LEARNING STYLES AND COGNITIVE EQUIVALENCE AMONG ELEMENTARY SCHOOL CHILDREN: A STUDY FROM ANTHRO-PEDAGOGICAL PERSPECTIVE

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1.0. Chapter-I: Introduction

1.1. Introduction

Education plays a vital role in influencing the paths of human existence and the advancement of society. Education is the process by which individuals gain knowledge, attitudes, values, and skills essential for understanding and dealing with their life's challenges and making positive contributions to society (Lamichhane, 2018). It is the key to developing concepts and fostering critical thinking, problem-solving, and creativity (Bailin, 1987). Education is not bound to formal institutionalised education, but it is much more. However, formal education plays a vital role in children's life. There are various stages of formal education, and the elementary school level is vital. It is the early formative stage of life where rapid physical, cognitive, social, emotional, and moral development occurs. It is considered the fundamental years where teaching and learning initially focus on the fundamentals of literacy and numeracy (Muhammadin & Pamungkas, 2024). However, the most significant developmental aspect of this stage is cognitive development. According to Piaget, cognitive development is the change in the cognitive structure and its functions (Cerovac & Keane, 2024). It encompasses modifications in mental abilities and functions. Various aspects of human cognition/cognitive development include thinking, reasoning, memorising, problem-solving, conservation, and cognitive equivalence.

Cognitive equivalence (CE) is a fundamental aspect of human cognition, which refers to the logical explains of similarity. It encompasses skills like recognising and categorising (Chen et al., 2024). CE plays a crucial role in the teaching-learning process within school contexts. Like other cognitive abilities, CE also varies from person to person based on various contexts, which parents and teachers should understand to ensure optimum development. Learning style (LS) is another significant aspect of human cognition that refers to the ways, patterns, or preferences in learning or processing information. Each individual prefers to learn, process, memorise, and retrieve information in their own way (Peña-Escalona, González-Garduño, & Cruz-Tamayo, 2024). Therefore, knowing LSs is crucial for students and teachers. Students can easily choose alternatives if they know their LS, and teachers can design their teaching strategies/styles (TSs) accordingly. It has empirically been proven that learning takes its optimum level when TSs match with the LSs. Interestingly, it enhances cognitive development when pedagogy is aligned with students' LSs (Muñoz-Pinargote & Alcívar-Castro, 2022). The stronger the relationship

between LSs and pedagogy, the more students' interest in learning will be enhanced, resulting in improved cognitive development.

Like all other cognitive abilities, LSs and CE are also not limited to a particular individual, group, or culture; these are universal. Further, these two aspects of cognitive development may be influenced by various factors like individuals' age, gender, physical growth pattern, education, schooling, and family dynamics, including education, culture, etc., collectively called anthro-pedagogical factors. The development and variations observed in LSs and CE are not exceptions for the Muslim children. Like their peers from other cultural backgrounds, Muslim community children also influenced by factors like family dynamics, educational practices, and cultural values whcih shape their cognitive development, highlighting the need for a nuanced understanding of how cultural contexts intersect with cognitive growth. We can gain insights into their learning and educational needs and developmental challenges by examining how these Anthro-pedagogical elements interact and manifest in Muslim children's cognitive growth, i.e. LSs and CE. This exploration is very significance, as it not only contributes to the broader discourse on cognitive development but also aims to foster a deeper understanding of the specific experiences of Muslim children.

The aim of this chapter is to orient the readers about different concepts and contexts of the study. It delves into various aspects of cognitive development, discussing the intricate interplay between individual and cultural factors and highlighting the implications for education and policy. This chapter highlights the significance and concept of the elementary school stage, cognitive development of elementary school children, especially of Muslim elementary school children, concept development, conservation, cognitive equivalence (CE), learning styles (LSs), Anthro-pedagogical and theoretical perspectives of the study.

2.0. Chapter-II: Review of Related Literature

When reading any research article, independent of discipline, the authors describe previous research to map and assess the research area to explore the research trends, identify the research gaps, formulate the study's objectives, and justify the research question and hypotheses. This is primarily known as the "literature review," or "research background" (Snyder, 2019). It is a process of evaluating previously conducted research by collecting, analyzing, and synthesizing more or less systematically to get an overview

of the field, to keep up with state-of-the-art research, to be at the forefront, to describe research insights, existing gaps, and future research directions (Baumeister & Leary, 1997; Tranfield, Denyer, & Smart, 2003, Snyder, 2019). Reviewing relevant literature is an essential feature of any academic research project. An effective review is crucial for advancing knowledge. It aids in theory development, addresses areas saturated with research, and highlights areas needing further investigation (Webster & Watson, 2002). However, for a literature review to be a research method, proper steps must be followed, and action must be taken to ensure the review is accurate, precise, and trustworthy (Snyder, 2019). As with any research, the worth of an academic review hinges on the actions taken, the findings obtained, and the clarity of the reporting (Moher et al., 2009). This chapter provides empirical evidence about cognitive development, conservation, cognitive equivalence, learning styles, and some significant factors related to these variables. It also presents the objectives and methodology of the present literature review and a brief overview of a wide range of related studies and their trends. Based on this literature review, the knowledge gaps were identified and the rationale was drawn. The objectives of the present literature review were:

1. To know the present research trends in the selected field;
2. To find out and critically analyze the most related literature to identify the research gaps in the existing literature;
3. To formulate research questions, stating the research problem, objectives, and hypotheses, as well as to identify the most appropriate research methods for the present study;
4. To gather information about the available research tools/instruments for measuring learning styles and cognitive equivalence and to select/develop the most appropriate instrument for measuring learning styles and cognitive equivalence;
5. To determine the key factors or variables for the present study.

While planning this study, the researcher followed the semi-systematic and integrative literature review approach. A semi-systematic literature review follows a systematic procedure like identifying search terms and setting inclusion-exclusion criteria, but it is not so much strict as a systematic literature review (Wong et al., 2013). The semi-systematic review helps to conceptualise research topic within diverse disciplines that hinder a full systematic review process (Wong et al., 2013). It also helps to identify

research gaps. Similar to semi-systematic review, integrative literature review is a research approach that integrates related literature followed diverse methods and conducted in diverse disciplines and cohesively reviews, critiques, and synthesizes to producing new frameworks and perspectives on the subject (Cronin et al., 2008; Torraco, 2005). In the present literature review, the researcher first identified a few search terms, keywords, and phrases related to the selected research area and specified some online research databases to find out the available research literature (Wong et al., 2013). Then, started gathering literature on those databases through the identified search terms. At the same time, the researcher also gathered research literature from printed journals and books. After that, all the identified search terms, keywords, and phrases were searched on the mentioned databases, and many studies (Articles and thesis) were found. However, only some of the studies were relevant to the present topic. Then, the researcher read the titles of the studies and downloaded only the studies related to the researcher's field. In the second phase, the researcher reviewed the abstract of the studies and excluded some more irrelevant studies. Finally, the researcher included the most related studies (N=66) for the full-paper review.

Table 2.1. The procedure followed for the Literature Review

Phases	Procedure	Description
Phase-1	Identification of Search terms (Keywords and Phrases)	"Cognitive development", "Learning Styles", "Cognitive Equivalence", "Equivalence", "Elementary School", "Elementary School Children", "Cognitive Development among Elementary School Children", "Pattern of Cognitive Development among Elementary School Children", "Influential Factors of Cognitive Development among Elementary School Children", "Demographic Perspective of Cognitive Development", "Teaching-learning Perspective of Cognitive Development", "Schooling and Cognitive Development", "Culture and Cognitive Development", "Concept development", "Concept Development among Elementary School Children", "Equivalence Judgement among Elementary School Children", "Similarity Judgement among Elementary School Children", "Conservation", "Classification", "Categorisation", "Learning Styles", "Learning Styles Preferences", "Learning Styles Preferences among School Children", "Demographic Perspective of Learning Style", "Teaching-learning Perspective of Learning Style".
Phase-2	Selection of Searched Databases	Online- Scopus, ScienceDirect, Google Scholar, ReaearchGate, ProQuest, and Shodhganga
		Printed- Journals, Edited Books
Phase-3	Inclusion Criteria	i. Studies were conducted on elementary school students aged 6 to 14 years. ii. Published between 2003 to 2023 (1966 to 2023 for the studies on equivalence). iii. Studies should provide sufficient information regarding the location of the study, participants, purpose, methodology, data collection tools and findings.
	Exclusion Criteria	i. Not available in the English language. ii. Unavailability of full texts. iii. Insufficient data.

2.1. Summary of the Trend Analysis

While carefully reviewing the full text of the included studies, the researcher prepared a review matrix side by side. Finally, based on the review matrix, the researcher analyzed the research trends presented at the end of chapter II. The trend analysis of the included sixty-six studies conducted between 2003 and 2023 (1966 to 2023 for studies on equivalence), revealed that thematically the highest number of studies were conducted on the cognitive development of elementary school children and the rest of the themes, like conservation, equivalence, and studies on LSs, were given less importance. A few studies were conducted on equivalence judgment. However, those studies were conducted long back in the 1970s or 1980s. Year-wise distribution of the studies on other themes showed unequal distribution. Location-wise analysis showed that most of the studies were conducted abroad, and only a few were conducted in Indian contexts. While research method/design was the concern, the analysis showed that a survey (cross-sectional or longitudinal) is the best suited for studying cognitive development and learning styles; experimental design is best suited for studying conservation and equivalence and the relationship between learning styles and cognitive development.

3.0. Chapter-III: Problem Statement

The primary purpose of this chapter is to describe the research problem and the procedure followed to identify it. It focuses on the researcher's assumptions, background, positionality, the rationale behind the present study, research questions, statement of the problem, and operational definition of the major terms, objectives, hypotheses, delimitations, and the conceptual framework of the present study.

3.1. Rationale of the Study

Human development is a lifelong process that starts from conception and continues until death (Hurlock, 1997, p. 23). The rate of development is speedy in the mother's womb and in the early years of life (Hurlock, 1997; Santrock, 2011). A child spends most of their early years in school, where the elementary school level is a vital stage. It is the foundational/ formative years. Among various types of development, like physical, social, emotional and moral, cognitive development is an essential aspect of this stage. The primary cognitive and behavioural functioning elements are set down during this period (Mohakud, 2017). The term 'cognitive' comes from 'cognition', which is an

umbrella term that refers to the process of obtaining knowledge, including perceiving, recognising, reasoning as well as judging (Bransford & Cocking, 2000). According to Taylor (2005), cognition is all our mental activities, thoughts, and thinking. Accordingly, 'cognitive development' refers to changes in mental abilities and functions like perception, thinking, reasoning, concept formation, intelligence, creativity, problem-solving, etc. Cognitive development plays a vital role in teaching-learning and daily life situations. Primarily, it helps humans deal with diversified environments effectively. Among the various aspects of cognitive development, conservation is an important one. Conservation refers to the knowledge about the invariance of quantities despite transformations in form, shape, or apparent size (Lambert & Spinath, 2017). While studying the cognitive development of human children, researchers give importance to each aspect which may influence cognitive development. Therefore, they started their study from the early pregnancy period to age-related changes and the influence of external factors. They consider that maternal pregnancy and birth-related issues such as type of birth (Polidano, Zhu, & Bornstein, 2017), birth time and birth weight (Oliveira et al., 2011), family environment and care (Morais et al., 2021; Ajayi et al., 2017; Peyre et al., 2016) has a significant impact on child's cognitive development. Nutritional status in the initial years (Ajayi et al., 2017; Kesari et al., 2010) and dietary intervention (Whaley et al., 2003; Watanabe, 2005) also impact children's cognitive development. Maternal education is also a vital determinant (González et al., 2020). Some of the researchers revealed that age plays a significant role in the development of conservation (Watanabe, 2019; Ahmad et al., 2018; Yenikalayci et al., 2018; Asante & Hanson, 2018; Ahmad et al., 2017; Lautrey et al., 1989), seriation and classification (Gakhar & Kaur, 1990). With age, children grow and start going to school and taking other educational interventions, which further impacts their cognitive growth (Parui, 2017). Early education or schooling (Ajayi et al., 2017; Burger, 2010), educational intervention programme (Malmberg et al., 2011), training (Rothenberg, 1969; Beridze, 2018; Dash & Dash, 1984; Asante & Hanson, 2018), pedagogical practices in the classroom like- use of stimulating package and multiple-intelligence approach (Mohakud, 2017; Delgoshaei & Delaware, 2012) helps in better cognitive development. Culture is also an essential factor in cognitive development. Some researchers reported culture's significant influence on conservation (Mukunthan, 2021; Goldschmid,1973). For example, considerable differences present in conservation between Canadian-Indian children and a group of Whites (Bowd (1975), between Indian and British children (Sharma, 1976), and between tribal and non-tribal

children (Sinha & Jha, 1989; Dash & Dash, 1984). Like culture, gender is another influential factor in cognitive development in general (Bart & Schils, 2014; Mierdel, 2019) and conservation in specific (Zarour, 1971; Omotoso & Shapiro, 1976). However, some researchers reported no significant gender differences in conservation (Riley, 1989; Sinha & Jha, 1989). Some other influential factors of conservation are residence (Uddinet et al., 2019) and socio-economic status (González et al., 2020; Bevli et al., 1989).

Like conservation, equivalence is another crucial aspect of cognitive development, which has two forms, identity and equivalence, and the former is the prerequisite for the latter (Piaget, 1968; Elkind & Schoenfeld, 1972). Identity refers to the ability to identify different attributes of objects or situations. Equivalence refers to the cognitive process by which individuals recognise that two or more objects or situations are equal or identical in some specific way despite possible differences in other respects. In the last decade, the term 'cognitive equivalence' (CE) was introduced to the ability to explain or justify grouping logically. It logically explains the similarity among objects or things (Khan, 2017; Khan & Mohakud, 2018). Olver and Hornsby's (1966) experimental studies are the initial and unique ones in equivalence judgment. They firmly stated that children and adults group discriminately different things and treat them as equivalent, and this equivalence judgement is a learned achievement (Olver & Hornsby, 1966). Group formation/categorisation is fundamental in equivalence judgment, which refers to the process of grouping objects, pictures, attributes, and so on based on similarity followed by some local or global rules (Harnad, 2017 cited in Brasselet & Arleo, 2018; Brasselet & Arleo, 2018). According to Bruner (1966), children represent their world through enactive, iconic and symbolic modes of representation and impose equivalence accordingly. Consequently, there are different bases of group formation or categorisation. It helps in finding patterns, which consequently helps in concept formation/development. Therefore, equivalence judgment is crucial in learning. Despite its so much importance, this aspect of cognitive development is overwhelming. Very few studies were conducted on equivalence judgement. A few studies reported that children performed better in equivalence judgment with non-symbolic problems than symbolic ones (Sherman & Bisanz, 2009). Their equivalence with verbal materials is more functionally based than pictures (Olver & Hornsby, 1966). It is also evident that pictorial stimuli have more perceptible responses than verbal stimuli (Wiviott, 1970). Early

studies by Olver and Hornsby (1966) established that students find similarities based on perceptible attributes, which go towards functional attributes at an early stage. The use of the perceptible basis of classification decreased, and attribute and nominal bases increased with grade levels, and high achievers used less perceptible categories and more attribute and nominal categories (Wiviott, 1970). Relational processing of colour develops more slowly than size or shape (Fahrmeier & Medin, 1977). The ability to discern numerical equivalence across different sets develops gradually with age (Mix, 1999). Carpentier and Smeets (2003) also stated that equivalence-equivalence is an age-related performance similar to classical analogies. Compared to sixth graders, college students tended to employ more abstract representational reasons for groupings, aligning with Piagetian assumptions of cognitive growth from concrete to formal thought (Fahrmeier & Medin, 1977). More recent studies on cognitive equivalence confirmed a consistent increase in cognitive equivalence abilities with age, perceptible equivalence decreased, and functional equivalence increased (Khan, 2017; Samanta, 2018; Khan & Mohakud, 2018; Bera, 2018). Age and grade levels, as well as learning, experience, and training, are significant factors in equivalence judgment. For example, experience with non-symbolic problems facilitates children's ability to apply successful concepts and strategies to symbolic equivalence problems (Sherman & Bisanz, 2009). Similarly, learning to read influences written word processing and affects optical object recognition among children (Caffarra et al., 2017). Okonji (1970) also reported that training on classificatory behaviour helps children to perform better in the animal-sorting task and utilise significantly more superordinate concepts than untrained children. Categorisation experience with colour and texture improves texture perception. Object perception differs based on categorisation background, with participants more sensitive to changes in objects learned at a subordinate level (Archambault, 1999). Markman (1992) revealed a significant role of analogical mapping during similarity judgments across mapping conditions. While similarity/ dissimilarity judgments in categorising paintings (Hughley, 1989) reported that similarity category and degree of realism were insignificant, similarity category and interaction were significant. However, socio-economic status (Gordon, 1971), sex/gender has no significant influence based on classification (Wiviott, 1970; Gordon, 1971), cognitive equivalence (Khan, 2017; Samanta, 2018; Khan & Mohakud, 2018; Bera, 2018). Similarly, other factors like habitat, family type, number of siblings, and schooling generation also have no significant influence (Khan, 2017; Samanta, 2018; Khan & Mohakud, 2018; Bera, 2018).

Learning Style (LS) is another critical aspect of cognition. LS refers to a person's natural, habitual and preferred ways of learning. Kolb (1981) sees learning style as "the way we process the possibilities of each new emerging event [which] determines the range of choices and decisions we see, the choices and decisions we make, to some extent determine the events we live through, and these events influence our future choices". It is a component of the broader concept of personality (Hawk & Shah, 2007), which varies from culture to culture (Yamazaki, 2005). LS play a significant role in the teaching-learning context and has many implications for students and educators. For example, the same kind of instruction is not helpful in all contexts and with all learners. It is most effective when matched to the learner's preferences (Pashler et al., 2009). Students grasp information in various ways; therefore, as facilitators of learning, teachers must employ the best teaching methods to match the student's learning styles (Johnson et al., 2022). Implementing various teaching strategies by identifying and applying students' learning styles would enhance information retention and depth of understanding (Chiu et al., 2019; Johnson et al., 2022). Identifying learning styles and providing a suitable learning environment aligned with students' preferences can foster their creative thinking and potential development (Demir, 2021; Yi et al., 2011). Students' achievement can be improved by matching each student's learning style with interactive learning methods (Adriana, 2011). Hamidon (2015) stated that most students can learn effectively if the lecture provides a blend of visual, auditory reading or writing and kinaesthetic activities. Therefore, it is essential to identify the learning style preferences of students.

While LSs are significantly influenced by some factors, LS itself also significantly influences some other cognitive abilities academic achievement (Ha, 2021; Bosman & Schulze, 2018; Stojanovska et al., 2015; Vaishnav, 2013; Rayneri & Wiley, 2006; Yoon, 2000), language achievement (Khodabakhshzadeh et al., 2017), spelling abilities (Olsson, 2010), childhood gross motor skills (Hayati, 2017). However, some studies reported that LSs and academic performance are unrelated (Yuliati et al., 2018; Yildirim et al., 2007; Dams, Kenneth Mark, 1994; Deanna Greene, 1984). LS models also improve emotional intelligence and problem-solving (Leasa, 2018), metacognitive awareness (Elevera, 2021), social arithmetic problem-solving (Soebagyo et al., 2022), and creativity (Puri, 2017). However, contradictory results are also present (Tsai, 2014). Learning style preferences vary across cultures, ethnicities, and locations, including

variations between native and non-native speakers (Leasa et al., 2018; Widharyanto & Binawan, 2020; Mulalic et al., 2009; Rayneri et al., 2003; Honigsfeld & Dunn, 2003; Reid, 1987; Vaishnav, 2013; Singh et al., 2015; Ewing & Yong, 1992; Massachi, 2000). Gender is another significant factor of LS (Mulalic et al., 2009; Honigsfeld & Dunn, 2003; Hamidon, 2015; Massachi, 2000; Ewing & Yong, 1992; Khodabakhshzadeh et al., 2017), though studies in Indonesia and India found no significant gender differences (Park, 2000; Nasution et al., 2019; Singh et al., 2015). Similarly, factors like religion, father education level (Singh et al., 2015), teaching processes and academic achievement (Wilson, 2011) also reported no significant impact on LS preferences.

Based on the above discussion, the extensive literature review and the trend analysis on different areas of cognitive development, it is evident that many studies have been conducted in the field of cognitive development in general, conservation, equivalence judgement and learning styles. The studies on cognitive development explored the influence of prenatal and birth-related factors like type of birth (e.g., natural vs. caesarean) and birth conditions, such as birth weight and timing, prenatal environment and maternal health, including factors like maternal education on cognitive development. Some of the researchers explored the role of family structure, caregiving practices, home environment, nutritional status in the early years, dietary interventions, early education, including pre-schooling, interventions and training programs, pedagogical methods, cultural context, gender, the socio-economic background also found to be a significant factor in cognitive development.

The studies on equivalence judgement showed age-related changes, shifting from identity recognition to complex grouping abilities, from perceptual to functional and abstract. The studies also explored the nature of equivalence judgments with symbolic and non-symbolic stimuli, verbal vs. pictorial materials and the role of analogical mapping. Some studies reported some influential factors of equivalence judgement, such as socio-economic status, gender, and family background factors. Some studies also explored the role of teaching practices and training on categorisation abilities and equivalence judgement.

Though many studies have been conducted, there are potential research gaps that need special attention from researchers. The studies conducted on children's cognitive development are in different areas of mental performance, such as gross-motor skills, language achievement, and academic achievement in various subject areas and

conservation; however, very few studies were found that focused on equivalence judgement. Further, most of the studies on equivalence judgement considered mathematical or logical equivalence but not categorisation and cognitive equivalence. They also used different methods and tools/techniques to measure equivalence. Most of the studies on equivalence were from various cultures and locations, mostly abroad; a few were conducted in the Indian context. However, those studies have explored varied types of equivalence, such as perceptible, functional, nominal, attributional, affective, and fiat equivalence. However, rare research analysed all of these types of equivalence in a single study. Limited studies focus on how family and community practices unique to specific cultural backgrounds affect cognitive equivalence in young children. Apart from rarely, research examines cognitive equivalence in ethnically or linguistically diverse elementary classrooms.

Some of the LS researchers explored the preferences of learning styles and cultural and demographic variability in learning styles. Interestingly, most LS research focuses on older students. A few studies reported the influence of LSs on cognitive abilities like emotional intelligence, problem-solving, critical thinking, creativity, language development, gross motor development, concept development, critical thinking, problem-solving and creativity. Researchers also established the relationship between LSs and pedagogical practices and educational outcomes. Though many studies have been conducted on LSs, there are potential research gaps in this field, which also need researchers' attention. While some researchers explore demographic influences on LSs, few studies examine how parental education or socio-economic status might affect LS preferences. While parental education levels affect cognitive outcomes, research rarely investigates if and how they influence cognitive equivalence and LSs among young children. Interestingly, no study measured the influence of learning styles on equivalence. No study explored all aspects of CE in a particular cultural group by considering LSs and various anthropological and pedagogical factors. Moreover, mixed results in gender and cultural studies suggest a need for more nuanced analyses of how LS preferences relate to intersecting identities, such as religion and gender, better to understand the role of social identity in learning preferences.

These identified research gaps and the researcher's personal experience raise the following questions-

1. What is the status of the development of cognitive equivalence among elementary school children?
2. Are there any anthropological or Pedagogical factors that can influence CE among elementary school children?
3. Do all elementary school children prefer the same learning style or differ in their LS preferences?
4. Do CE and LSs change with age?
5. Are there any anthropological or Pedagogical factors that can influence LS preferences among elementary school children?
6. Is there any association between learning style preferences and cognitive equivalence among elementary school students?
7. Are there any potential anthro-pedagogical factors that can moderate the relationship between LSs and CE among elementary school students?

The insights underscore the importance of examining the development of equivalence within a specific ethnic and education-related backdrop of Muslim elementary school children in West Bengal, who may present unique developmental patterns due to their distinct cultural influences.

3.2. Statement of the Problem

In light of the rationale, the identified research gaps, and the above-raised questions, the problem for the present study can be stated as "**Learning Styles and Cognitive Equivalence among Elementary School Children: A Study from Anthro-Pedagogical Perspective**".

3.3. Operational Definition of the Major Terms Used

An operational definition in research outlines the specific processes or criteria employed to measure or identify a particular variable. It converts abstract concepts into measurable variables, ensuring they are accurately and consistently stated. The key terms or concepts used in this study are operationally defined by the researcher as given below:

Cognitive Equivalence (CE): It refers to the ability to find similar characteristics among different objects/things/situations, or it is the logical explanation of how different things/ objects are alike. The grounds for similarity explanations may be perceptible, functional, nominal, affective, and fiat. In the present study, we referred to these as perceptible equivalence (PE), functional equivalence (FE), nominal equivalence (NE), affective

equivalence (AE), and fiat equivalence (FiE), respectively. CE can be measured by presenting different types of objects/stimuli. In this study, three different types of stimuli, viz. pictures, models and words, were used, and the respective measured abilities were considered as picture-based cognitive equivalence (PCE), model-based cognitive equivalence (MCE), and word-based cognitive equivalence (WCE).

PE refers to the logical explanation of similarity from perceptible or structural viewpoints. One may determine the items equivalent based on immediate phenomenal qualities such as colour, size, shape, position in time or space, etc. For example, a cycle, bike, and car are the same because they are red and all have wheels.

FE refers to the logical explanation of similarity based on functions or uses. One may draw equivalence by considering what they do or what can be done to them. For example, a cycle, bike, and car are the same because we use them for travelling.

NE refers to the logical explanation of similarity based on common names. One may draw equivalence based on a general identity or common name. For example, cycle, bike, and car are the same because they are vehicles.

AE refers to the logical explanation of similarity involving affections or emotions. One may draw equivalence by relating their emotions with objects/attributes. For example, rose, lotus and marigold are beautiful flowers, and I love those.

FiE refers to a child's inability to give justification after forming groups. For example, cycle, bike, and car all are similar, but I can't say how, or the child may stay silent after forming the group.

PCE refers to the logical explanation of similarity on picture-based tasks. The explanations may be perceptible, functional, nominal, affective or fiat type.

MCE refers to the logical explanation of similarity on model-based tasks. The explanations may be perceptible, functional, nominal, affective or fiat type.

WCE refers to the logical explanation of similarity on word-based tasks. The explanations may be perceptible, functional, nominal, affective or fiat type.

Learning Styles (LSs): Generally, learning styles refer to the preferred ways to learn, understand, and process information. There are various LS models and, consequently, different LSs. One of the most preferred models is Neil Fleming's VARK model. Where 'V' represents Visual Learning Style (VLS), 'A' represents 'Auditory Learning Style' (ALS), 'R' represents 'Read/Write Learning Style' (RWLS), and 'K' represents 'Kinaesthetic Learning Style' (KLS). In the present study, LSs refer to participants' preferences from one or a combination of two or three from the Fleming's VARK model.

The preference of one style, for example, V or K, is considered unimodal LS, and the preference of a combination of two or more styles is considered multimodal LS.

VLS refers to individual's preference to process, understand and retain information more effectively through visuals like images or pictures, diagrams, charts, and videos, and the persons who prefer this model are known as visual learners.

ALS refers to individual's preference to process, understand and retain information more effectively through auditory inputs like verbal explanations or lectures, discussions, listening to recordings, and the persons who prefer this model are known as auditory learners.

RWLS refers to individual's preference to process, understand and retain information more effectively through textual information like reading and writing tasks, such as taking notes, reading books, completing worksheets, and writing essays, and the persons who prefer this model are known as read/write learners.

KLS refers to individual's preference to process, understand and retain information more effectively through hands-on experiences and physical activities that involve movement, touching and doing, such as experiments, simulations, and role-playing, and the persons who prefer this model are known as kinaesthetic learners.

Elementary School Children: In India, the elementary school level refers to Class-I to Class-VIII, which covers the six-to fourteen-year-old age group. In the present study, elementary school children refer to the students studying in Class I to class VIII in different schools in India.

Muslim Elementary School Children: Muslim elementary school children refer to elementary school children (as defined earlier), who belong to the Muslim ethnic community.

Anthro-Pedagogical Perspective: In the present study, the term Anthro-Pedagogical Perspective refers to the integration of anthropological variables such as type of birth, birth order, BMI and pedagogical variables such as class level and parental educational qualifications.

3.4. Objectives of the Study

The present study was undertaken to meet the following objectives:

1.0 To develop and standardise an instrument to measure CE among Muslim elementary school children;

2.0 To measure the average number of stimuli and total time taken for forming groups of concepts by each class of Muslim elementary school children;

2.1 To measure the average number of stimuli taken by each class of Muslim elementary school children to form groups of concepts in the context of CET, PCET, MCET, and WCET;

2.2 To measure the average time taken by each class of Muslim elementary school children for completion of CET, PCET, MCET, and WCET to form groups of concepts;

3.0 To analyse the variations in CE among Muslim elementary school children caused by Anthro-pedagogical factors (Age, class, gender, birth type, birth order, BMI, number of siblings, parental educational qualification, family type, and family monthly income);

3.1 To analyse the variations in overall CE among Muslim elementary school children caused by anthro-pedagogical factors;

3.2 To analyse the variations in test-wise CE among Muslim elementary school children caused by anthro-pedagogical factors;

3.3 To analyse the variations in dimension-wise CE among Muslim elementary school children caused by anthro-pedagogical factors;

4.0 To identify the preferred LSs among Muslim elementary school children;

5.0 To find out the association between anthro-pedagogical factors (Age, class, gender, birth type, birth order, BMI, number of siblings, parental educational qualification, family type, and family monthly income) and LSs preference among Muslim elementary school children;

6.0 To assess the influence of LSs on CE among Muslim elementary school children;

6.1 To assess the influence of LSs on OCE among Muslim elementary school children;

6.2 To assess the influence of LSs on test-wise CE among Muslim elementary school children;

6.3 To assess the influence of LSs on dimension-wise CE among Muslim elementary school children;

7.0 To explore the moderating effect of selected anthro-pedagogical factors, i.e. number of stimuli taken, total time taken, age, BMI and family monthly income in the relationship between LS preference and CE among Muslim elementary school children.

3.5. Hypotheses of the Study

Keeping in mind the research questions and the stated objectives, the researcher formulated the following null hypotheses:

- **$H_0$1:** The variations in OCE among Muslim elementary school children are not significantly caused by anthro-pedagogical factors, i.e. age, class, gender, birth type, birth order, BMI, number of siblings, parental educational qualification, family type, and family monthly income.
- **$H_0$2:** Variations in the selected anthro-pedagogical factors do not significantly cause variations in test-wise CE (i.e. PCE, MCE and WCE) among Muslim elementary school children.
- **$H_0$3:** Dimension-wise CE (i.e. PE, FE, NE, AE and FiE) do not significantly vary due to variations in the selected anthro-pedagogical factors among Muslim elementary school children.
- **$H_0$4:** There are no significant associations between anthro-pedagogical factors and LS preference among Muslim elementary school children;
- **$H_0$5:** OCE does not vary significantly across various LS preferences of Muslim elementary school children.
- **$H_0$6:** Test-wise, CE does not vary significantly across various LS preferences of Muslim elementary school children.
- **$H_0$7:** Dimension-wise, CE does not vary significantly across various LS preferences among Muslim elementary school children.
- **$H_0$8:** Selected Anthro-pedagogical factors (i.e. number of stimuli taken, total time taken, age, BMI and family monthly income) have no significant moderation effects in the relationship between LS preference and CE among Muslim elementary school children.

3.6. Delimitations of the Study

To clearly define the scope of the study and to specify the research objectives, the present study is delimited to the following areas:

1. Only elementary school students studying in Class-I, II, III, IV and V in Rural area of Purba Bardhaman district in the state of West Bengal, India, were considered;
2. Only two Bengali Medium schools affiliated to WBBPE were considered for this study;

3. As the present study concerns the Anthropological viewpoints, consequently to give a culture-specific perspective, only 175 Muslim students are included in the present study;
4. To identify the LS preferences of the participants, only one LS inventory is used (the VARK Model);
5. The cognitive equivalence test (CET) was used to measure the CE of Muslim elementary school children;
6. In the present study, OCE, PCE, MCE, WCE, PE, FE, NE, AE, and FiE were considered as dependent variables;
7. The Anthro-pedagogical factors like age, class, gender, birth type, birth order, BMI, number of siblings, parental educational qualification, family type, and family monthly income were considered in the present study, which further considered as independent and moderating variables;
8. In the present study, class, gender, birth type, birth order, number of siblings, parental educational qualification and family type were considered independent variables;
9. In the present study, LS was considered as both dependent and independent variable;
10. In the present study, the number of stimuli taken to form groups and time taken to complete the CETs were considered as both dependent and moderating variables;
11. In the present study, age, BMI and family monthly income were considered as both independent and moderating variables.

3.7. Significance of the Study

The present study holds significant importance in education and related fields as it explores the associations between LSs and CE among Muslim elementary school children through an anthro-pedagogical perspective, addressing a critical gap in educational research. By focusing on a specific ethnic and educational context, it seeks to understand unique cognitive developmental patterns influenced by culture and pedagogy-related factors. The study's outcomes can contribute to the field of education in many ways. The research provides insights into the status and development of CE among elementary school children, examining how various anthropological and pedagogical factors influence its growth. By identifying the preferred LSs of Muslim elementary school children, the study can guide educators in designing instructional strategies to

accommodate diverse learning needs, enhancing student engagement and performance. The findings on the relationship between LS preferences and CE will contribute to the theoretical understanding of how children process and organise knowledge, which can inform classroom practices and curriculum development. By analysing the moderating effects of Anthro-pedagogical factors, the study sheds light on how these variables can influence the relationship between LS preferences and CE, providing a holistic view of the learning process. The insights gained can inform policymakers to design educational interventions and support systems tailored to Muslim elementary school children's socio-cultural and developmental needs, promoting equity and inclusivity in education. Ultimately, this study seeks to bridge the gap between anthropology and pedagogy in the educational context, offering a comprehensive framework to understand and enhance children's cognitive and learning processes.

3.8. Conceptual Framework

Based on the theoretical and conceptual perspectives discussed in chapter I, the researcher developed a conceptual framework that represents the associations between LSs, CE, and Anthropo-pedagogical factors. The conceptual framework for the study can be presented as:

A. Variables:

	Independent Variable/s	Moderating variables	Dependent Variable/s
1.	Anthro-pedagogical Factors	-	Cognitive Equivalence and Learning Styles
2.	Learning Styles	-	Cognitive Equivalence
3.	Learning Styles	Number of Stimuli taken, Time taken, age, BMI and family monthly income	Cognitive Equivalence

B. Theoretical Links:

Bruner and Olver & Hornsby's equivalence judgement model states that children represent their world through different modes (enactive, iconic and symbolic) consequently categorise objects of their world differently and impose equivalence on them accordingly. This categorisation and equivalence judgement of children differ from adults.

Fleming's learning style model (VARK) classifies learners as Visual, Auditory, Read/Write and Kinaesthetic Learners states that students learn bets by their preferred ways of learning, which further excel their cognitive performance.

Bronfenbrenner's ecological systems theory states that the environment/society/culture (the ecological systems) where a child born and brought up have significant influence on their development and learning.

C. Hypothesised Relationships:

Anthro-pedagogical factors → CE: Anthro-pedagogical factors influence CE and LSs

LSs → CE: LSs influence CE

LSs→ [Selected Anthro-pedagogical factors] →CE: The selected Anthro-pedagogical variables (Number of Stimuli taken, Time taken, Age, BMI and family monthly income) potentially moderate the relationship between LSs influence CE

D. Visual Representations:

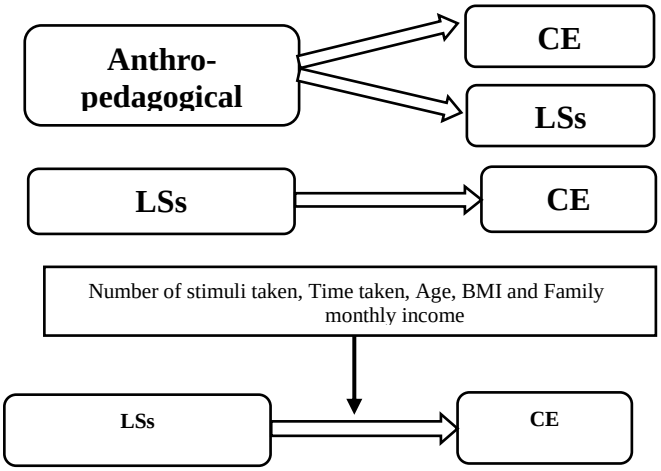

Fig. 3.2. Conceptual Framework

4.0. Chapter-IV: Methodology of the Study

The success and quality of any research are determined by the methodology used to conduct it (Sahu, 2013). A correctly identified and implemented method could increase the genuenity and predictability of the research findings (Blackford, 2017). The primary purpose of this chapter is to describe the research design, locale of the study, participants of the study, description of the variables, method and procedure, tools and techniques of data collection and analysis, ethical considerations and analysis designs.

4.1. Research Design

The present study is a quantitative, descriptive, observational study with a cross-sectional design. For this study, the researcher collected numerical data regarding the cognitive equivalence of the participants and measured its relationship with learning styles and

other Anthro-pedagogical variables using statistical techniques. Quantitative researchers often collect numerical data and try to establish relationships between variables through statistical techniques (Gay, Mills & Airasian, 2014; Creswell, 2012). This study also provides a description of participants' performance with the help of descriptive and inferential statistics without manipulating any variable. A descriptive study simply describes data on a variable of interest without manipulating the variables (Cohen, Manion & Morrison, 2007). It is also an observational study because the researcher administered the cognitive equivalence test (CET) to the participants, observed their engagement with the CETs and noted their performance. In this study, the researcher included different age groups of children studying in Class I, II, III, IV and V in the academic year 2023, gathered data about their learning styles and cognitive equivalence, and compared concerning Anthro-pedagogical factors. Cross-sectional studies use a snapshot of participants' beliefs, behaviours, or other variables of interest of a study population at a specified point in time (Maier et al., 2023; Mertens, 2010; Olsen & George, 2004). The specific research design is given in Fig. 4.2. in the last section of this chapter.

4.2. Locale of the Study

The present study was conducted in Purba Bardhaman District in West Bengal, India. Purba Bardhaman district is one of the important districts of the Burdwan Division in West Bengal. It is situated between Latitude 23o53′ N to 22o56′ N and Longitude 88o25′ E to 87o56′ E. The principal town and administrative headquarters is Burdwan. As per the census of 2011, the district covers an area of 5432.69 km^2. Purba Bardhaman district was recast from Bardhaman district in 2017. The district had a total population of 4,835,532, with 51% males and 49% females. Most (84.98%) of the people of this district live in rural areas. By religion, 73.75% are Hindus and 25.14% are Muslims; rest are other religious people (Census report, Govt. of India, 2011). About 58 per cent of the total population depends on agriculture. The undivided Burdwan district was known as the rice bowl of Bengal because it was the largest producer of rice in West Bengal, and the bulk of it was produced in the Purba Bardhaman district. As per the census 2011, the total literacy rate of the district is 75.48%. The district constitutes four subdivisions [Bardhaman Sadar (North), Bardhaman Sadar (South), Katwa and Kalna], twenty-three blocks and six municipalities (Govt. of West Bengal, 2024). Six blocks are under the Kalna subdivision (Purbasthali-I, Purbasthali-II, Kalna-I, Kalna-II, Kalna (M) and

Monteswar). The specific location of the study is Purbasthali-I Block, the rural part of the district. The total area of the block is 148.44 km^2. The total population of the block is 206,977, where 74.7% are Hindus and 24.95% are Muslims; the rest are followers of other religions. The total literacy rate of the block is 77.59 per cent, where the male literacy rate is 74.41%, and the female literacy rate is 64.05%. By occupation, the block is dominated by agriculture, but weaving and bidi factories are also present. Besides household work, many women are engaged in bidi-making and weaving. This study was conducted in two primary schools, Nasipur Free Primary School and Singhajuly Free Primary School. Both the schools are government-sponsored, Bengali-medium schools affiliated with WBBPE and located in a Muslim-populated area. The location where the study was conducted is shown in Fig. 4.1.

4.3. Participants of the Study

4.3.1. Population

The Muslim elementary school-going children (studying in Class I to VIII) of West Bengal, India, aged six to fourteen years, constitute the target population for the present study. In West Bengal, elementary schools are divided into lower primary levels (Class I to IV) and upper primary levels (Class V to VIII) (Government of West Bengal, 2012). In the last few years, the school education department of West Bengal started shifting Class V to the lower primary level (Government of West Bengal, 2019). Therefore, few lower primary schools offer education up to Class V (For government-aided/or sponsored schools). As of 2023, in West Bengal, there are 58110 elementary schools. Of these, 31379 lower primary schools offer education from Class I to IV, and 17996 schools offer Class I to V. Further, 8735 (as of 2021) schools offer upper primary education (Class V to VIII). In the academic year 2023, there were 7195728 students in the lower primary level (Class I to V) (Govt. of West Bengal, 2023). The researcher could not identify the data concerning the exact number of students, and Muslim students in particular in Class I to V level under WBBPE. The estimated percentage of the Muslim population in West Bengal in 2023 is about 27% of the total population (Hussain et al., 2012). So, the assumed number of Muslim students studying in Class-I to V is 1942846 [27% of 7195728].

4.3.2. Determination of Sample Size

As of 2023, there were 3111 elementary schools (Class-I to VIII) and 967 lower primary schools (Class-I to V) in the Purba Bardhaman district, and the total number of students

in elementary level was 58029, and at the lower primary level (Class-I to IV) the number is 44179. At the upper primary level (Class V to VIII), it is 13850 *(Govt. of West Bengal, 2023*). The researcher could not identify the data concerning the exact number of students, and Muslim students in particular in Purba Bardhaman district, who are studying in Class I to V level under WBBPE. The number was assumed to be around 47641 [44179 at Class I to IV level, plus, for Class V, 25% of the upper-primary level, i.e. 13850/4=3462]. The estimated number of Muslim students studying in Class-I to V is 12863 [27% of 47641] (Hussain et al., 2012). As per Morgan's table, when the population size is more than ten lacs, the suitable sample size in questionnaire-based survey research is 384 or more (Krejcie & Morgan, 1970). However, the present study is not questionnaire-based, rather the researcher used an interview schedule, and task-based observation. On average, data collection took about an hour per participant, making the process time-consuming and challenging to conduct with a large sample size. So, the researcher included 175 Muslim elementary school children and their respective parents/guardians as participants in this study.

4.3.3. Sampling Procedure and Sample of the Study

The researcher employed purposive and random sampling techniques to select the sample for the present study. A purposive sample is one whose characteristics are defined for a purpose relevant to the study (Andrade, 2021). On the other hand, the random sampling method ensures the probability of each population unit being selected as representative (Rahman, 2022; 2020; Jawale, 2012). As the present study was delimited to Muslim elementary school children studying in Class I to V, therefore, the researcher purposively selected the mentioned two schools because both the schools were located in Muslim-populated areas and offered lower primary education from Class I to V. In Nasipur Free Primary School, there were 60 students, and all were Muslims. In Singhajuly Free Primary School, there were 197 students, of which only one non-Muslim student. As the target population of the study is Muslim students, therefore, that particular student was eliminated from this study. After that, participants were selected randomly from each Class. However, at the data cleaning stage, three participants were excluded from the final consideration because of the unavailability of some anthro-pedagogical information. Therefore, finally, the sample constituted 172 Muslim elementary school children [Class I (n=28), Class II (n=34), Class III (n=30), Class IV (n=38) and Class V (n=42)] and their respective parents/guardians. The

parents/guardians were included in this study because the students were too young to provide some of the Anthro-pedagogical information like- birth type, birth order, family type, and family monthly income. Therefore, for accuracy and reliability, the information was collected from their parents/guardians through an interview schedule. The detailed distribution of the sample has been presented in Table 4.1.

Table. 4.1. Anthro-pedagogical Profile of the Participants

Variables	**Labels**	**N**	**Percent**
Class	Class-I (7;4)	28	16.3
	Class II (8;6)	34	19.8
	Class-III (9;4)	30	17.4
	Class-IV (10;55)	38	22.1
	Class-V (11;55)	42	24.4
	Total (9;75)	172	100.0
Gender	Male	77	44.8
	Female	95	55.2
Birth Type	Normal Delivery	95	55.2
	Caesarean Delivery	77	44.8
Birth Order	1st	87	50.6
	2nd	67	39.0
	3rd	18	10.5
BMI Level	Underweight	147	85.5
	Normal Weight	20	11.6
	Over Weight	5	2.9
Number of Siblings	Single Child	25	14.5
	Having One Siblings	112	65.1
	Having More than One Siblings	35	20.3
Father's Educational Qualification	Illiterate	16	9.3
	Up to Class-IV	29	16.9
	Class-V to VIII	86	50.0
	Class-IX to X	20	11.6
	Class-XI and Above	21	12.2
Mother's Educational Qualification	Illiterate	13	7.6
	Up to Class-IV	29	16.9
	Class-V to VIII	67	39.0
	Class-IX to X	42	24.4
	Class-XI and Above	21	12.2
Family Type	Joint Family	42	24.4
	Nuclear family	130	75.6
Family Monthly Income	Up to 6174	70	40.7
	6175 to 18496	91	52.9
	18497 to 30830	11	6.4

Note: The mean age of the participants is given in parenthesis in years and months (YY;MM) for each Class

4.4. Description of the Variables Under Consideration

A variable is something that varies in value. These are observable features of something that can take on several different values or can be put into several discrete categories (Lewis-Beck et al., 2003). Variables may be independent, dependent, mediating, or moderating, depending on how they are employed in a research study (Bhattacherjee, 2012). Based on the identified research problem and objectives, two types of variables were considered in this study and categorized into two broad heads: Anthro-Pedagogical variables and measured variables. Further, based on the hypothesis, these variables were considered as truly dependent variables (OCE, PCE, MCE, WCE, PE, FE, NE, AE, and FiE), truly independent variables (class, gender, birth type, birth order, number of siblings, parental educational qualification and family type), both dependent and independent variables (LSs), both dependent and moderating variables (Number of stimuli taken to form groups, Time taken to complete the CE tests), and both independent and moderating variables (age, BMI and family monthly income).

4.4.1. Measured Variables

In this study, the researcher considered OCE, Task-based CE (PCE, MCE and WCE), dimension-based CE (PE, FE, NE, AE and FiE), number of stimuli taken to form groups, Time taken to complete the CE tests, and LSs as measured. Though there was no highest limit of the scores in CE, a high score in these variables indicates higher cognitive ability, and vice versa.

- **Overall Cognitive Equivalence (OCE):** The sum of a student's scores in all three cognitive equivalence tests (CETs).
- **Picture-based Cognitive Equivalence (PCE)**: It is the sum of the scores a student gets in all the five dimensions of CE in the PCET.
- **Model-based Cognitive Equivalence (MCE)**: The sum of a student's score in all the five dimensions of CE in the MCET.
- **Word-based Cognitive Equivalence (WCE)**: The sum of scores a student got in all the five dimensions of CE in the WCET.
- **Perceptible Equivalence (PE):** The total of a student's scores for his/her perceptible responses in all eighteen trials under all sub-tests of CET [6x3=18].
- **Functional Equivalence:** The total of a student's scores for his/her functional responses in all eighteen trials under all sub-tests of CET.

- **Nominal Equivalence (NE):** The total of a student's scores for his/her nominal responses in all eighteen trials under all sub-tests of CET.
- **Affective Equivalence (AE):** The total of a student's scores for his/her nominal responses in all eighteen trials under all sub-tests of CET.
- **Fiat Equivalence (FiE):** The total of a student's scores for his/her inability to explain similarity after group formation with stimuli in all eighteen trials under all sub-tests of CET.
- **Number of stimuli taken to form groups:** The mean/average of the number of stimuli a student takes to form a group in all eighteen trials under all sub-tests of CET. Though the minimum number is 2, students can take as many stimuli as they want from the given stimuli.
- **Time taken for completing the CET:** The sum of time each student takes to complete all eighteen trials under all sub-tests of CETs [6x3=18].
- **Learning Styles:** These are the preferences for LSs. This study followed the VARK model, and students were labelled as unimodal-visual, auditory, read/write, or kinaesthetic learners. Further, based on multiple preferences, they were also labelled as multimodal learners.

4.4.2. Anthro-Pedagogical Variables

In the present study, the considered Anthro-Pedagogical variables were age, class, gender, birth type, birth order, BMI, number of siblings, parental educational qualification, family type and family monthly income as discussed below:

- **Age:** In this study, age refers to biological or chronological age, and this variable was measured in years and months (YY; MM).
- **Class:** It refers to the grade or class in which the child studies in school. This study includes Class I, II, III, IV, and V students.
- **Gender:** Gender represents a person's social identity, unlike sex, which is biological. It was a dichotomous variable, with two major categories: male and female.
- **Birth Type:** Birth type refers to the type of delivery in which a child is born. It was a dichotomous variable; the two major categories were normal delivery (normally born) and caesarean delivery (caesarean-born).
- **Birth Order:** Birth Order refers to the order in which a child is born. For example, if someone has two children, the elder child's birth order is first, and the

younger child is second. It is discrete, and in the present study, the researcher found children's birth order up to third.

- **Body Mass Index (BMI)**: BMI is a quantitative measure derived from an individual's weight and height. It is calculated as weight in kilos divided by height in square meters. It serves as a criterion to classify individuals into several weight categories: Underweight (BMI < 18.5), Normal weight (BMI=18.5 to 24.9), Overweight (BMI=25.0 to 29.9), and Obesity (BMI ≥ 30.0).
- **Number of Siblings:** The number of Siblings is a discrete variable. In this study, the researcher found that some participants were single children, some had one sibling, some had two siblings, and only five participants had three siblings. Therefore, to get a well distribution, the researcher categorised the participants into groups and merged the participants having two and three siblings into more than one sibling group. Therefore, in this study, the number of sibling variables has three categories: single child, having one sibling, and having more than one sibling.
- **Parental Educational Qualification:** Parental educational qualification refers to the highest educational qualification of the father or mother of the participants. The researcher categorised this variable into the father's and mother's educational qualification groups, viz. 1. Illiterate, 2. Up to Class-IV, 3. Class-V to VIII, 4. Class-IX to X, 5. Class-XI and Above.
- **Family Type:** It refers to the type of family or the structure of the family a child belongs to. In Indian contexts, different types of families are found. For example, joint family, nuclear or broken family, separated family, and a few single mothers or single fathers. In this study, the researcher found that the participants belonged to a joint or nuclear family. Joint family refers to a family where children live with their mother and/or father, siblings (if any), grandmother and grandfather (if alive), paternal uncle and aunty (if any), and their cousins (if any). A nuclear family is a family where a child lives with his/her mother and/or father and the sibling (if any).
- **Family Monthly Income:** It refers to a family's average monthly income (including all the sources). It was measured as a family's average monthly earning in Indian rupee (including all the sources). Though it was a continuous variable, the familial income was divided into familial income groups following the modified Kuppuswamy SES scale (Saleem & Jan, 2021). The specific income

categories used in this study were: 1. Up to 6174, 2. 6175 to 18496, and 3. 18497 to 30830. Only a few students who belong to a family with a monthly income of more than Rs. 30830 were found.

4.5. Methods of Data Collection

4.5.1. Tools and Techniques Used for Data Collection

Data collection tools/instruments are vital in any research (Heath et al., 2018, cited in Mwita, 2022). The data quality and reliability depend mostly on the instrument (Sadan, 2017). Therefore, it is a vital task for every researcher to select and use appropriate data collection method(s), tool(s), and technique(s) (Mwita, 2022). To collect appropriate data for the present study, the researcher used three tools viz. 1. An Interview Schedule (Containing Anthro-pedagogical Information), 2. A Learning Style Inventory, and 3. A Cognitive Equivalence Test (CET) and observation technique.

4.5.1.1. The Interview Schedule

The researcher prepared this interview schedule. The primary purpose of this instrument was to collect and record participants' anthro-pedagogical information like their age, gender, habitat, birth type, birth order, present height and weight, number of siblings, Class, parental educational qualification, family type, and family monthly income.

4.5.1.2. Cognitive Equivalence Test (CET)

The CET was developed and standardised by Mohakud and Khan (2023). The concept of this instrument was taken from the ‘Equivalence Task with Pictorial Material’ (Olver & Hornsby, 1966) and the ‘Cognitive Equivalence Measuring Pictorial Task’ (Khan & Mohakud, 2017). The primary purpose of this test is to measure the Cognitive Equivalence ability of school children aged six to fourteen years. The CET consists of three sub-tests viz. Picture-based Cognitive Equivalence Test (PCET), Model-based Cognitive Equivalence Test (MCET) and Word-based Cognitive Equivalence Test (WCET). The PCET comprises 35 (Thirty-five) pictures such as locally available fruits and vegetables. The MCET comprises 30 (Thirty) models such as animals, vehicles, numbers, and letters. The WCET comprises 40 (Forty) naming words such as different animals, human body parts, and national figures.

4.5.1.2.1. Development and Description of the CET

While conceptualising and developing the CET, the curriculum of Class-I to V of WBBPE was first analysed to identify different concepts given in the curriculum and syllabus. For this purpose, a detailed review and critical analysis of the curriculum and

syllabus in each Class was done. The analysis identified the core concepts for each Class. Then, the core concepts were compared among the classes to find the common concepts, and 24/25 common concepts were found, and those common concepts were distributed into three sub-tests of the CET. Then, the initial draft of the CET was prepared by adding content (stimuli pictures, models, and words) to the three sub-tests (PCET, MCET, and WCET) based on the identified concepts. At this stage, 60 stimuli were added to each sub-test. In the next stage, the initial draft was sent to five experts to judge whether the added stimuli represents the included concepts or not. Experts gave their opinion through a 1 to 5 rating points, where one stands for very low representation and five stands for very high representation. After that, based on the experts' rating, those stimuli that had an average rating point of below four were excluded from each sub-test. After excluding 18, 22 and 12 stimuli from the PCET, MCET and WCET, respectively, the second draft of the CET was prepared with the remaining 42, 38 and 48 stimuli for each sub-test. Then, a pilot study was conducted on a small sample of 40 elementary school students (five from each class I to VIII) [The administration procedure was the same as described in point no. 4.5. of this chapter]. Based on the pilot study results, 7, 8 and 8 stimuli were excluded from PCET, MCET and WCET, respectively. The exclusion criteria were rarely picked stimuli and mean scores. Finally, the final draft of the CET contained 35 pictures, 30 models and 40 words. Finally, to standardized the CET, a pilot study was conducted with the final version of the CET by administering on 75 participants (15 students from each class I to V).

4.5.1.2.2. Contents of the CET

The final version of the CET contained the following-

1. Thirty-five pictures, each printed on a small and thick rectangle-shaped paper (3×2 inches).
2. Thirty models.
3. Forty naming words, each printed on a small and thick rectangle-shaped paper (3×2 inches).
4. A plastic tray (18×12 inches).
5. A square-shaped wooden board (10×10 inches).
6. A response sheet (Nine A4 size pages).

4.5.1.2.3. Technical Information about the CET

The construct and content validity of the CE measure was ensured by experts' opinions. To ensure the content validity of the CET, the test developers ensure that children aged 6 to 14 years are familiar with the stimuli (pictures, models, words). Then, the included concepts and respective stimuli were sent for experts' opinions. Experts rated which stimuli best represented the concepts on a 1 to 5-point rating scale, and the highly rated stimuli were included in the pilot study. Finally, based on the pilot study results, a few stimuli were excluded to form the final draft. To ensure the reliability of the CET, the developers checked the Test-retest and interrater reliability coefficients. The test-retest and interrater reliability coefficients were found to be .85 and .92, respectively, which is relatively high for this type of subjective measure.

4.5.1.3. The Learning Style Inventory (LSI)

The LSI purports to identify the learning styles of young children. This instrument consists of ten (10) items. Each item consists of four alternative choices. The four choices were given under options A, B, C and D, and the options represent the attributes of Visual, Auditory, Read/Write and Kinaesthetic learning styles, respectively. It categorises children as Visual, Auditory, Read/Write, and Kinesthetic learners. It is the translation and cultural adaptation of the Kids Learning Style Survey (Meleen, 2019). The original version was in English. The Bengali translation and cultural adaptation was done by Khan and Mohakud (2023).

4.5.1.3.1. Translation and Cultural Adaptation of the LSI

For the translation and cultural adaptation, the researcher and the supervisor first translated the ten LSI items into Bengali. For some items, a few alternatives were inappropriate (available/practised) in the local culture. Therefore, those alternatives were replaced with similar (locally available/practised) alternatives. Then, the Bengali translations were sent to a language expert for blind retranslation into English. Further, the blind retranslated version was sent to another language expert for translating it again into Bengali. Finally, this Bengali version was compared with the original English version by the researcher, the research supervisor and the other RAC members. With some modifications, the final draft was prepared and used in the pilot study. This instrument is a Bengali-translated version, so the instrument's content and construct validity was ensured through experts' opinions. The reliability of the LSI was ensured through a pilot study, and the Test-Retest reliability was found to be .92.

4.6. Procedure of Data Collection

After getting consent from the school heads, the researcher first went to the classroom and established a good rapport with all the students in each Class. To do so, the researcher introduced himself to the students, asked their names, and did some introductory conversation. The researcher then told them the purpose of his visit and then randomly selected students as representatives for the study. Then, the researcher contacted the parents/guardians and took consent for their children to participate in the study. At that time, the researcher also collected the Anthro-pedagogical information of their children through an interview schedule (Anthro-pedagogical information sheet). After that, the researcher visited the school again and started collecting data from the selected students. The researcher asked the students to come to a quiet, separate room and told them to sit in a chair in front of him and look. There was a small table between them, and the Learning Style Inventory (LSI) was first administered. The researcher told the participant, "I will tell you some situations and give you four choices. You have to tell me which of the four choices best suits you/apply for you. Do not think much because there is no right or wrong answer. It only indicates which you mostly prefer". After that, the researcher read out the LSI items and the alternative choices (explanations were given if required). When the participant confirms their choice, the researcher puts a tick mark on their chosen alternative in the response sheet and then reads out the next item. This procedure was repeated for all the ten LSI items. When the LSI items were completed, the researcher then administered the CETs one after one. At first, the PCET was presented, followed by the MCET and WCET. Before presenting the PCET, the researcher told the participants, "I will play a game with you. I will show you some pictures; you just have to find out similar pictures". Then, the researcher presented the 35 pictures (stimuli) in a plastic tray in front of the participants. Then, they were asked to arrange the pictures in rows and columns individually. The researcher also helped the participants to arrange the pictures. When the pictures were arranged, the researcher told them to see each picture minutely. They minutely saw each picture in the tray and confirmed whether they were familiar with the pictures or not. If any participants were unfamiliar with any of the pictures, the researcher explained the picture to them. Then, they were asked to select the pictures that are similar/alike in any way and put those selected pictures/stimuli on a different square-shaped wooden board placed aside. Then, the researcher started the stopwatch to count the time. They could take as many pictures/stimuli as they wanted and as much time as needed. The only condition was to

form one group at a time. After that, they were asked to explain why the pictures were similar/alike (which means giving similarity justifying their grouping). They could provide as many justifications as they could for their grouping. There was a response sheet, where all the pictures were printed and next to it was a blank space where similarity explanations could be written. The researcher maintained the response sheet, the task was to mark each picture they took to form a group and note down the similarity explanations in the given space. The researcher motivated the participants to give more and more justification. When they stopped giving justification, the researcher counted time and wrote it on the response sheet. Then, the selected stimuli were replaced in their original place. Afterwards, the researcher asked the participant to form a new group with the stimuli. They could also take those stimuli they had already used in the previous grouping, but they had to give new/separate justifications for their newly formed group. The researcher again marked the new group and noted their justification and the time taken in the given space. The procedure was repeated six times (six trials). When all six trials were completed, then the researcher presented the MCET. The procedure for MCET was similar to PCET. The only difference was the set of stimuli (i.e., the models). Finally, the WCET was administered, and the procedure for this test was the same as that for the PCET and MCET. The only difference was the set of stimuli (i.e. words). The researcher counted the time for each trial in each task. On average, each student took 40 to 45 minutes to complete the whole procedure. When the total procedure was completed, the researcher gave a token of appreciation to the participants. The whole data collection was done under the supervision of the researcher. In some cases, the researcher took some assistance from his co-researchers and students. However, the researcher gave proper training to the assistants beforehand. The total data collection was done between October 2023 and December 2023. At that time, students had completed their overall syllabus and were preparing for their final examination.

4.7. Data Cleaning and Tabulation

Participant responses were first evaluated to ensure the full completion of the personal information sheets, all the items of the LS measure, and all the trials in the CET. For data genuenity, some personal information, such as the participant's date of birth, was confirmed from the school records. The researcher himself did the coding and scoring. Due to the unavailability of some anthro-pedagogical information, 3 participants were excluded from the final consideration. After data cleaning and scoring, the researcher

entered all the collected data into an MS Excel worksheet with some assistance from co-researchers. The raw data collected from 172 participants were systematically and sequentially tabulated for further analysis. The stored data were accessible to the present researcher only.

4.8. Data Analysis Techniques

The researcher used different tools and techniques to analyze the data. The researcher manually coded the responses into PE, FE, NE, AE and FiE. The quantitative analysis was done in MS Excel and SPSS. The data normality was checked through Skewness, Kurtosis, Kolmogorov-Smirnov, and the Shapiro-Wilk test (Hatem et al., 2022; Okeniyi et al., 2020). Descriptive statistics like mean score, SD, mean rank, frequency, percentage analysis, and graphical representation. These statistics are used to describe the student's performance (Witte & Witte, 2017, cited in Dong, 2023; Sutanapong & Louangrath, 2015). Further, inferential statistics like the chi-square test, Pearson's Correlation, independent samples t-test, one-way ANOVA, Mann-Whitney-U test, Kruskal-Wallis test, and moderator analysis were done through regression analysis in Process Macro in SPSS. These statistics are used for testing hypothesis (Sutanapong, & Louangrath, 2015; Barnes, & Lewin, 2005; Connolly, 2007).

4.9. Ethical Considerations

Like other sciences, ethical considerations are also vital in social science research and must be taken care of (De Wet, 2010; Broom, 2006). In the present study, the researcher was concerned about that. The purpose, methods and procedures, and consequences of the study were transparent to all, the school heads, parents and students. First of all, permission was obtained from the Research Advisory Committee (RAC) and the research supervisor to collect data for the study (copy attached in appendix A). Written consent was taken from the school heads and the parents/guardians of the participants (copy attached in appendix-F_1, F_2 & A). In all regards, the participation was voluntary. Participants could exit from the study at any point in time. The researcher did not use any method or treatment that could physically or psychologically harm the participants. The researcher gave some incentives (viz. Chocolate, a piece of cake, a banana, and an educational kit containing a document organizing file, a notebook, a pen, a pencil and an eraser) to the students to appreciate their participation in the research.

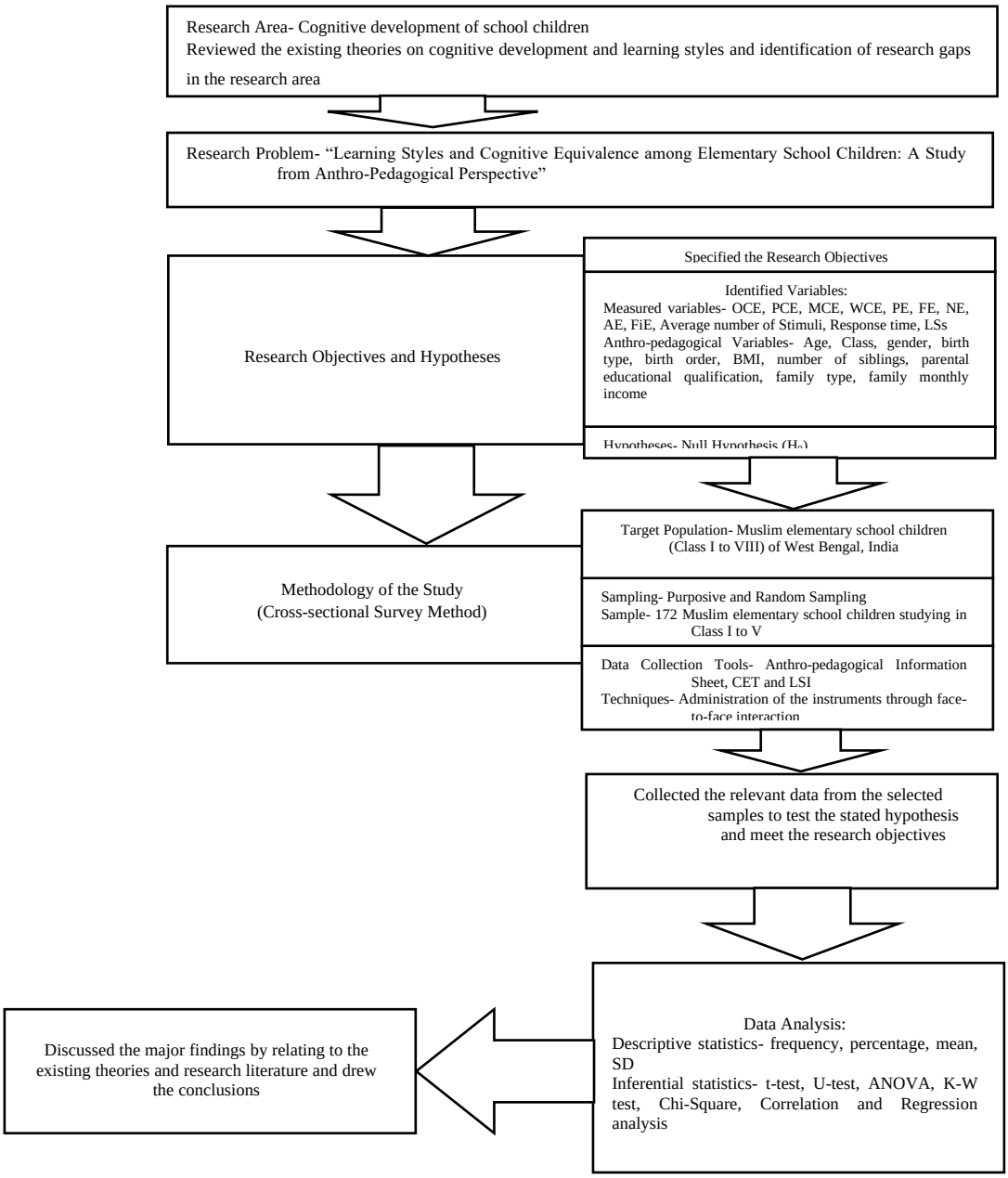

Fig. 4.1. Research Design

5.0. Chapter-V: Analysis and Interpretation of Data

This chapter presents the analysis and interpretations of the data collected from the participants. The primary purpose was to understand the relationships among the variables comprehensively. To achieve this, both descriptive and inferential statistics were employed. These types of statistics are used to summarise participants' data and to estimate the parameters from the statistics (Cooksey, & Cooksey, 2020; Nick, 2007). The chapter begins with descriptive statistics and an overview of the observed cognitive equivalence and learning styles, followed by inferential statistical techniques to identify significant relationships and patterns among the variables.

5.1. Analysis and Interpretations

Before starting the hypothesis testing, data normality was checked using the Kolmogorov-Smirnov (K-S) and Shapiro-Wilk (S-W) tests. The basic assumption of these tests is data is normally distributed among the sample units (Okeniyi, Okeniyi & Atayero, 2020; Drezner, Turel & Zerom, 2010; Steinskog, Tjøstheim, & Kvamstø, 2007). A significant result in these tests rejects the assumptions of normality. Further, Skewness (Sk) and Kurtosis (Ku) also checked (Hatem et al., 2022; Bai, & Ng, 2005; Blanca, Arnau, López-Montiel, Bono, & Bendayan, 2013). Results are presented in Table 5.3. The K-S test and S-W test statistics show that the data of the present study were non-normal, as the P-value (Sig.) is less than 0.05 for overall, test-wise, and dimension-wise CE. That is why the researcher further calculated the Skewness (Sk) and Kurtosis (Ku) statistics. In the Sk and Ku tests, data is considered normal when the Sk statistic is zero and the Ku statistic is .263. Literally, the deviation in these values indicates the non-normality of data. But, in social sciences, some empirical evidence is also present where a deviation up to 1.96 in the value (Sk or Ku statistics divided by Std. Err.) is considered normal or near normal. However, in this connection, Curran et al. (1996) considered up to a variation of 2 for Sk and 7 for Ku. Similarly, Kline (2005) considered the variation up to 3 and 10 for Sk and Ku. In this study, the researcher followed Curran et al. (1996) and Kline (2005) and considered the distribution normal among the representatives as the Sk and Ku statistics for overall, testk-wise CE, and PE, FE, and NE dimensions were within the variation range considered. However, the variations in Sk are more than 10 for AE (10.37) and FiE (10.978); in Ku, the variation in AE is 10.20, and for FiE, it is 9.95. Therefore, AE and FiE are not normally distributed among the participants. Consequently, parametric statistics were used for overall and test-wise CE and its PE, FE, and NE dimensions. However, non-parametric tests were used for the AE and FiE dimensions.

6.0. Chapter-VI: Major Findings and Conclusion

The ‘major findings and conclusion’ section is crucial in any research report. The primary purpose of this chapter is to pull the whole thesis together (Murray, 2017). In this chapter, the findings of own work are compared with the existing theory, which helps drawing conclusions (Evans, Gruba & Zobel, 2011). The researcher has reached this crucial phase, guided by the previous chapters. This chapter is structured into five

sub-sections: major findings, discussion of the major findings, educational implications, limitations, and suggestions for further research.

6.1. Major Findings of the Study

Based on the analysis and interpretation of data given in the previous chapter, the following findings were drawn:

6.1.1. Number of Stimuli Taken to Form Groups

1. The Muslim Elementary School Children studying in higher classes (Class IV a& V) have formed groups with more stimuli than lower classes (Class I, II & III) in the CET.
2. On average, Muslim Elementary School Children studying in lower classes took fewer pictures to form groups in the PCET than the children studying in higher classes.
3. On average, Muslim Elementary School Children studying in lower classes took fewer models to form groups in the MCET than children studying in higher classes.
4. On average, Muslim Elementary School Children studying in lower classes took fewer naming words to form groups in the WCET than the children studying in higher classes.
5. Muslim Elementary School Children studying in Class I and V have formed groups with the highest number of stimuli in the PCET and the lowest in the WCET.
6. Muslim Elementary School Children studying in Class II, III, and IV have formed groups with the highest number of stimuli in the MCET and the lowest in the WCET.
7. All the Muslim elementary school children formed groups with the highest number of stimuli in the model-based cognitive equivalence test and the lowest stimuli in the word-based cognitive equivalence test.

6.1.2. Time Taken to Complete the CET

1. The Muslim elementary school children studying in Class IV and V took more time to complete the CET than in Class I, II, and III.
2. The children studying in Class IV and V have spent more time to complete the picture-test than the children studying in Class I, II, and III.

3. The Muslim elementary school children in Class V took more time to complete the MCET than Class I, II, III, and IV.
4. The analysis revealed an apparent class-wise increase in the time to complete the MCET.
5. The Muslim elementary school children studying in Class I, have spent more time completing the picture-test and less time on the word-test.
6. The Muslim elementary school children studying in Class II also have spent more time to complete the PCET and less time in the WCET.
7. The Muslim elementary school children studying in Class III also spent more time completing the PCET and less time on the WCET.
8. The Muslim elementary school children studying in Class IV also spent more time completing the PCET and almost the same time on the MCET and WCET.
9. The Muslim elementary school children studying in Class V completed the MCET in less time than the WCET and PCET.
10. All the Muslim elementary school children have spent the highest time to complete the PCET and the lowest time in the WCET.

6.1.3. Association between Age and Overall, Test-wise and Dimension-wise CE

1. The age of the Muslim elementary school children is positively and significantly correlated with OCE.

2. The age of the Muslim elementary school children is not significantly correlated with PCE.

3. The age of the Muslim elementary school children is positively and significantly correlated with MCE.

4. The age of the Muslim elementary school children is positively and significantly correlated with WCE.

5. The age of the Muslim elementary school children is negatively but not significantly correlated with PE.

6. The age of the Muslim elementary school children is positively and significantly correlated with FE.

7. The age of the Muslim elementary school children is positively but not significantly correlated with NE.

8. The age of the Muslim elementary school children is positively and significantly correlated with AE.

9. The age of the Muslim elementary school children is negatively and significantly correlated with FiE.

6.1.4. Variations in Overall, Test-wise and Dimension-wise CE Concerning Class

1. There are significant variations in overall CE concerning the Class of the Muslim elementary school children.
2. There are no significant variations in PCE concerning the Class of the Muslim elementary school children.
3. There are significant variations in MCE concerning the Class of the Muslim elementary school children.
4. There are significant variations in WCE concerning the Class of the Muslim elementary school children.
5. There are significant variations in PE concerning the Class of the Muslim elementary school children.
6. There are significant variations in FE concerning the Class of the Muslim elementary school children.
7. There are no significant variations in NE concerning the Class of the Muslim elementary school children.
8. There are significant variations in AE concerning the Class of the Muslim elementary school children.
9. There are significant variations in FiE concerning the Class of the Muslim elementary school children.

6.1.5. Variations in Overall, Test-wise and Dimension-wise CE Concerning Gender

1. There is no significant difference in OCE between male and female Muslim elementary school children.
2. There is no significant difference in PCE between male and female Muslim elementary school children.
3. There is no significant difference in MCE between male and female Muslim elementary school children.
4. There is no significant difference in WCE between male and female Muslim elementary school children.
5. There is no significant difference in PE between male and female Muslim elementary school children.

6. There is no significant difference in FE between male and female Muslim elementary school children.
7. There is no significant difference in NE between male and female Muslim elementary school children.
8. There is no significant difference in AE between male and female Muslim elementary school children.
9. There is no significant difference in FiE between male and female Muslim elementary school children.

6.1.6. Variations in Overall, Test-wise and Dimension-wise CE Concerning Birth Type

1. There is no significant difference in OCE between normally-born and caesarean-born Muslim elementary school children.
2. There is no significant difference in PCE between normally-born and cesarean-born Muslim elementary school children.
3. There is no significant difference in MCE between normally-born and cesarean-born Muslim elementary school children.
4. No significant difference is present in WCE between normal and cesarean-born Muslim elementary school children.
5. There is no significant difference in PE between normally-born and cesarean-born Muslim elementary school children.
6. There is no significant difference in FE between normally-born and cesarean-born Muslim elementary school children.
7. There is no significant difference in NE between normally-born and cesarean-born Muslim elementary school children.
8. There is no significant difference in AE between normally-born and cesarean-born Muslim elementary school children.
9. There is no significant difference in FiE between normal and cesarean-born Muslim elementary school children.

6.1.7. Variations in Overall, Test-wise and Dimension-wise CE Concerning Birth Order

1. There are no significant variations in OCE among the Muslim elementary school children concerning their birth order.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their birth order.

3. There are no significant variations in MCE among the Muslim elementary school children concerning their birth order.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their birth order.
5. There are no significant variations in PE among the Muslim elementary school children concerning their birth order.
6. There are no significant variations in FE among the Muslim elementary school children concerning their birth order.
7. There are no significant variations in NE among the Muslim elementary school children concerning their birth order.
8. There are no significant variations in AE among the Muslim elementary school children concerning their birth order.
9. There are no significant variations in FiE among the Muslim elementary school children concerning their birth order.

6.1.8. Variations in Overall, Test-wise and Dimension-wise CE Concerning BMI

1. There are no significant variations in OCE among the Muslim elementary school children concerning their level of BMI.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their level of BMI.
3. There are significant variations in MCE among the Muslim elementary school children concerning their level of BMI.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their level of BMI.
5. There are no significant variations in PE among the Muslim elementary school children concerning their level of BMI.
6. There are no significant variations in FE among the Muslim elementary school children concerning their level of BMI.
7. There are no significant variations in NE among the Muslim elementary school children concerning their level of BMI.
8. There are significant variations in AE among the Muslim elementary school children concerning their level of BMI.
9. There are significant variations in FiE among the Muslim elementary school children concerning their level of BMI.

6.1.9. Variations in Overall, Test-wise and Dimension-wise CE Concerning Number of Siblings

1. There are no significant variations in OCE among Muslim elementary school children concerning their number of siblings.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their number of siblings.
3. There are no significant variations in MCE among the Muslim elementary school children concerning their number of siblings.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their number of siblings.
5. There are no significant variations in PE among the Muslim elementary school children concerning their number of siblings.
6. There are no significant variations in FE among the Muslim elementary school children concerning their number of siblings.
7. There are no significant variations in NE among the Muslim elementary school children concerning their number of siblings.
8. There are no significant variations in AE among the Muslim elementary school children concerning their number of siblings.
9. There are no significant variations in FiE among the Muslim elementary school children concerning their number of siblings.

6.1.10. Variations in Overall, Test-wise and Dimension-wise CE Concerning Parental Educational Qualification

6.1.10.1. Father's Educational Qualification

1. There are no significant variations in OCE among the Muslim elementary school children concerning their father's educational qualification.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their father's educational qualification.
3. There are no significant variations in MCE among the Muslim elementary school children concerning their father's educational qualification.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their father's educational qualification.
5. There are no significant variations in PE among the Muslim elementary school children concerning their father's educational qualification.

6. There are no significant variations in FE among the Muslim elementary school children concerning their father's educational qualification.
7. There are no significant variations in NE among the Muslim elementary school children concerning their father's educational qualification.
8. There are no significant variations in AE among the Muslim elementary school children concerning their father's educational qualification.
9. There are no significant variations in FiE among the Muslim elementary school children concerning their father's educational qualification.

6.1.10.2. Mother's Educational Qualification

1. There are no significant variations in OCE among the Muslim elementary school children concerning their mother's educational qualification.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their mother's educational qualification.
3. There are no significant variations in MCE among the Muslim elementary school children concerning their mother's educational qualification.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their mother's educational qualification.
5. There are no significant variations in PE among the Muslim elementary school children concerning their mother's educational qualification.
6. There are no significant variations in FE among the Muslim elementary school children concerning their mother's educational qualification.
7. There are significant variations in NE among the Muslim elementary school children concerning their father's educational qualification.
8. There are no significant variations in AE among the Muslim elementary school children concerning their mother's educational qualification.
9. There are no significant variations in FiE among the Muslim elementary school children concerning their mother's educational qualification.

6.1.11. Variations in Overall, Test-wise and Dimension-wise CE Concerning Family Type

1. There is no significant difference in OCE among the Muslim elementary school children concerning their family type.
2. There is no significant difference in PCE among the Muslim elementary school children concerning their family type.

3. There is no significant difference in MCE among the Muslim elementary school children concerning their family type.
4. There is no significant difference in WCE among the Muslim elementary school children concerning their family type.
5. There is no significant difference in PE among the Muslim elementary school children concerning their family type.
6. There is no significant difference in FE among the Muslim elementary school children concerning their family type.
7. There is no significant difference in NE among the Muslim elementary school children concerning their family type.
8. AE has no significant difference in AE among the Muslim elementary school children concerning their family type.
9. There is no significant difference in FiE among the Muslim elementary school children concerning their family type.

6.1.12. Variations in Overall, Test-wise and Dimension-wise CE Concerning Family Monthly Income

1. There are no significant variations in OCE among the Muslim elementary school children concerning their family monthly income.
2. There are no significant variations in PCE among the Muslim elementary school children concerning their family monthly income.
3. There are no significant variations in MCE among the Muslim elementary school children concerning their family monthly income.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their family monthly income.
5. There are no significant variations in PE among the Muslim elementary school children concerning their family monthly income.
6. There are no significant variations in FE among the Muslim elementary school children concerning their family monthly income.
7. There are no significant variations in NE among the Muslim elementary school children concerning their family monthly income.
8. There are no significant variations in AE among the Muslim elementary school children concerning their family monthly income.

9. There are no significant variations in FiE among Muslim elementary school children concerning their family monthly income.

6.1.13. Associations between Age and LS Preferences

1. The age of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.14. Associations between Class and LS Preferences

1. The Class of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.15. Associations between Gender and LS Preferences

1. The gender of Muslim elementary school children is significantly associated with their LS preferences.

6.1.16. Associations between Birth Type and LS Preferences

1. The birth type of Muslim elementary school children is not significantly associated with their LS preferences.

6.1.17. Associations between Birth Order and LS Preferences

1. The birth order of Muslim elementary school children is not significantly associated with their LS preferences.

6.1.18. Associations between BMI and LS Preferences

1. The BMI of Muslim elementary school children is not significantly associated with their LS preferences.

6.1.19. Associations between Number of Siblings and LS Preferences

1. The number of siblings of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.20. Associations between Parental Educational Qualification and LS Preferences

1. Father's educational qualifications of the Muslim elementary school children is not significantly associated with their LS preferences.
1. Mother's educational qualifications of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.21. Associations between Family Type and LS Preferences

1. Family type of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.22. Associations between Family Monthly Income and LS Preferences

1. The family monthly income of the Muslim elementary school children is not significantly associated with their LS preferences.

6.1.23. Variations in Overall, Test-wise and Dimension-wise CE Concerning LS Preferences

1. There are significant variations in OCE among the Muslim elementary school children concerning their preferences for LSs.
2. There are significant variations in PCE among the Muslim elementary school children regarding their preferences for LSs.
3. There are significant variations in MCE among the Muslim elementary school children concerning their preferences for LSs.
4. There are no significant variations in WCE among the Muslim elementary school children concerning their preferences for LSs.
5. There are no significant variations in PE among the Muslim elementary school children concerning their preferences for LSs.
6. There are significant variations in FE among the Muslim elementary school children concerning their preferences for LSs.
7. There are no significant variations in NE among the Muslim elementary school children concerning their preferences for LSs.
8. There are no significant variations in AE among the Muslim elementary school children concerning their preferences for LSs.
9. There are no significant variations in FiE among the Muslim elementary school children concerning their preferences for LSs.

6.1.24. Moderating Effects of Selected Anthro-Pedagogical Factors in the Relationship Between LSs and OCE

1. The average number of stimuli taken by the Muslim elementary school children to form groups do not significantly moderate the relationship between LSs and OCE.
2. The total time taken by the Muslim elementary school children to complete the CET does not significantly moderate the relationship between LSs and OCE.
3. There is no significant moderating effect of BMI of the Muslim elementary school children on the relationship between LSs and OCE.
4. The age of the Muslim elementary school children has no significant moderating effect on the relationship between LSs and OCE.

5. The family monthly income of the Muslim elementary school children has no significant moderating effect on the relationship between LSs and OCE.

6.2. Discussion of the Major Findings

This section is the most crucial part of the study. In this section, the major findings that emerged from the analysis and interpretations are compared with the existing theories and previous research findings, and the conclusions are drawn, as in the preceding paragraphs.

One of the objectives of the study was to know how many stimuli the Muslim elementary school children are taking to form groups with pictures or models or words. The findings of the study revealed that compared to higher classes, students in lower classes have formed groups with fewer stimuli. The trend is also similar in PCE, MCE and WCE. It might be because children in lower classes or younger ages cannot think from multiple perspectives. As they grow, they become aware of different perspectives and think accordingly. Their memory also develops with age. This may be why older children form groups with more stimuli than younger children. Not a single study found that can relate to the present finding. Therefore, this finding is unique is the elementary school context. Further, it was found that overall, Muslim elementary school children in each Class formed groups with the highest number of stimuli in the MCET, followed by the PCET and the WCET, which means that the MCET and the PCET were easier for them than the WCET because the first two tests present concrete situation to the children. The participants were in the concrete operational stage of cognitive development (7 to 11 years). At this stage, the child develops logical thinking, and their logic centers around concrete situations. As the MCET and the PCET were present in front of them, therefore those tests were easier for them. The WCET was more difficult than the others because it requires language development, reading abilities, and higher-order thinking. This finding confirms the findings of Melkman, Tversky & Baratz (1981) and Caffarra et al. (2017), which state that learning to read influences written word processing and visual object recognition. This finding also confirms the Piagetian notions of age-related changes in cognition and the findings of Joseph and Joseph (1982).

Another objective of the present study was to measure the time taken by Muslim elementary school children to form groups with pictures, models, and words. Generally, it is expected that compared to younger, older children take less time to complete any

cognitive task. However, the present study revealed that, on average, children studying in Class I, II, and III had taken less time to complete all CETs than in Class IV and V. The reason behind this is that there was no pre-fixed grouping. There is no fixed time frame to complete the tasks and no fixed justification for the groups. They formed their groups, took as much time as needed, and provided as many justifications as possible. Elderly children (studying in Class IV and V) have given more justifications and scored higher than younger ones (studying in Class I, II and III), which is why elders have taken more time. This is also a unique finding in the context of the cognitive development of elementary school children.

Anthro-pedagogical Factors and CE

This study also intended to explore the association between age and overall, test-wise, and dimension-wise CE among the Muslim elementary school children studying in Class-I, II, III, IV, and V. Results revealed a low positive and significant relationship of age with OCE, MCE, WCE, WCE, and the FE and AE. That means the mentioned aspects of CE increase with age. This trend is similar at the Class levels. However, no significant variation was present in PCE and NE. That means in most of the cases of CE, class (Academic grade) plays a significant role. Similar to the findings of Olver and Hornsby (1966), this study also found that except for FiE, all the other aspects of CE increased from the lower class to the higher class. Only FiE decreased with age. Except FiE, overall, test-wise and dimension-wise CE increased because the age of the Muslim elementary school children also increased with their class levels. Consequently, their logical and critical thinking also developed. These findings supported the notions of earlier theorists like Piaget and Bruner. Few other researchers also reported age-related changes in similarity judgment (Fahrmeier & Medin, 1977) and cognitive transformations and showed proficiency with both words and pictures (Joseph & Joseph, 1982). Hughley (1989) also reported a similar finding, which states that structural dimension influences similarity/dissimilarity judgments in categorizing paintings across academic grades. Mix (1999) reported a gradual increase in numerical equivalence. However, contradictory results are also present (González et al., 2020; Schmedemann, 1970), which is years back. Further, it also revealed a negative relationship between age and PE and FiE, which indicates that PE and FiE decrease with age. Therefore, it can be concluded that Cognitive Equivalence significantly increases with age and class level. Fiat Equivalence is the inability to justify similarity after forming groups based on similarity. It mainly happens due to delayed or inadequate language development. It

represents intuitive thoughts, which is a characteristic of the Piagetian pre-operational stage of cognitive development. At young ages, when children are in lower classes, sometimes they lack an adequate stock of words or vocabulary. However, when children grow, their brains function more, and consequently, FiE disappears. This study revealed that the trend of more perceptible responses with pictorial stimuli than verbal stimuli is the same even after more than fifty years (Wiviott, 1970).

One of the significant findings of this study is that OCE or PCE, MCE, WCE, and each dimension of CE is the same between male and female Muslim elementary school children. Which means gender is not a significant factor in cognitive equivalence. This finding aligns with the findings, which reported that male and female students possess similar levels of CE (Khan, 2017; Samanta, 2018) and in other areas of cognitive performance like- Piagetian conservation (Riley, 1989; Ahmad et al., 2018). However, some of the studies contradicted this finding (González et al., 2020; Xu et al., 2019), who reported that cognitive functioning varied by gender. Some studies reported that boys perform significantly better than girls in conservation (Zarour, 1971; Omotoso & Shapiro, 1976) in cognitive structuring (Bar-Tal & Jarymowicz, 2010). A few studies reported gender-dependent results in favour of girls in languages (Bart & Schils, 2014), cognitive development (Mierdel, 2019), and conservation ability (Uddinet et al., 2019). Therefore, this gender-independent result in the context of cognitive development in general is still inconclusive; however, in the CE context, this finding is unique.

Another objective of this study was to measure the difference in overall CE and CE measured through pictorial, model and word tasks, and the PE, FE, NE, AE, and FIE dimensions of CE concerning Birth Type (normal delivery and cesarean delivery) of the Muslim elementary school children. The result revealed no significant difference in all aspects of CE. No other study reported this finding in the context of CE. However, a few studies reported contradictory results, but those results are from other cognitive aspects. For example, cesarean-born children perform significantly below normally-born children in cognitive performance in terms of numeracy tests (Polidano et al. (2017)**.** More recently, Lupu et al. (2024) reported that cesarean delivery has a high risk of neurocognitive disorders like ASD and ADHD.

Another objective of this study was to measure the variations in overall, test-wise and dimension-wise CE concerning Birth Order (firstborn, second-born, third-born) of the Muslim elementary school children. By contradicting the finding that firstborns display significantly better cognitive development regarding verbal ability than later-born

children (Heiland, 2009), the present study revealed no significant variations in all aspects of CE, however, in most cases of CE, second-born children performed better than first and third-born children. The reason may be the sibling interaction, where firstborn elder children help the later-born children.

This study also measured the difference in overall, test-wise and dimension-wise CE concerning BMI (in terms of underweight, normal weight, overweight and obesity) of the Muslim elementary school children. Results revealed that most of the children were in the underweight category, which may be due to a lack of parental awareness and care or a lack of nutritious foods because the familial financial conditions of most of the children were deplorable. The results revealed no significant difference in all aspects of CE except MCE and AE; however, in most of the cases of CE, underweight children performed below normal weight and overweight children. Most previous studies support these findings (Krombholz, 2012; Hjorth et al., 2016; Li et al., 2018; Gunstad et al., 2008; Poh et al., 2013). Another study also reported that enhanced cognitive performance in early life may correlate with a reduced risk of being overweight in later childhood (Guxens, 2009). This means BMI plays a significant role in children's cognitive development; however, for generalising this finding, further study is required.

This study also measured overall, test-wise and dimension-wise CE among Muslim elementary school children who are single children with one sibling and more than one sibling and revealed no significant difference. This finding aligns with the findings of Khan (2017) and Samanta (2018). Further, this revealed that children with one sibling performed better than single children having more than one sibling. Supporting evidence is also present (Peyre et al., 2016; Rochebrochard & Joshi, 2013; McAlister & Peterson, 2007; Zhou et al., 2016). However, sibling additions are only crucial to first- and second-born children's cognitive development, not later (Yue et al., 2022). The reason is that older brother/sister contributes much to their younger sibling’s cognitive achievement (Dai & Heckman, 2013). Therefore, the sibling factor must be considered for better cognitive development.

This study also measured the overall, test-wise and dimension-wise CE variations among Muslim elementary school children concerning parental educational qualification. The result showed that except for the NE dimension for the mother's educational qualification, no significant variation was present in any aspect of CE concerning parental educational qualification. This finding is contradicted with the previous findings (González et al., 2020; Peyre et al., 2016; Schady, 2011), which state that parental

education has some impact on a child's cognitive development. Therefore, it can be said that parental education is also crucial for children's other aspects of cognitive development.

When the Muslim elementary school children were compared in terms of overall, test-wise, and dimension-wise CE concerning their family type, the results revealed no significant difference between the children from joint and nuclear families. This finding aligns with the findings of Khan (2017) and Samanta (2018). However, other studies contradict this finding by reporting that family type and home environment impact children's cognitive development (Ajayi et al., 2017; Morais et al., 2021). Therefore, it is not easy to draw a certain conclusion.

This study revealed no significant influence of family monthly income on overall, test-wise and dimension-wise CE among Muslim elementary school children. This finding is contradicted with the findings of Peyre et al. (2016), who reported that household income has a significant influence on children's verbal and nonverbal cognitive skills. No other studies support or contradict this finding, so it is easy to say that familial income is not an influential factor in the CE context.

Anthro-pedagogical factors and LSs

This study examined the association of the Muslim elementary school childrens' age and class with their LS preference and found no evidence of a significant association. This implies that learning styles do not change with age or academic level. In the present study, all the students were at a lower primary level, studying in classes I to V. However, Yusuf and Erviana's (2022) contradictory research suggested that learning style preferences are highly influenced by class level. This finding might be relevant for the contexts where primary school children are compared with high school or higher education students. It suggests that factors other than age may significantly impact learning preferences.

The present study found that gender is significantly associated with LSs of Muslim elementary school children. This result is supported by several studies, including Khodabakhshzadeh et al. (2017), Hamidon (2015), Mulalic et al. (2009), Honigsfeld and Dunn (2003), Massachi (2000), Ewing and Yong (1992), and Cohen (1986). However, this finding contrasted by Park (2000), Singh et al. (2015), and Nasution et al. (2019), who reported no significant gender differences in learning style preferences. As a result,

it makes it difficult to draw certain conclusions regarding gender differences in preferred learning styles.

The current study's results also revealed that LSs of Muslim elementary school children are not significantly influenced by their birth order. This finding aligns with some other research (Chow & Amzat, 2024; Luo et al., 2022; Tobias, 2003). However, contradictory findings also exist (Queen & Chika, 2023; Menchak et al., 2022; Sucgang & Fabella, 2018), which state that birth order significantly influences learning style preferences. This contradictory finding makes it difficult to conclude and calls for further research.

The present study revealed that birth order has no significant influence on the learning style preferences of Muslim elementary school children. This finding corroborates Cohen's findings (1986). This suggests that children's learning style references remain largely unaffected regardless of birth order. Other factors, such as cultural context, family environment, or individual personality, may substantially shape their learning styles more than birth order. This finding aligns with research suggesting that birth order may not play a critical role in learning strategy.

One of the primary objectives of this study was to measure the association between BMI and LS preferences of Muslim elementary school children, and the result revealed no significant association. Babu (2020) and Alswat et al. (2017) corroborated this finding, meaning the learning style will remain unchanged even if body weight changes. No such study was found which could contradict this finding. Therefore, it can be concluded that LS preferences are independent of BMI.

The study findings also indicated that the number of siblings of Muslim elementary school children is not significantly associated with their preferences for LS. This finding aligns with some recent researchers (Alamineisi & Sadeghi, 2023; Jiao, 2023; Sivanandan et al., 2014) who reported that siblings may not play a direct role, but cultural factors could influence learning style preferences. No such study was found which could contradict this finding. Therefore, it can be concluded that LS preferences are independent of the number of siblings.

This study also explored the association between parental educational qualification and LSs of Muslim elementary school children, and the analysis revealed no significant association between these variables. This finding aligns with the findings of Casinillo et al. (2023), Mozaffari et al. (2020), Taheri et al. (2021), Singh et al. (2015), Ningsih et al. (2023), and Casinillo et al. (2023). However, a few researchers, like Cholifah et al. (2016), Sinaga (2022), Sirait et al. (2024), Singh et al. (2015), and Maulidah et al.

(2020), reported contradictory results. This contradictory finding makes it difficult to conclude and calls for future studies.

The present also revealed no significant association between the family type and learning styles of Muslim elementary school children. This finding is supported by Maurine et al. (2022), Yoo and Kim (2019), and Taheri et al. (2021). However, some contradictory evidence is also present (Krishnamoorthy & Lokesh, 2020; Mozaffari et al., 2020). This contradictory finding makes it difficult to conclude and calls for future studies.

The current study revealed that the family monthly income of Muslim elementary school children is not significantly associated with their LSs. Krishnamoorthy and Lokesh (2020), Mozaffari et al. (2020), and Taheri et al. (2021) also reported similar findings. However, noteworthy contrary findings were reported by Yoo and Kim (2019), Sintia et al. (2019), and Dutsinma and Temdee (2020), indicating that LSs are indeed influenced by family income. This finding is contradictory; therefore, to draw certain conclusions, further study is required.

One of the primary objectives of this study was to measure the influence of learning styles on the overall, test-wise and dimension-wise CE among Muslim elementary school children. The results revealed significant OCE, PCE, MCE, and FE variations. This finding aligns with Zain et al. (2019) and Hames and Baker (2014), who highlighted that learning styles can substantially impact cognitive performance. A few contradictors are also present; however, those are in other areas of cognition. For example, learning styles and language achievement are not significantly related (Gohar & Sadeghi, 2015), and learning styles have little effect on elementary students' critical thinking skills (Leasa et al., 2020).

It was assumed that factors like the number of stimuli in forming groups, time taken to complete the CET, age, BMI and family monthly income may moderate the relationship between LS and CE among Muslim elementary school children. However, the results of this study revealed that these factors do not significantly moderate the relationship. A similar study reported that different aspects of student motivation significantly moderate the relationship between LSs and student engagement, including cognitive engagement (Halif et al., 2020). Personality type is also reported as a moderator between LSs and reading comprehension (Carrel & Monroe, 1993; Ehrman & Oxford, 1990; Myers & Myers, 1993; Sadeghi et al., 2012). This means that internal psychological factors, like motivation and personality, may play a more significant role in mediating the effects of LSs on cognitive performance than external variables.

6.3. Educational Implications of the Study

The present study revealed exciting findings about Muslim elementary school children's learning styles and cognitive equivalence. These findings have varied educational implications for students, teachers, parents, educators and policymakers. The following are essential areas of implications of this study.

1. Children with better exposure to the test stimuli demonstrated better CE. Therefore, it is important to orient children with different perspectives on environmental factors that will help them develop concepts.
2. Spending more time on cognitive tasks does not always indicate cognitive delay; it may be due to approaches to processing information. Therefore, it is important to provide enough time so that students can learn in their own space and speed.
3. LSs do not vary significantly with age. Therefore, it is better to identify each individual learner's LSs at an early stage and teach them accordingly.
4. Schools must have facilities for all LS modalities so children can learn according to their preferences.
5. This study confirmed the notions of age-related changes in cognitive abilities; therefore, the curricular load should be given accordingly.
6. Younger children studying in lower classes performed better in concrete situations (with pictures and models) than in abstract situations (words). Therefore, curriculum developers and implementers need to give more importance to concrete experiences in earlier stages of education and proceed towards abstract conceptualizations. This means that textbooks should contain concrete examples in the form of colours, pictures, and diagrams. Other curriculum support materials and instructional strategies should also be designed based on these principles.
7. Variations in cognitive equivalence are not significantly caused by anthro-pedagogical factors like gender, birth type, birth order, BMI, number of siblings, family type, and family income; therefore, instead of focusing on these factors, it is important to treat all children equally in educational contexts.
8. Logical thinking, reasoning, and abstraction are vital in cognitive equivalence and are the basis of language. Therefore, stress must be given to the language development of this age group of children.
9. Parental education has a positive role in cognitive equivalence among Muslim elementary school children. Therefore, educational institutions and policymakers

must advocate for parental education campaigns to facilitate comprehensive cognitive development in children.

10. Educators and parents should be urged to cultivate a supportive and engaging home environment that allows children to gain cognitive stimulation from sibling interactions. Having only one elder sibling is better for the cognitive growth of the younger sibling.
11. A specific LS category of children performed better in CE; therefore, it is important for the schools to identify the reason for the lack of progress in the other LS preference groups and take necessary steps for those children.
12. This study will guide to identify the moderating factors of learning styles (LS) and cognitive equivalence (CE), which is crucial for designing educational strategies that enhance cognitive development among elementary school children.

6.4. Limitations of the Study

The major limitations of the study lie in the following:

1. There was some error in the BMI calculation. As the researcher maintained the response sheet of the CET and wrote the students' responses on paper by himself, sometimes the researcher failed to count the exact time. Due to limited experience, the researcher also made some errors in measuring the height of the children. The weight of the participants was not measured in similar conditions. For example, some of the participants were empty stomachs. Therefore, there were some errors in weight measurement. As height and weight are the two components of BMI, there were some errors in the calculation of BMI.
2. There was no equal number of participants in each LS preference group; as the sampling was not done based on LS categories, and the LSs of the participants were measured after sampling, it was not in the researcher's hands to include an equal number of participants in each LS preference group.
3. The LSI could have been more effective in identifying the LSs of the participants, as there was no exposure to all the VARK components in pedagogical practices in the school.
4. The presence of the present while performing the CE tests influenced the children's performance. For example, sometimes the parents prompted, and some of the participants hesitated to give their natural responses.

6.5. Suggestions for Further Study

Several areas warrant attention to build on this research's findings and improve the robustness of future studies.

1. Proper attention should be given to measuring time accurately, and researchers should undergo training to become experts in measuring height and weight.
2. It would be better to use audio and video recorders instead of only written documents when recording CE responses.
3. To get better results, it is better to randomly select at least 30 participants from each LS preference category.
4. It should be ensured that schools have exposure to all the VARK components (facilities in schools) in teaching.
5. While performing the tasks, Parental influence should be minimized.
6. It is recommended that enough time be provided for performing each task, and more trials should be provided.
7. Regarding the difficulty of Task 3, the researcher must ensure that all the participants are able to read.
8. While assigning scores for CE, the researcher should adequately follow the scoring procedure.
9. Further research is necessary to comprehensively understand CE, focusing on secondary and higher secondary students, incorporating other community demographics, and accounting for geographical variances.

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