant influence on how well they achieve. One child may like structure in their education while another may choose fresh approaches. Similarly, one child may accomplish activities in an organised and methodical manner while another may do so in a spontaneous way. This is a result of personal variances in learning styles (Venugopal & Mridula, 2007).

Styles are inclinations as opposed to abilities. They are the intellectual directions that a person feels most at ease with (Venugopal & Mridula, 2007). Students choose to process information in a variety of ways, including by hearing and seeing, acting and reflecting, using logic and intuition when reasoning, analysing and visualising, and doing so consistently or in fits and starts. It is not necessary for everyone to learn in the same way as someone else does. To provide the students with the most educational opportunities possible, the instructor instructs in the classroom. Despite receiving the same instruction in the same classroom, pupils' comprehension levels differ for a number of reasons. Many instructors have suggested recently that taking these student preferences into consideration might make teaching more successful. The student can learn things more quickly and effectively if he or she determines how they best process knowledge (Chauhan, 2007). A decade of studies shows that when taught using their preferred learning style, both poor and average performers score higher on standardised achievement exams and attitude assessments (Dunn & Griggs, 1998). Learning style preferences evolve throughout time. However, when a person has strong style preferences, they will learn best when given teaching methods and resources that go along with those preferences. Even experienced professionals acquire knowledge most

effectively by leveraging their learning style strengths, in spite of the fact that many individuals can grasp fundamental concepts through an incompatible method. No particular style is inherently superior or inferior to any other (Dunn & Griggs, 1998).

1.7.2 Characteristics of learning styles

1. *Learning Styles are value-neutral:* Learning styles generally exist in a bipolar manner, encompassing two extremities of a wide-ranging continuum (e.g., reflective versus impulsive, random versus sequential). Nevertheless, the position of a learner along this continuum does not inherently indicate value, as each extreme possesses its own set of potential advantages and disadvantages (Dörnyei, 2005). No single learning method can be identified as being more advantageous than another, according to Curry (1990). Every person may learn provided teachers respond appropriately to the variety of students' learning styles, according to Bennett (2003). Additionally, despite the fact that people may have strong style tendencies and preferences, learning styles are not set ways of behaviour and can be extended and adjusted based on various tasks and situations (Reid 1987; Oxford 2011). The degree to which people may modify or adapt their styles to fit a specific circumstance varies (Ehrman, 1996). According to Reid (1995), students who are conscious of their learning styles do better in class activities than those who are not.
2. *Learning styles are not dichotomous concepts.:* Learning styles have frequently been presented as the two poles of a continuum. This claim does not imply that the existence of one style, for example, analytical, means that its counterpart, global, is necessarily absent. A learner may approach a learning activity critically while also displaying a somewhat less pronounced overall preference. Similarly, not everyone "fits neatly into one or these categories to the exclusion of the other" (Ehrman & Leaver, 2003). A learner may be equally auditory and visual but less tactile and kinesthetic. Ehrman (1996) further asserted that few, if any, people could be categorised as having nothing in any or all of the style dimensions.
3. *Learning Styles are modifiable though relatively stable*: Researchers and experts have differing opinions on whether a person's learning style will remain constant over time or change as they develop. Learning preferences can alter as a child matures, according to researchers (Ehrman & Leaver, 2003). Prior research,

however, indicated that learning styles, like aptitude, were unchangeable in secondary and higher secondary students and remained constant regardless of the material taught or the environment. Some studies have shown that adult and adolescent learning styles can be modified and expanded since they are relatively strong habits rather than unchangeable biological traits (Davidman, 1981). According to research by Ellis (1989), students adjusted to the teaching style they were exposed to rather than using their own preferred learning methods. Researchers also urged students to try to adjust to learning styles that are different from their own and to emulate their teachers' teaching methods. The effectiveness of learning could be increased by working comfortably within a variety of learning styles (Reid, 1987; Oxford, 2002).

4. *Learning Styles are different from abilities:* In general, learning is a process that involves primarily employing a human's senses to input information or experiences into the mind, where they are subsequently processed. Learning, as stated by Ambrose (2013), instigates transformation. Consequently, this transition is induced by experience, thereby increasing the likelihood of improved performance and subsequent learning. The behavior, attitude, or knowledge level of the learner may all undergo changes. Students gain new perspectives on concepts, ideas, and/or the world as a result of their education. Ability, conversely, pertains to the capacity of the learner to employ the learning method. According to Dörnyei (2005), there is a clear correlation between ability and performance, meaning that when ability increases, performance also improves. In conclusion, learners at both ends of the style continuum will have the chance to succeed when a variety of diverse tasks are used.
5. *Learning Styles are different from cognitive styles:* Cognitive style is used to describe how people think, interpret, and retain information. According to Dörnyei & Skehan (2003), learning styles can be characterised as a typical preference for addressing learning in general, whereas cognitive styles can be defined as a predisposition to process information in a particular manner. In other words, the former is more constrained by preferences for information-processing, whereas the latter encompasses all facets of learning.
6. *Learning Styles are different from learning strategies:* According to Reid (1995), learning styles and learning strategies are differentiated based on their

nature. Learning strategies refer to external abilities that students consciously use to improve their learning. On the other hand, learning styles are internal qualities that learners have a preference for and knowing or unknowingly utilize it in all of their learning tasks. According to Sternberg and Grigorenko's (2002) discussion of the degree of consciousness involved in using learning strategies and styles, styles operate independently of the individual while strategies need intentional decision-making. In conclusion, learning styles and learning techniques both interact with one another and occasionally combine to have an impact on the teaching and learning process. In order to understand his learning more clearly, a learner must be aware of both of them as well as their fundamental contrasts.

1.7.3 Perceptual learning styles: Meaning and definitions

As stated by Davis (2007), perceptual learning styles are "the means by which learners extract information from their surroundings through the use of their five senses". Also, Oxford (2001) opines that perceptual preferences are "the physical, perceptual channels with which the student is most at ease." They are "the variations among learners in using one or more senses to understand, organise, and retain experience" as mentioned by Reid (1987). The level of learning varies greatly depending on how the material is presented (Dunn & Burke, 2008; Daud, 2014). For example, a learner who prefers the kinesthetic sense will be at a disadvantage in a teacher-centered setting. Each student prefers to be exposed to the material in the way that facilitates the optimum learning for them (Chiya, 2003). The next subsections will provide an explanation of the different types of perceptual learners.

1.7.3.1 Visual Learners

According to Renou (2009), people who "rely on their sight to take in information" are known as visual learners. These students possess a vivid imagination (Davis, 2007). When given visual aids like maps, handouts, flashcards, images, diagrams, and graphs, they are more likely to remember the material (Dunn & Missere, 2007). They value printed materials in textbooks and written information on the chalkboard in a classroom setting the most (Reid, 1998). Visual learners take a lot of notes in class and closely observe the body language and facial expressions of their lecturers (Montemayor et al., 2009). Visual exposure to words and illustrations in books or on charts, posters, the

chalkboard or in workbooks helps these children learn better. They favour reading-related jobs and frequently employ colourful highlighting techniques to make certain material stand out visually. Videos and other visual material are preferred by visual learners. Pamphlets, visual aids like overhead transparencies, or independent note-taking during lectures all significantly improve their learning (Dörnyei, 2005).

1.7.3.2 Auditory Learners

When someone prefers to learn through hearing and listening to words, they are said to be an auditory learner (Renou, 2009). Contrary to visual learners, aural learners benefit from and feel at ease in lectures and discussions (Scarcella, 1990). They retain the information they read or speak aloud (Renou, 2009). Auditory learners "interpret the underlying meaning of speech by listening to the tone of voice, pitch, speed, and other nuances," according to Montemayor et al. (2009). Videos, audiotapes, and CDs are the types of materials they are most comfortable with (Juris et al., 2009). Simply said, auditory learners gain knowledge by listening to themselves or to others. They can retain knowledge by speaking aloud while reading or by moving their lips. Participating in group projects and conversations improves their learning (Dörnyei, 2005). Some auditory learners attempt to memorise material by reading it aloud. By doing this, individuals convert the textual material into an audio version that suits them. When people talk to themselves as they think, they are more likely to remember information (Nilson, 2003).

1.7.3.3 Kinesthetic Learners

According to Bennouna (1999), kinesthetic learners retain information "primarily through the performance of body movements". This group of students "will use movement to help their concentration" (Davis, 2007). They must feel as though they are actively engaged in the learning process (Marcia, 1995). As a result, in a teacher-centered classroom, kids find it extremely challenging to remain motionless (Montemayor et al., 2009). Field outings, role-playing games and pantomime are beneficial to them (Reid, 1998; Daud, 2014; Dunn & Burke, 2008). They are more attentive in classrooms where instructors are actively involved. Moreover, instruction retention is enhanced when students are permitted to engage in classroom activities. Some researchers distinguish between a tactile learning style and a kinesthetic learning

style on the grounds that the latter requires the use of physical contact and manipulation, whereas the former emphasizes the engagement and movement of the entire body. (Dörnyei, 2005), but on the other hand, some researchers incorporate tactile into kinesthetic style in research (Renou, 2009). As an illustration, consider the Barsch Learning Style Inventory (1996) which lumps kinesthetic and tactual learners together without making a distinction. Thus, we comprehend that tactile and kinaesthetic learning methods can be combined into a single category.

1.7.4 Theoretical foundations on Perceptual learning styles

Various learning style modalities and classifications have been offered by various authors like Dunn & Dunn (1978); Gregorc (1979); Kolb (1984); Reid (1987); Oxford et al. (1991). In the preceding three decades, more than thirty learning style models have been devised, according to Felder and Henriques (1995). However, only models that are relevant to the ongoing investigation will be considered in this section.

Dunn and Dunn (1978) found five dimensions on which learning styles differed. They refer to students' preferred learning styles as their strengths since investigations conducted in labs and in classroom settings have shown that this is the case when students perform better when their preferred learning styles are used as teaching tools (Dunn, 1984; Dunn, 1990). The five dimensions are as follows: 1) environmental factors that consist of light, sound and temperature; 2) emotional factors like persistence, motivation, and responsibility); 3) sociological factors like working in pairs, peer groups, adults, self, and group work); 4) physiological factors that include sensory modalities like auditory, visual, tactile, kinesthetic, intake of food, time of day like morning, afternoon, evening and night, and mobility; and 5) psychological factors like being global or analytic, being impulsive or reflective, and being left brained or right brained. Research on brain hemisphericity and learning has shown that people who think more sequentially or analytically are better at handling grammatical structure and contrastive analysis, whereas people who think more rhythmically and with their right brain are better at understanding language intonation. Finally, impulsive learners jump to conclusions and make judgements without carefully considering all of their options (Prescott, 2001; Dunn & Dunn, 2003). In contrast, reflective learners carefully consider all of their options and weigh them before making a choice.

Gregorc (1979) identified two fundamental learning processes: perceiving concrete information or abstract information and arranging information sequentially or randomly. There are, consequently, four primary learning methods among students: (1) Concrete Sequential (CS), in which students exhibit a preference for learning that is organized and consists of specific schedules, clearly specified distinct necessities, and explicit expectations; (2) The Concrete Random (CR) method emphasizes hands-on learning, creative problem-solving, and brainstorming among its students; (3) Abstract Sequential (AS), in which students derive pleasure from conducting research and developing theories; and (4) Abstract Random (AR), in which students prefer collaborative work and interaction. As an individual develops and acquires knowledge, his or her learning preferences, as opposed to remaining constant throughout life, alter over time. A safe learning environment should be offered so that individuals can develop their learning styles. A secure location offers mental, physical, and emotional security. Teenagers in particular need to question authority and put their own ideas to the test. That is conceivable in a setting that allows for questioning and research, as well as in a setting where genuine learning may take place (Gregorc & Butler, 1984).

Barsch's (1980) model aims to identify a learner's preference for visual, auditory, or tactile/kinesthetic learning. Visual learners, as stated by Davis (1994), absorb information primarily through their eyes. If available, instructors should make every effort to utilize chalkboards, books, periodicals, posters, charts, photographs, films, and computer monitors. Auditory learners conduct their studies with their hearing. Educators may utilize radio, television, lectures, group discussions, recordings, and cassettes in the classroom. The instructor ought to provide explicit verbal directives accompanied by rationales. Kinesthetic learners require sight, sound, and action to learn. Teachers are required to provide mobile and touchable items for these students. Students should be encouraged to maintain written, visual, and electronic records of information by the instructor. Students should be capable of preparing, demonstrating, reporting, and evaluating models and real objects.

Reid (1987) identified the following six primary modalities of learning styles: 1) Visual learners who rely on their eyes to learn and prefer to view videos, images, text, and infographics, as well as other visual aids. 2) Auditory learners, who rely on their auditory senses for optimal learning, exhibit a preference for discussing the materials

presented to them while listening to lectures and audiotapes, as opposed to perusing them. 3) Kinesthetic learners are those who prefer to learn with their entire body, have a passion for performing and become easily frustrated when presented with only visual or auditory materials. 4) Tactile: learners who prefer experiments and hands-on activities, acquire knowledge most effectively through tactile experiences, and are easily distracted by materials that are only visual or auditory. 5) Group: in which students acquire knowledge more efficiently by collaborating with one another. 6) Individual: in which students acquire knowledge more efficiently by working independently. Reid (1987; 1998) was particularly intrigued by the degree of preference for these perceptual learning approaches. It is her contention that individuals who are learning possess multiple styles and, as a result, modify or alternate between them in response to their surroundings (Renou, 2009). She categorized these preferences according to a scale that extended from significant to inconsequential learning style preferences. An individual's strong grasp of the information is demonstrated when a particular preference is regarded as a significant one. On the contrary, it is identified as a deficiency when it receives a negligible preference score. Finally, a minor preference is positioned intermediately, signifying that it does not constitute either an abundance nor a deficiency.

Another model that has become well-known in the area of perceptual learning styles is Fleming's (1995) model. He is well recognised internationally for creating the VARK model. VARK stands for kinesthetic, auditory, read/write, and visual. His VARK model was developed in collaboration with Lincoln University in the year 1987. Before the work of Fleming, VAK was extensively employed. Fleming separated the symbolic Visual (V in VAK) and Read/Write (R) for text components into two distinct parts: Visual (V) and Read/Write (R). The consequence of this was the development of a fourth mode, Read/write. Fleming developed the VARK paradigm during his tenure as a New Zealand education system inspector. As a result of its emphasis on perceptual modes, VARK is classified as an instructional preference. Visual learners have a preference for various types of visual aids such as maps, charts, graphs, diagrams, highlighters, images, word pictures, and diverse spatial arrangements, according to Fleming (1995). Auditory learners derive pleasure from participating in lectures, establishing discussion groups, elucidating novel ideas to their peers, engaging in conversations with professors and fellow students, and acquiring fresh knowledge.

Read/write learners prefer to learn using materials like subjective materials, lists and points, essays that contain a lot of textual content, various reports, textbooks, descriptions and definitions, printed leaflets and brochures, readings from magazines or pamphlets, webpages, and taking down notes. Kinesthetic learners display a preference for activities such as field visits, excursions, activities and experimentations, and demonstrations (Fleming & Baume, 2006).

1.7.5 Determination of Perceptual learning style preferences in the present study

The dimensions of Perceptual learning style preferences for the present study are drawn from Reid (1987) and Fleming's (1995) theories on perceptual learning styles. The three styles are Visual learning (V), Auditory learning (A) and Kinesthetic learning (K). Tactile learning has been included under the umbrella of Kinesthetic learning as suggested by subject experts because in a subject like Biology where a lot of experiments, demonstrations, hands on activities, manipulations are required, touching objects and learning (tactile) and moving around and learning (kinesthetic) are very closely intertwined and go hand in hand together. Unlike Reid (1987) who also measures social learning and individual learning in her model, the present study measures only their preferences for V, A, K learning because the investigator is interested to measure only their perceptual modes of learning and not their social modes.

1.8 Significance of the present study

The importance of senior secondary education can be appreciated in light of the nation's rising need for higher education. In our country's educational system, the senior secondary level is crucial because it introduces students to two major dichotomies of course options: higher education and vocational education. Additionally, it serves as a link between secondary and tertiary education. The elementary and primary education curricula are the fundamental curriculum and only serve as a foundation for students; however, the secondary and senior secondary levels provide them with the opportunity to continue their studies in the subjects and fields of interest of their choice (NCERT, 2007).

In the current educational system, despite decades of work on developing educational policies, curriculum frameworks, establishing pedagogical guidelines, etc., we can still agree that learner centric education hasn't been fully realised and that individual

differences are still ignored. Although it is not a bad thing that passing tests has become the primary focus of schools, doing so has resulted in children carrying around a lot of information that they don't know how to properly digest. In this academic rush they have very little awareness of their own learning. Teachers are less concerned with their classroom teaching strategies, which may or may not be in line with the preferences of their students. This can occasionally lead to students being poorly adjusted in the classroom.

Research on learning shows that the brain facilitates all learning. The two hemispheres of the brain may even absorb and interpret information in different ways, according to brain studies. When presenting material to pupils in the classroom, teachers frequently use a preferred method of cognitive processing that is associated with the predominance of left or right cerebral hemisphere activity. For instance, one child may prefer a set structure for learning while another may prefer novel approaches to activities, and one child may execute tasks in an organised and systematic pattern while another may do so in an impromptu and imaginative manner. One student could not be paying attention in class very well yet benefit from visual stimulations, whilst another student in the same class might be a superb listener and particularly strong at internalising information. There is a lacuna in the educational process if the teacher is not aware of this diversity and is not catering to various student types.

Hence, determining whether senior secondary students recognise themselves as learners or not is the purpose of the current study. Are they conscious of their mental processes and preferred methods of learning? Has the educational system so far been able to develop kids who are so cognizant of their own metacognition? Learning can only take place when students are aware of what they are doing, how to improve themselves, and how to move forward. So, the question is, even after many years of education, have they learned to recognise their own learning styles and preferences or have they only been filling their heads with information?

Higher education is a step up from the senior secondary level. It's an important stage when they've already chosen the academic path they want to take in the future. In this study, the sample specifically comprises of Biology students of Class 12, who in the future might pursue an array of professional and academic courses. We are discussing tomorrow's physicians, nurses, educators, scientists, engineers, and entrepreneurs,

among others. The researcher, who is a Biology student herself, feels the need to ascertain whether a person's brain hemispheric patterns, awareness of cognition, and learning preferences are having an effect on how they perform academically in order to draw some significant educational conclusions and implications from the survey's findings and to improve the teaching-learning environment in the classroom. The results of the current study could offer guidelines and useful information for resolving various psychological and educational issues.

1.9 Statement of the problem

The statement of the problem has been formulated as: Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences as correlates of senior secondary school students' Academic achievement in Biology.

1.10 Rationale of the study

This thesis does not seek to absolutely resolve and concentre on the perfect model and measurement of students' brain hemispheric dominance patterns, metacognitive awareness, perceptual learning style preferences, and their impact on academic achievements but rather to contribute to the academic community's understanding through a descriptive analysis. It is meant to serve as a resource for researchers, teachers, educators, and other professionals who want a better understanding of these topics. It may help those who possibly may have only a thin awareness of the fields. Educators across all disciplines are progressively recognising the significant implication of comprehending the mechanisms of individual learning. Consequently, it is imperative that any endeavours to incorporate these psychological aspects into educational curricula are approached with a well-informed perspective. In spite of the fact that educators in every field are becoming increasingly conscious of the critical requirement of understanding how individuals acquire knowledge, it is of equal significance that any efforts to incorporate psychological aspects into educational programs are made from a place of knowledge.

The meanings of Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences have been established. It is also widely acknowledged that metacognitive awareness plays a significant role in the regulation and control of cognitive activities. According to literature, it is suggested that

metacognition is a core competency that students in grades XI and XII should acquire. This skill is important as it integrates various foundational competencies, including attitudes, skills, and knowledge, which are essential for students to learn at the school, class, and subject level (Kemendikbud, 2013). A review of the relevant literature indicates that several investigations have been conducted at various levels. However, it should be noted that there has been a limited amount of research conducted in the Indian context, particularly at the senior secondary level, focusing on a specific study sample consisting of Biology students. The majority of research investigations are undertaken in foreign countries.

Several researchers like Alam (2001), Sahu and Sood (2005), Mittal (2008), Gakhar (2008), Yala and Wanjohi (2011), Adodo and Oyeniyi (2013), Himghaempanah et al. (2014), Ow and Ikwut (2015), Panchu et al. (2016), and Lee et al. (2017) have investigated the influence of socio-economic status, internet addiction, learning and thinking styles, learning strategies, anxiety levels and achievement motivation, mental health and locality, students' perception of their teachers' attitudes towards them, as well as teachers' experience and educational qualifications on academic achievement. Adewole (2001), Xia (2005), Cubukcu (2008), Kummin and Rahman (2010), Rani and Govil (2013), Kristiani et al. (2015), Aghayousefi et al. (2016), and Siswati & Corebima (2017) conducted studies on metacognition and other variables at different levels. Hansen (2000), Wang et al. (2001), Gafoor (2008), Khalid et al. (2013), Bhakhshayesh (2014), Bhadawkar and Padmanabhan (2016), and Khan and Unnisa (2017) conducted research on learning styles in conjunction with other variables at different levels. Brain hemisphere dominance and learning styles were found to be researched separately in majority of studies. Many studies have been conducted on metacognition, learning and thinking styles, involving students, teachers, and prospective teachers in relation to several variables. However, there is a lack of research on the relationship between academic achievement and the three factors of brain hemispheric dominance, metacognitive awareness, and perceptual learning styles.

Given this information, the present study was formulated with the aim of contributing to the existing body of research on hemisphere laterality, providing support to the benefits of metacognition, and examining variations in learning preferences. The individual learners themselves may benefit by knowing more about their own dominant

modes of hemispheric processing. Teachers may benefit by recognising that these variances might have an impact on training, instruction, and knowledge acquisition. Understanding these individual differences, as well as how learning takes place and how teaching-learning strategies should be adjusted based on students' learning preferences, can assist educators in establishing a highly effective learning environment. This study would be of relevance to policy makers and curriculum experts in the education sector as it would assist them in evaluating our current educational policies and curriculum with the objective of incorporating these factors as fundamental elements of the teaching-learning process to enhance students' learning abilities.

1.11 Objectives of the study

1. To find out the Brain hemispheric dominance, Metacognitive awareness levels, Perceptual learning style preferences and Academic achievement levels in Biology of senior secondary school students.

2. To study the Brain hemispheric dominance, Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of senior secondary school students with respect to different demographic variables (gender and type of school).

3. To study the Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences of senior secondary school students with respect to their Academic achievement levels.

4. To investigate the relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement of left brained and right brained students.

5. To investigate whether Metacognitive awareness and Perceptual learning style preferences would be significant predictors of Academic achievement in left brained and right brained students.

1.12 Hypotheses of the study

	Hypotheses
Objective 2	**Gender:** $H_0$1: Brain hemispheric dominance has no association with gender. $H_0$2: There is no significant difference in the mean scores of Metacognitive knowledge with respect to gender. $H_0$3: There is no significant difference in the mean scores of Metacognitive regulation with respect to gender. $H_0$4: There is no significant difference in the mean scores of Visual learning style with respect to gender. $H_0$5: There is no significant difference in the mean scores of Auditory learning style with respect to gender. $H_0$6: There is no significant difference in the mean scores of Kinesthetic learning style with respect to gender. $H_0$7: There is no significant difference in the Academic achievement scores with respect to gender. **Type of school:** $H_0$8: Brain hemispheric dominance has no association with type of school. $H_0$9: There is no significant difference in the mean scores of Metacognitive knowledge with respect to type of school. $H_0$10: There is no significant difference in the mean scores of Metacognitive regulation with respect to type of school. $H_0$11: There is no significant difference in the mean scores of Visual learning style with respect to type of school. $H_0$12: There is no significant difference in the mean scores of Auditory learning style with respect to type of school. $H_0$13: There is no significant difference in the mean scores of Kinesthetic learning style with respect to type of school. $H_0$14: There is no significant difference in the Academic achievement scores with respect to type of school.
Objective 3	$H_0$15: Brain hemispheric dominance has no association with Academic achievement levels. $H_0$16: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on metacognitive awareness. H017: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on perceptual learning style preferences.
Objective 4	H018: There is no relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Left brained students. H019: There is no relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Right brained students.

Objective 5	$H_0$20: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Left brained students. H021: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Right brained students.

1.13 Operational definitions of the terms used

Brain hemispheric dominance: In this study, it refers to the consistency of an individual in utilising cognitive functions that are associated with the left hemisphere or the right hemisphere, leading to left hemispheric dominance or right hemispheric dominance. Some individuals are able to utilize cognitive functions associated with both the hemispheres in an equal and balanced way, leading to whole brain dominance. The brain hemispheric dominance of senior secondary students has been investigated with the help of the Brain Dominance Inventory (BDI) by Davis, Nur & Ruru (1994).

Left brainers/Left brained students: Students who consistently utilize functions associated with the left brain.

Right brainers/Right brained students: Students who consistently utilize functions associated with the right brain.

Whole brainers: Students who utilize functions associated with the left brain and right brain both in an equal way.

Metacognitive Awareness: In this study, it refers to having the knowledge about one's cognition and also having the ability to regulate one's learning. The Metacognitive awareness of senior secondary students has been measured with the help of the Metacognitive Awareness Inventory (MAI) by Schraw and Dennison (1994).

Perceptual learning style preferences: The way a person prefers to learn is their learning style and perceptual learning style preferences refers to the learning styles utilized by the students to learn Biology. In this study, the three perceptual learning styles are visual learning style (V), auditory learning style (A) and kinesthetic learning style (K). The perceptual learning style preferences of senior secondary students has been measured with the help of a self-developed tool.

Academic Achievement in Biology: It refers to the marks obtained by the students in the Achievement test in Biology which has been developed by the investigator for this study.

Senior secondary students: It refers to the students of Bio Science stream studying in Class XII with Biology as a major subject.

Gender: It refers to either males or females.

Type of school: It refers to either Private or Government senior secondary schools.

1.14 Delimitations of the study

The study was delimited to:

- Senior secondary students of Sikkim studying in Class XII.
- Students of Science stream studying Biology as one of the major subjects.

1.15 Organization of the thesis

This thesis has been presented in six chapters:

Chapter 1: This chapter presents an overview of the thesis and an introduction of the variables being researched. This chapter also includes the conceptual and theoretical underpinnings of the investigation, as well as its significance and rationale.

Chapter 2: Reviews of relevant literature from 2010-2023 are displayed in this chapter, along with an identification of the research gap based on the reviews. Further, the research objectives which forms the bridge to address the research gaps, the hypotheses and the operational definitions of the terms used are also presented.

Chapter 3: This chapter provides a comprehensive discussion of the research methodology employed to accomplish the research objectives. It encompasses the research design, population and sample selection, research instruments, their validity and reliability, data collection procedure, and the statistical tests utilized for data analysis.

Chapter 4: This chapter presents the findings of the study. Here, the results pertaining to every objective along with its analysis and interpretation are provided.

Chapter 5: The findings from the previous chapter are discussed in this chapter. This chapter examines and explains the interpretations of the results in the light of existing literature.

Chapter 6: This chapter provides an overview of the study's contribution to the current body of knowledge, as well as its educational implications. Additionally, a brief summary of the thesis is also provided.