SIMULTANEOUS IMPACT OF JUXTAPOSED LEARNING THEORIES ON LEARNER INFORMATION PROCESSING ABILITY FOR COGNITIVE GROWTH AND DEVELOPMENT

By

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Submitted in fulfilment of the requirements for the degree

DOCTOR OF EDUCATION DEGREE

(Educational Psychology)

In the

Department of Post Graduate Studies

Faculty of Humanities

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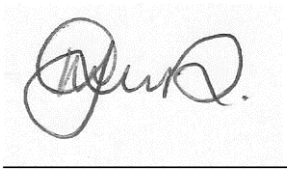
DECLARATION

I declare that **SIMULTANEOUS IMPACT OF JUXTAPOSED LEARNING THEORIES ON LEARNER INFORMATION PROCESSING ABILITY FOR COGNITIVE GROWTH AND DEVELOPMENT** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



13 April 2019

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DATE

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ACKNOWLEDGEMENTS

As *LIFE* guides one's journeys far above what one can imagine, believe or comprehend, eloquent reason attempts to explain the emotions, experiences and behaviour yet so truly entrenched in the utmost inner being of a person. God has wisely planned the circle of family, loved ones, friends, acquaintances, and foes included to make one concomitantly believe in the beauty of the sunrise, sunset and the journey ahead. Friendships are sonorous footprints engraved in your heart and soul. Writing this thesis was an inspiration instigated from this journey. There are no words to be found adequate in expressing my heartfelt gratitude towards my almighty Father and the following beloved people.

1. *Almighty God (my reverential source of refuge, shelter, guidance, and strength)*

I humbly thank you Lord for allowing me to pursue my dreams by providing the wisdom, inner strength, perseverance and courage to complete this study. I am because of Your Grace Lord, because You have never failed me. This thesis is a symbol of Your *LOVE* and *GRACE*. I hold on to Your promise as acclaimed in 1 Peter 5:6 that enunciates "Humble yourselves therefore under the mighty hand of God, that He may exalt you in due time."

2. *Johan Malan (my devoted, loving and compassionate confidante)*

God blessed me with a precious friend, an exceptional gift of love, and an exquisite companion. You have always believed in me, encouraged me, and supported me. You were an immeasurable source of support throughout writing this thesis… and still, you are a place I refer to as my gregarious shelter. You always reminded me of how proud you are of my accomplishments … receiving the accolades of my work. How can I ever find words unfathomable and incomparable enough to express my gratitude towards you? You came into my life when I was intensely discombobulated with life. *Confused* because of the vicissitudes of life having dismantled the core of my being. *Frustrated* because life had disembodied my perceptual radar for intra- and interrelations. I was emotionally vulnerable, and lost into oblivion. But, like a master artisan, you peeled off the onerous layers that had colonised my zest. You are the embodiment of the expression, "What will I do without you?" You are something, Johan … I scrupulously love you.

3. *Marcél and Xandré (my beloved and wonderful children)*

Marcél and Xandré, my boys and centre of my life, entrusted to me by my Heavenly Farther. Where can I ever start by telling you how much I love you? You are the precious gemstones that I, your proud mother, treasure to eternity. You have grown up into brave young men that I proudly call my sons! You are the oak trees that provide the convivial shade in my life, a place where I find peace and comfort. Words alone cannot express the appreciation I hold for you as my children. Thank you for your endurance and perseverance on our journey, you have embraven me with your great courage. In writing this thesis, I was always being reminded of the inexorable vision and astounding dreams I treasure for your future. Please never forget these words: "I believe in you – never give up – where there is a will, there is a way – and there is nothing you cannot do!" I hold faith, that in God's time, you will experience the immeasurable blessings I pray Him to bestow upon you. Marcél and Xandré, I love you both so much and more ... from my deepest heart treasury.

4. *Louis, Annemarie and Philané (My bravura farther, precious mother, and beloved sister as my family)*

Mom and Dad, I unequivocally appreciate the inspirational belief you hold for me as your eldest daughter, which empowered me throughout this entire endeavour, writing this thesis. It gave me the superlative confidence to believe that I am able to accomplish the goals I set for myself in life. The great expectations and confidence you have in and of me, serve as the immense motivation to be the *best* I can be as a mother, a companion, a student, a person, and a daughter to you as my adoring parents. Thank you for the manner in which you have raised me, it moulded my abilities to always reach out to my ambitions. I have always strived to do you proud, no matter the hardships faced in life. You are the concomitant reason for my success and I deeply honour you for being the greatest parents a daughter could ever ask for! I love and appreciate you in a sense that words cannot describe. I honestly pray to God that He will be gracious upon me in blessing you with an extended and extraordinary life in which you can contentedly and gracefully grow old. I love you deeply.

My sister, Philané. If I have to describe you, I bleakly fall short in finding words ever virtuous enough to express the love and appreciation I hold for you. I deeply admire and treasure your earnest encouragement (especially in the most destitution phases of my life) and astonishing inspiration which helped me to stay focussed in writing this thesis, and to incessantly remind me

of the goals I am working for. Your remarkable example and extraordinary achievements served as a basis for my lavish commitment to success. You are my dearest sister and best friend! I love you very much.

5. *Dr DK Selaledi (my astounding mentor)*

Words are indeed insufficient to describe what your inimitable mentorship has meant to me, thus leaving you as the *GREATEST* teacher I ever had in my life. I regard you as a master scholar who teaches with the subtle skills, those of the expert! Your profound professional knowledge of teacher education, especially in the field of Educational Psychology, has been indispensable to my intellectual development as well as my efficacious approach to education. If I think of you, your profound life qualities of vivacity, incessant academic energy, interminable compassion and commitment, solicitous consideration and joy, are the substantial qualities that I hope to emulate in my career. In writing this thesis, you have tolerantly accommodated all the moments of impatience, obstinacy, and autarkical pride. You are something Doctor! Your inexorable motivation and relentless support in writing this thesis is instrumental. Thank you, Doctor!

6. *Prof. GJ Schlebusch (my goal-orientated co-promotor)*

Gawie, my heartfelt appreciation for your valued guidance and unswerving support throughout my engagement with CUT. Especially in writing this thesis, your unbounded consideration and leadership is commendable and conspicuous of appreciation. As your fervent student, from undergraduate studies throughout becoming an esteemed member of the academic society, I deeply express feelings of gratification for your presence throughout my academic journey! I believe that you will accept my countenance of sincere acknowledgement as anticipated.

7. *Respondents (the vivid contributors to my study)*

I am grateful in thanking the principals, FET teachers, and Grade 11 learners of the Fezile Dabi FET schools who participated in this research. My appreciation expressed for your esteemed cooperation and gargantuan contributions to this study.

Conclusive remarks

A prodigious acknowledgement to all of the abovementioned aficionados (devotees) in my life, and subsequently in writing this thesis. In the absence of your substantial contributions, this study would not have been materialised or achieved.

Dedicated to:

This study is dedicated to Dr DK Selaledi.

ABSTRACT

The scientific knowledge base that undergirds and serves as a nexus to unravel the complexity of the ubiquitous but subtle factors to learn maximally is couched in the fields of educational psychology (specifically, cognitive psychology) and educational neuroscience. Within this ambit, the researcher sought to investigate the mental dynamics that are primary, draw, and necessitate attention prior to information becoming knowledge to learners in the classroom. Hence, the appropriate topic for the study as conceived by the researcher is, *The simultaneous impact of juxtaposed learning theories on learner information processing ability for cognitive growth and development.*

The dynamics of learning studied and explained in this study, align with the researcher's inquisitiveness regarding "How best to teach learners, so that they can learn best." Thus, the study appeals to teachers for the need to take recourse to the required considerations of juxtaposed learning theories in the classroom towards the enhancement of learners' information processing abilities. The considerations are encapsulated in the qualitative behaviours of learner's conscious awareness, cognitive engagement, and metacognitive engagement.

The study irradiated the research paradigm, research design, and the research survey method (sample, data collection, and data analysis) employed to answer the research questions and to statistically reject, or fail to accept, the stipulated hypotheses of the study. A questionnaire was designed as a research instrument to collect data. Furthermore, the validity and reliability tests, as well as tests for statistical assumptions were conducted. Inferential statistics were employed to test the Hierarchical Linear Model (HLM) hypotheses and the Structural Equation Model (SEM) hypotheses.

It is proper to conclude that from the researcher's suggested model MEIPAC (Model to Engender Information Processing Ability in the Classroom), the variables germane to information processing by the learners, and the variables that undergird good and successful teachers in facilitating effective and efficient processing of information by learners, are paramount. The results, discussions, and recommendations of the study, therefore, attest to the latter, and the need for teachers to heed *The simultaneous impact of juxtaposed learning theories on learner information processing ability for cognitive growth and development.*

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LIST OF ABBREVIATIONS

AAS	Anterior Attentional System
AMOS	Analysis of a Moment Structures
ANOVA	Analysis of Variance
CA	Conscious Awareness
CE	Cognitive Engagement
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CLT	Cognitive Load Theory
CMIN	Chained Multilateral Index Number
DBE	Department of Basic Education
DF	Degrees of Freedom
DHET	Department of Higher Education Training
DV	Dependent variable
EFA	Exploratory Factor Analysis
ES	Effect Size
FET	Further Education and Training
ICC	Intra-class Correlation
IV	Independent Variable
IPA	Information Processing Ability
HLM	Hierarchical Linear Modelling
KMO	Kaiser-Meier-Olkin
LOLT	Language of Learning and Teaching
LTM	Long-term Memory

M	Mean
ME	Metacognitive Engagement
MKO	More Knowledgeable Others
MSE	Mean Square Error
OLS	Ordinary-least Squares
PAS	Posterior Attentional System
PFC	Prefrontal Cortex
PL	Post Level
RAS	Reticular Activating System
RMSEA	Root Mean Square Error of Approximation
SD	Standard Deviation
SEM	Structural Equation Modelling
SM	Sensory Memory
SPSS	Statistical Package for Social Sciences
TLIE	Teaching Learning Interactive Environments
WM	Working memory
ZDP	Zone of Proximal Development

CHAPTER 1

OVERVIEW OF THE STUDY

1.1 INTRODUCTION

Research about the brain over the past two decades has led to a phenomenon called brain-based learning, particularly in the teaching-learning interactive environment. This marvel is a movement in education that attempts to apply the research findings to teaching and learning with the emphasis on a teaching-learning interactive environment. According to Jensen (2008), an understanding and application of such brain-based research findings by teachers in their craft of teaching, could serve as the single most powerful choice teachers can make to improve classroom teaching and learning; most importantly, by enhancing information processing of learners.

Laxman and Chin (2010) state that the brain is an organ of learning, designed to gather and store an infinite amount of information, and then put it to use. Krause, Bochner, Duchesne and McMaugh (2009) refer to the process by which the brain acquires and use knowledge as *cognition***.** Woolfolk (2007) concurs and further explains that cognition is those intellectual or perceptual processes occurring within us that the typical individual would describe as thinking, rational processing, or the mind. Eggen and Kauchak (2014) assert that through learning, an individual's *cognition develops* long-term changes in mental representations or associations because of environmental learning and experiences. The developmental changes that occur include the construction of thought processes (i.e. thinking, rational processing, or the mind) such as the mental processes of perception, memory, judgment, and reasoning, as contrasted with emotional and volitional processes from childhood through adolescence to adulthood.

Ormrod (2008) clarifies that learning, including classroom learning, is largely a mental phenomenon that presumably has its basis in the brain. Through cognitive (mental) development, long-term change in mental representations or associations because of continuous construction of thought processes results in learners becoming more capable and sophisticated in their thinking.

Willis (2012) argues that not only traditional theories of learning from the past three decades, but also the new branch of neuroscience research implications for teaching and learning are imperative for inclusion in the professional teacher education curriculum. The author further

contends that teachers grounded on the knowledge-based research of the implications of neuroscience have the requisite efficacy to build the brain potential of learners regardless of their past knowledge acquisition and performance. Such teachers would become a conduit to bridge the achievement gap of learners because of their efficacious motivation and the resultant optimism to build the brain potential of learners to higher levels of complex and sophisticated minds.

1.2 CONCEPTUAL FRAMEWORK

The conceptual framework of the study, comprises the theoretical framework, learning theories, and learner performance. The theoretical framework encapsulates scientific perceptions, principles, and tenets of cognitive psychology and educational neuroscience. The latter underpinnings undergird and influence the essence of learning theories, which in turn explain how learning takes place, and are compared to learner performance for cognitive growth and development (Figure 1).

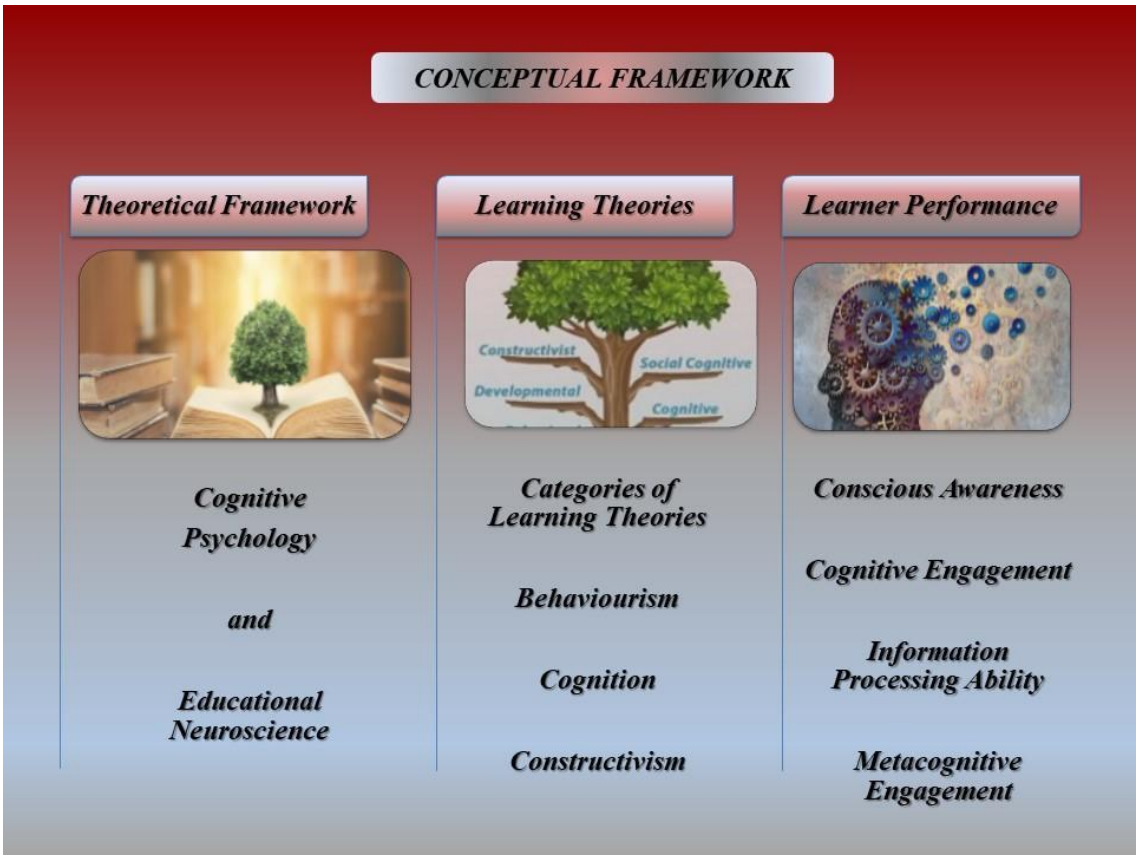

Figure 1: Conceptual framework of the study

The learning theories (Figure 2), depicts the learning theories categorised into Behaviourism, Cognition, and Constructivism by virtue of the learning behaviours each exudes during the teaching-learning process. The theories within the three major categories that guided the quintessence of the study are those of BF Skinner and Erik Erikson as *behaviourists;* Sigmund Freud, Jean Piaget, Albert Bandura and John Flavell as *cognitivists;* and Lev Vygotsky, Albert Bandura, and John Flavell as *constructivists.* It is important to note that the theoretical contributions of both Bandura and Flavell straddle the *cognitive* and *constructivists'* domains.

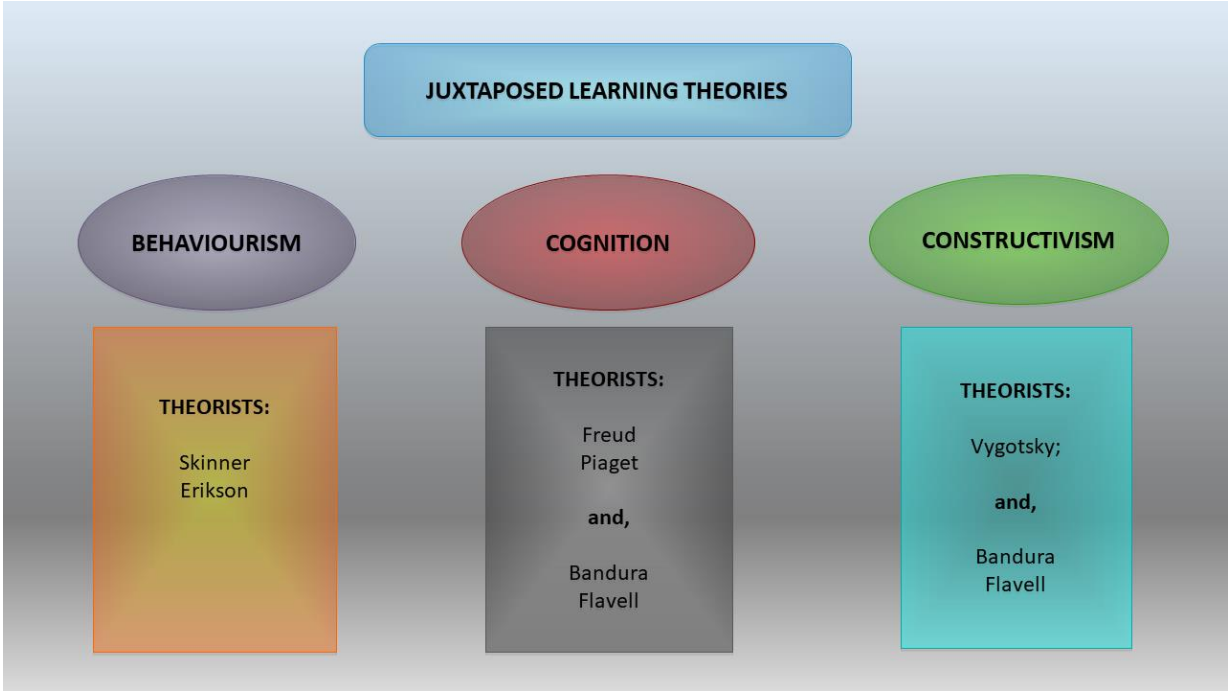

Figure 2: Juxtaposed learning theories

In the study, the researcher juxtaposed the learning theories (Figure 2) to determine the parallels between and amongst the learning theories, and the concomitant similarities and differences that determine the impact and influence the learning theories exert on learning by individuals – specifically learners in a traditional classroom.

The researcher surmises that a teacher's depth of knowledge base and application of the theoretical contributions of the theorists are of paramount importance to facilitate for learner information processing, quality of learning, learning performance, and cognitive growth and development.

1.3 RESEARCH QUESTIONS, AIM, OBJECTIVES AND HYPOTHESES

This section explains the research questions, aim, objectives, and hypotheses formulated and expressed to guide the structuring of the topic, the collection of data, and the analysis of data. It is hoped by the researcher that, employing these tactics, will render valid results that are consistent with the need to enhance learners' depth and breadth of processing information, and thereby become sophisticated and complex producers of knowledge.

1.3.1 Main and sub-research questions

For this study, the following main research question was formulated:

What is the simultaneous impact of juxtaposed learning theories in the classroom on learner information-processing ability towards learner cognitive growth and development?

The following sub-questions were formulated:

i. What are the opinions of the ***learners*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom?
ii. What are the opinions of the ***teachers*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom?
iii. According to ***learners***, is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom?
iv. According to ***teachers***, is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom?

1.3.2 Aims and objectives

The aim of the study was to ascertain the simultaneous impact of juxtaposed learning theories (behaviourism, cognition, and constructivism) in the classroom, on learner information-processing ability towards learner cognitive growth and development.

The objectives of the study were as follows:

i. To determine the opinions of the ***learners*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom.
ii. To obtain the opinions of the ***teachers*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom.
iii. To find out what the relationship is between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom, according to ***learners.***
iv. To determine what the relationship is between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom, according to ***teachers.***

1.3.3 Independent and dependent variables

Inferential statistics were employed to test the statistical relationship between and amongst the independent variables (IVs) and the dependent variables (DVs) of the learners and teachers respectively.

1.3.3.1 Independent Variables (IVs)

The following IVs were identified for use on learners.

- Age
- Home language
- Language of learning and teaching (LOLT)
- Grades repeated
- Average obtained
- Class size

The IVs for use on teachers comprise:

- Age
- Highest qualification
- Experience
- Post level
- Class size

1.3.3.2 Dependent Variables (DVs)

Dependent variables are not manipulated by the researcher, and as a result, predictions can be made about them as well.

The DVs for the learners and teachers are:

- Information processing ability (IPA)
- Conscious awareness (CA)
- Cognitive engagement (CE)
- Metacognitive engagement (ME)

1.3.4 Hypotheses

Two main hypotheses groups were tested. They were the Hierarchical Linear Modelling (HLM) hypotheses, and the Structural Equation Modelling (SEM) hypotheses.

The HLM is defined as a generalisation and extensions of regression analysis model. HLM is also developed from Analysis of Variance (ANOVA) inferential statistics. It is in this regard that the HLM model explains variability across levels (Raudenbush & Bryk, 2002). On the other hand, SEM attempts to analyse complicated casual models and can incorporate unobserved (latent) variables – sometimes called factors – and mediating variables as well as observed (measured) variables. SEM involves imposing a theoretical model on a set of variables to explain their relationships. Combining SEM and HLM, therefore, allows for the advantage of being able to model both the hierarchical structure of the data and the complex relationships between variables and subsequently lead to more accurate and reliable models.

The HLM research hypotheses formulated for learners are the following:

1. There is no significant statistical difference between ***age*** and ***learner performance*** (IPA, CA, CE and ME).

2. There is no significant statistical difference between ***home language*** and ***learner performance*** (IPA, CA, CE and ME).
3. There is no significant statistical difference between ***LOLT*** and ***learner performance*** (IPA, CA, CE and ME).
4. There is no significant statistical difference between ***grades repeated*** and ***learner performance*** (IPA, CA, CE and ME).
5. There is no significant statistical difference between ***average obtained*** and ***learner performance*** (IPA, CA, CE and ME).
6. There is no significant statistical difference between learners' ***average class size*** and ***learner performance*** (IPA, CA, CE and ME).

The SEM research hypothesis formulated for learners is:

There is no statistically significant relationship between ***IPA, CA, CE,*** and ***ME***.

The HLM research hypotheses formulated for teachers are the following:

1. There is no significant statistical difference between ***age*** and ***learner performance*** (IPA, CA, CE and ME).
2. There is no significant statistical difference between ***highest qualification*** and ***learner performance*** (IPA, CA, CE and ME).
3. There is no significant statistical difference between ***experience*** and ***learner performance*** (IPA, CA, CE and ME).
4. There is no significant statistical difference between ***post level*** and ***learner performance*** (IPA, CA, CE and ME).
5. There is no significant statistical difference between learners' ***average class size*** and ***learner performance*** (IPA, CA, CE and ME).

The SEM research hypothesis formulated for teachers is:

There is no statistically significant relationship between ***IPA, CA, CE,*** and ***ME***.

1.4 PRELIMINARY LITERATURE REVIEW

A succinct review of the theoretical underpinnings, learning theories, and learner performance in an interactive teaching-learning environment is provided below.

1.4.1 Theoretical framework

Cognitive psychology is a science that is interested in the domain of the brain, particularly the functioning of the brain that is called cognition. The cognitive processes underlie learning, behaviour, reasoning, and decision-making (Goldstein, 2011). With regard to cognitive neuroscience, Anderson (2015) professes that cognitive neuroscience, as an emerging scientific field of cognitive psychology, not only focuses on how the cognition is organised to produce intelligent thought; but in addition, cognitive neuroscience refers to developing methods that enable us to understand the neural basis of cognition. Frank and Badre (2015) espouse that cognitive psychology overlaps with cognitive neuroscience in that cognitive neuroscience attempts to link latent cognitive processes with the neural mechanisms that generate them.

Theoretical resources from neuroscience and educational psychology are brought together specifically to support the principles, policies and practices in education. Billington (2017) highlights that the context of educational neuroscience has valuable implications for education and learning.

1.4.2 Learning Theories

Learning theories inform teachers' understanding of both teaching and learning, and provide a comprehensive understanding of the key components of learner behaviour as could be indicated by learner performance. In addition, theories of learning enlighten teachers' understanding of the necessity by learners to be consciously aware and purposefully engaged in the delivery of presented content. The researcher abides by the view that teachers' knowledge and application of the suggested techniques and tactics postulated by the theories will translate into a deep and profound behavioural tendency to acquire and become complex and sophisticated cognitivists, themselves.

The cognitive theories briefly examined for the study are those of the following theorists: Freud, Piaget, Erikson, Vygotsky, Bandura, Flavell, and Atkinson and Shiffrin.

1.4.2.1 Freud's theory of the mind

Freud's psychoanalytical theory had a profound influence on the mainstream of educational thinking (the theory of learning). Freud developed a topographical model of the mind that asserts that the mind consists of three levels – the conscious, the subconscious, and the unconscious

(McLeod, 2015). Within the three levels of the conscious mind of the learner in the classroom, Freud asserts that a learner is continuously bombarded by the conflicting forces of the *id* and *superego* embedded in the subconscious mind. Freud likens the *ego*, ensconced in the conscious level, as the tip of the iceberg (De Sousa, 2011), to which the teacher appeals for attention to evoke the attributes of learner performance (conscious awareness, cognitive engagement, metacognitive engagement, and information-processing ability).

1.4.2.2 Erikson's psychosocial developmental theory

Erikson adapted his psychosocial theory from the developmental theory of Freud, who was regarded as a great psychiatrist. Erikson's psychosocial theory relates to principles of psychological and social development (Slavin, 2009). As learners improve their cognitive skills such as information-processing ability and metacognitive skills, they are also developing their concepts of themselves, ways of interacting with peers, and attitudes toward the environment.

Eggen and Kauchak (2014) further mention that Erikson's psychosocial theory integrates personal and social development, and that psychosocial development occurs in stages. Krause et al. (2009) add that each stage is marked by a psychosocial challenge called a crisis and positive resolution of the crisis in each stage prepares the individual for the challenge at the next. O'Donnell, Reeve and Smith (2009) propose that a teacher's understanding of these personal and social developments is very important to the teacher's ability to motivate, teach, and successfully interact with learners at various ages and cognitive developmental levels.

1.4.2.3 Piaget's theory on cognitive development

According to Piaget's theory of cognitive development, learners are viewed as naturally curious explorers who constantly try to make sense of their surroundings (O'Donnell et al., 2009). Piaget described this need for understanding as the drive for equilibrium, a cognitive state in which new experiences make sense because of our existing understanding (Eggen & Kauchak, 2014). They add that thought processes are adapted in response to new experiences. Slavin (2009) further explains that Piaget explored both why and how mental abilities of learners change over time. He further states that the cognitive development of a learner progresses through four distinct stages and are characterised by the emergence of new abilities and ways of processing information.

1.4.2.4 Vygotsky's social constructivist theory

In the same vein as Piaget, Vygotsky is of the view that activities that are of sociocultural nature, are regarded as the engine of cognitive development. For a learner to develop new cognitive structures, he/she must first learn to employ the cultural tools that the environment provides, in shared activity with other, who is regarded as people that are more skilled. The theory of Vygotsky implies that thoughts are the internalised product of a social and historical culture, and according to him; learning precedes development (Selepe, 2016). Vygotsky believed that the learning process occurs through the zone of proximal development (ZDP) which encapsulates that the potential learning ability of the learner can be achieved through a process called scaffolding. Slavin (2009) proposes that Vygotsky's theory includes the desirability of setting up cooperative learning arrangements among groups of learners who display different ability levels in the classroom. The teacher, however, has to monitor the awareness and engagements of e.g. groups and give support to the groups wherever needed (support such as explanations provided), with the purpose of enhancing cognitive and metacognitive engagement.

1.4.2.5 Bandura's social cognitive theory

Cherry (2019b) states that Bandura's social cognitive theory combines elements from behavioural theories, which suggest that all behaviours are learned through conditioning, and cognitive theories, which take into account psychological influences such as attention and memory. Social learning theory is also known as modelling or vicarious learning and is influenced by internal processes involving attention, memory, and motivation, which might not be as readily observable as behaviour and its consequences (McLeod, 2016). The key features of Bandura's theory include reciprocal determinism, self-efficacy, and self-regulation.

Bandura explains that observational learning is a behavioural process, which is learned from the environment, and that learning can be seen as a mediating process that occurs between stimuli and response (McLeod, 2016c). Vygotsky, as well as Bandura, suggested that learning is a socially interactive process. Vygotsky believed that children construct their knowledge from their immediate social environments and use peers that are knowledgeable (i.e. adults) as a tool to solve their problems relating to knowledge. Similarly, Bandura believed that good role models would produce better behaviour than negative role models would. Social cognitive learning theory has become perhaps the most influential theory of learning and development as it is rooted

in many of the basic concepts of traditional learning theories. This theory has often been called a bridge between behaviourist learning theories and cognitive learning (Nabavi, 2012).

For learners to successfully imitate modelled behaviour, teachers as role models, should ensure learners' attention are captured and direct their conscious awareness to the activities of the model to successfully replicate the role model's behaviour. This researcher views the success of learners to replicate the model's behaviour as their sense of engagement, awareness, and processing the information construed from the model.

1.4.2.6 Atkinson and Shiffrin's information processing theory

The information processing theory describes how information is perceived from the environment and processed accordingly. Kandarakis and Poulos (2008) intone that learning is defined as the process of acquiring new information, while memory is defined as the persistence of learning that can be accessed later. The structure of human memory was initially proposed by Atkinson and Shiffrin (1968) and is often described in the framework of information processing theory (Eggen & Kauchak, 2014). Woolfolk (2007) elaborates on this by asserting that processing involves gathering information and organising it in relation to what is already known (or encoding), holding information (or storage) and getting at the information when needed (or retrieval).

1.4.2.7 Flavell's theory on metacognition

Flavell (in O'Donnell et al., 2009) explains that metacognition refers to one's knowledge concerning one's own cognitive processes. Schmorrow and Fidopiastis (2011) agree that Flavell was a pioneer researcher of the metacognition field, coined the metacognition term, and set the earliest formal model for metacognition. Moreover, Flavell (in Livingstone, 2003) adds that higher order thinking of learners, which he calls metacognition, involves active control over the cognitive processes engaged in learning by an individual. Ormrod (2008) confirms that the greater the learner's metacognitive awareness, the better the learning and achievement would be.

1.4.3 Learner performance in an interactive teaching-learning environment

Learners come to class voluntarily, bringing with them previously learned information, and experiences. The efficiency and effectiveness of the teacher's conscious utilisation of attention

seeking strategies to get the attention of the learners, evoke the learners' awareness of learning, and stimulates absorption in the task, to lay the basis for the brain to process information deeply.

1.4.3.1 Conscious awareness

Ramachandran (2011) explains conscious awareness as a process by which an individual gains knowledge or becomes aware of events or objects in the environment, such as in the classroom. Madrid (2000) avers that in cognitive theory, the learner should initially be consciously aware of the learning process by paying attention until the learner has reached the stage where the skill has been acquired, i.e. the skills to understand facts, relate events, undertake tasks, and display skills. The stimulated awareness subsequently encourages the learner to use the acquired knowledge for comprehension and problem solving.

1.4.3.2 Cognitive engagement

Van Amburgh, Delvin, Kirwin and Qualters (2007) postulate that the concept of learner engagement and active learning is a strategy for teachers to promote engagement with both discipline material and learning. It involves the extent to which learners attend to the teacher, as the teacher seeks to arouse their curiosity, interest, and feelings of excitement, and the determination to learn. The researcher contends that such engagement inexorably modifies learners' behaviours to commit, participate, and be involved in the meaningful processing of information into new knowledge.

1.4.3.3 Information-processing ability

Kim and Lee (2014) espouse the idea that it is more useful for learners to select knowledge and information by thought, than to simply memorise what is provided to them. Learners should possess more than simply a quantity of knowledge, i.e. how much they know, instead, learners should possess the abilities to assimilate or accommodate incoming information to existing knowledge in the schemata. The new knowledge would then be constructed, and inadvertently excite teachers' commitment to create an environment that enables the development of information-processing abilities of learners.

1.4.3.4 Metacognitive engagement

Metacognition is a strategy that refers to our knowledge about attention, recognition, encoding, storage and retrieval, and how these operations might be used to achieve a learning goal.

Metacognitive knowledge develops with age, experience, and instruction, and has a profound influence on classroom practices (Schneider, 2008).

1.5 METHODOLOGY

The components of the methodology in this study are as follows: research paradigm, research approach, research design, research method, data collection techniques, the population from which the sample of respondents for the study was drawn, and data analysis.

1.5.1 Research paradigm

The study resides within the post-positivist research paradigm. Creswell (2013) points out that the post-positivist approach represents the thought process after positivism. Positivism contests the traditional notion of the absolute truth of knowledge. Post-positivism recognises that we cannot be positive about the claims of knowledge when studying the behaviour and actions of human beings. The knowledge that develops through a post-positivist lens is based on careful observation and measurement of the objective reality that exists "out there" in the world. Thus, developing numeric measures of observations and studying the behaviour of individuals becomes paramount for a post-positivist.

1.5.2 Research design

The study followed a quantitative design. A quantitative design means that by examining the relationship among variables, the testing of objective theories becomes evident. These variables can be measured, typically on instruments, so that empirical data can be analysed using statistical procedures. The purpose of using a quantitative design in this study is mainly to gain an understanding of the underlying perceptions and conceptions of respondents, getting insights into the setting of the problem and formulating hypotheses to uncover prevalent trends, ideas, and opinions of respondents.

Creswell (2009) points out that quantitative research is "confirmatory and deductive in nature" and thus post-positivist and common to modern researchers. The methods of quantitative research ensure objectivity (questionnaire as an example), generalisability and reliability, as well as ensuring that the researcher becomes an external factor to the actual study (Howell, 2010). Most importantly, quantitative results become replicable at any given setting (Creswell, 2009).

The quantitative design enables the researcher to specify the phenomena under study and to quantify the relationships between and within variables of the study.

1.5.3 Research method

The research followed a nonexperimental design, investigating complex relationships among variables by applying techniques of Hierarchical Linear Modelling (HLM) and Structural Equation Modelling (SEM). Specifically, a survey method was employed.

1.5.4 Research methodology

The research methodology employed was to determine the target population of the study, and the sample for information collection from the respondents in the sample. Data was subjected to statistical analysis to obtain the results of the study.

1.5.4.1 Population and sample

A population comprises a target and accessible population. The target population of this study was Further Education and Training (FET) Phase teachers and Grade 11 learners in the Fezile Dabi Education District. A probability, multi-stage cluster sampling procedure was conducted to select a sample for the study. The sample consisted of 840 Grade 11 learners and 140 FET teachers that represented 20 schools of the 65 schools in the district. The total sample cohort consisted of 980 respondents.

1.5.4.2 Data collection technique

The study employed a questionnaire as the data collection instrument. The questionnaire consisted of two sections. Section A contained the demographic variables of the sample (consisting of approximately 20 questions), and section B consisting of approximately 80 questions ranging on a four-point Likert-type scale from ‘strongly disagree’ to ‘strongly agree’. Issues pertaining to the validity and reliability of the questionnaire were addressed during the research. The validity of the questionnaire was ensured by conducting an exploratory factor analysis and a confirmatory factor analysis. Only items that had a regression weight of above 0.3 were selected to constitute the final questionnaire. The reliability of the questionnaire items was measured conducting a Cronbach’s alpha in SPSS statistical software program.

1.5.4.3 Data analyses

Frequency tables and graphs were drawn in SPSS statistical package to project the pictorial version of the data using descriptive statistics to obtain measures of central tendencies inclusive of frequency distributions, means, standard deviations, and percentages.

A quantitative data analysis was done by computing inferential statistics. HLM and SEM analysis were part of the inferential statistics done in SPSS and AMOS statistical packages. Hypotheses were formulated to test statistical relationships between the IVs and DVs of the study. The statistical analysis is explained and illustrated in depth as part of chapter four of this study.

1.6 SIGNIFICANCE OF THE STUDY

The aim in undertaking this study was to consider what research conceives of how cognitive growth and development is promoted through consciousness awareness, cognitive and metacognitive engagement, and the information-processing ability of learners. Consequently, this study intended to articulate the challenges facing education with regard to delivering educational professionals who are capable to induce meaningful information processing by the learners during teaching. Efficient information processing would result in meaningful learning and understanding by the learners.

1.7 PARAMETERS/DELIMITATIONS OF THE STUDY

This study was conducted in the field of educational psychology. It was confined in the Further Education and Training Phase (FET), in the Fezile Dabi education district. The results of the study cannot therefore, be extrapolated to both teachers and learners of Basic Education and those in the tertiary institutions.

1.8 DEFINITIONS AND CONCEPTS

The following concepts and constructs below are defined to accentuate their denotative meaning relevant to the context and overall semantics utilised in the study.

a) Brain-based learning

Brain-based learning is an understanding in teaching and learning that is based on knowledge of the brain, and its functions. This educational discipline unites the knowledge of neuroscience,

psychology, and education, with the objective to optimise the learning and teaching process (Tabibian, 2018).

b) Teaching-learning interactive environment

A teaching-learning interactive environment is an environment in which teachers involve the learners in their learning process actively, by way of: regular teacher-learner interaction, learner-learner interaction, use of audio-visuals, and hands-on demonstrations. The learners are constantly encouraged to be active participants in the learning process, where their information-processing ability is enhanced (Interactive Tutors, 2011).

c) Cognition

The mental action or process of acquiring knowledge and understanding through thought, experience, and the senses (English Oxford Dictionary, n.d.).

d) Metacognition

The awareness or analysis of one's own learning or thinking processes where research on metacognition has demonstrated the value of monitoring one's own cognitive processes (Merriam-Webster Dictionary, online).

e) Behaviourism

Behaviourism refers to a psychological approach in education and is concerned with observable stimulus-response behaviours only, and states that all behaviours are learned through interaction with the environment (McLeod, 2017).

f) Constructivism

Constructivism is a paradigm or worldview that posits that learning is an active and constructive process. The learner becomes a constructor of information. New information is subjectively created and linked to prior knowledge. The result is subjective mental representations by the individual (David, 2015).

g) Social constructivism

Social constructivism teaches that all knowledge develops because of social interaction and language use. Knowledge is, therefore, shared experiences with the others. Consequentially knowledge is not a result of observing the world, but it results from many social processes and interactions. We therefore find that constructivist learning attaches as much meaning to the process of learning as it does to the acquisition of new knowledge. In other words, the journey is just as important as the destination (Lynch, 2016).

h) Reciprocal determinism

Bandura's theory of reciprocal determinism states that the environment affects changes in the behaviour of the individual, and in return, the behaviour of the individual changes the environment – meaning, not only does the environment influence the learner's thinking, but the learner's thinking also influences the environment (Singh, 2018).

i) Cognitive growth and development

Cognitive development is a field of study in psychology and neuroscience that focuses on the development of a child's cognition. Development occurs through the manipulation of incoming information from the environment to make sense of it – i.e. through information processing. The medium of processing entails conceptual resources, perceptual skill, language learning, and other aspects that the adult brain utilises to acquire knowledge (Eggen & Kauchak, 2014).

j) Cognitive psychology

Cognitive psychology is a branch of psychology that focuses on the way humans process information. It looks at how humans process information they receive and how the treatment of this information leads to their responses. Cognitive psychology is interested in what is happening within our minds that links stimulus/input and response/output (Slavin, 2009).

k) Positive psychology

Positive psychology is the scientific study of human flourishing, and an applied approach to optimal functioning. It has also been defined as the study of the strengths and virtues that enable individuals, communities and organisations to thrive (Seligman & Csikszentmihalyi, 2014).

l) Neuroplasticity

Neuroplasticity refer to the brain's ability to dynamically reorganise itself, by changing – in the process - the neural circuits at cell or molecular level (cortical remapping). More specifically, the neurons, as well as the neural networks, can actually change their connections and behaviour, as a response to new information, to sensory stimulation, during the development process or in the case of injuries or dysfunctions (Joja, 2013).

m) Cognitive neuroscience

The field of cognitive neuroscience concerns the scientific study of the neural mechanisms underlying cognition and is a branch of neuroscience. Cognitive neuroscience overlaps with cognitive psychology, and focuses on the neural substrates of mental processes and their behavioural manifestations (Nelson & Luciana, 2008).

n) Educational neuroscience

Educational neuroscience is an emerging multidisciplinary field wherein the aim is to link basic research in neuroscience, psychology and cognitive science, with educational technology. Broadly defined, educational neuroscience explores the relationship between education and brain sciences, the latter encompassing neurosciences, child psychology and cognitive science (Tandon & Singh, 2015).

o) Conscious awareness

Conscious awareness is an important component of conscious experience and describes a mental state of being truly aware of the events and situations in one's life (Fieser, 2018). Conscious awareness is closely linked to attention when referring to information processing.

p) Information processing ability

Information processing ability refers to the ability of learners to process information, i.e. learning. For meaningful learning to take place, where information is transferred from the working memory to the long-term memory, information processing has to occur (Van der Merwe, 2013).

q) Cognitive engagement

Cognitive engagement refers to engaging in effortful tasks with purposiveness and strategy use, making cognitive investment in learning, and engaging in metacognition and self-regulated learning. Cognitive engagement is a major part of overall learning engagement. An effective cognitive engagement should enable learners to immerse themselves in in-depth reflective learning processes that are situated in realistic problem-solving tasks (Wang, 2013).

r) Metacognitive engagement

Metacognitive engagement refers to engagement in the learning process involving higher-order cognition. Cognitive engagement precedes metacognitive engagement (Wang, 2013).

s) Learner performance

Learner performance refers to behaviours learners display that elucidates learning behaviour in the classroom (Van der Merwe, 2013). For the purposes of this study, learner performances refer to conscious awareness, information processing ability, cognitive engagement, and metacognitive engagement.

t) Learning theory

Learning theories provide an educational basis for understanding how learners learn; and are conceptual frameworks that describe the manner in which a learner absorbs, processes, and retains knowledge during the learning process, i.e. information processing (Richard, 2015).

u) Juxtaposed

Placed side by side or close together for the purpose of comparing or contrasting (Merriam-Webster Dictionary, online).

v) Cognitive load

Cognitive load refers to the total amount of mental activity imposed on the working memory in any one instant during information processing (Heick, 2017).

w) Traditional classroom

Traditional classroom refers to a typical classroom setting in which learners are taught. The teacher acts as the facilitator of the teaching-learning process. The teaching strategies are teacher-centred in an attempt to achieve the learning outcomes (Van der Merwe, 2013).

1.9 ETHICAL CONSIDERATIONS

Ethical values are norms and values to be consciously pursued and adhered to by the researcher upon commencement of the study. The considerations stipulate the validity and integrity of the interaction with respondents. The primary considerations discussed are permission to collect data, informed consent by the learners, teachers, and parents to participate in the study. The respondents were also availed the certainty of confidentiality and anonymity.

1.9.1 Permission to collect data

Permission to gain access and collect information from the FET schools in the Fezile Dabi education district was sought and obtained from the Head of Department, Department of Basic Education in the Free State.

1.9.2 Informed consent

A letter requesting permission from the parents to allow their children to participate in the study was sent to the parents. The letter stipulated the need for parents to be in agreement with their children whether they would voluntarily participate or not. Teachers and learners were also asked to complete a letter of consent, to take part or not in the study voluntarily. The response from both the parents, teachers, and the learners was affirmative.

1.9.3 Confidentiality and anonymity

To ensure confidentiality, respondents were reassured in writing (on the cover of the questionnaire) that the information will be treated with the utmost confidence. Although the research report will be published, it will contain figures, percentages, and deductions based on the analysis and interpretation of the data provided without identifying any respondent personally.

1.10 CONCLUSION

Chapter 1 provided an overview of the study. The aim of the research was to examine learners' information-processing ability as influenced by the simultaneous impact of juxtaposed learning theories towards cognitive growth and development. Equally important, how learner performance is also influenced in the classroom.

The researcher posits that teacher conscious awareness and application of the creeds of the effectiveness and efficiency of the findings about the contribution of the information processing knowledge base to learning, and the relevance of the educational implication of various theorists in the various domains of cognitive psychology, have the requisite necessity to improve learner performance.

1.11 CHAPTER OUTLINE

Chapter 1: Introduction and overview

This chapter provided an overview of the study as a whole with emphasis on the background and the context of the educational phenomena at interest. This chapter further presented the theoretical and conceptual frameworks, preliminary literature review on learning theories, learners' performances, research question and hypotheses, as well as the research paradigm, research design, and the survey research method. The significance of the study was highlighted inclusive of the ethical considerations. The chapter was concluded by an outline of chapters for the rest of the study.

Chapter 2: Literature review

Chapter 2 focuses on the theoretical framework and the organisational framework of the study. These frameworks encapsulate the theoretical underpinnings of positive psychology, cognition (i.e. cognitive psychology, cognitive development, and cognitive neuroscience), and educational neuroscience as discussed through key concepts, theories, and models associated with the emergence of cognitive theories that explain the quintessence of the various learning theories. The essence of choosing these underpinnings is because they are positioned in the ambit of the study's context. The frameworks are used to explain the genesis of the cognitive learning theories.

The chapter further discusses the learning theories to extract the educational implications of each theory and to relate its implications to educational learning. It will enable the researcher to

identify, *inter alia*, the strengths and weaknesses of teachers to teach the learners ability to process information and the certain gaps, such as what are the conceptual and methodological strengths and weaknesses. What are the things we can say with confidence, and what are speculative and tentative? What is clearly established and what is missing? Equally so, the chapter will close by highlighting learner performance (i.e. conscious awareness, cognitive engagement, metacognitive engagement, and information-processing ability) in interactive teaching-learning environments. The researcher will explain how learners process information using aspects of Atkinson and Shiffrin's model of the human memory.

Chapter 3: Research methodology

This chapter irradiates the research paradigm, research design, and the research survey method (sample, data collection, and data analysis) employed to answer the research questions and to statistically reject, or fail to accept, the stipulated hypotheses of the study.

Chapter 4: Results of the study

This chapter provides the results, analysis, discussions, and interpretation of data gathered through the research. The reporting was an objective presentation of results, through tables, and statistical analyses inclusive of descriptive statistics and inferential statistics.

Chapter 5: Discussions and recommendations

The discussions and findings of the study are presented in this chapter based on the analysis done. The researcher also links the discussion and findings to the theoretical and conceptual framework, learning theories, and learner performances as discussed in previous chapters. The chapter reaffirms the research aim and hypotheses and illustrates how the findings retort to these questions. Conclusions that cover the research and recommendations are forwarded and the chapter ends with suggestions for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 THE ORGANISATIONAL FRAMEWORK

This chapter is divided into three sections, namely: the theoretical framework of the study (Section A); cognitive theories of learning (Section B), and learner performance in an interactive teaching-learning environment (Section C). The organisational framework presented in Figure 3 illustrates an overview of the different sections discussed.

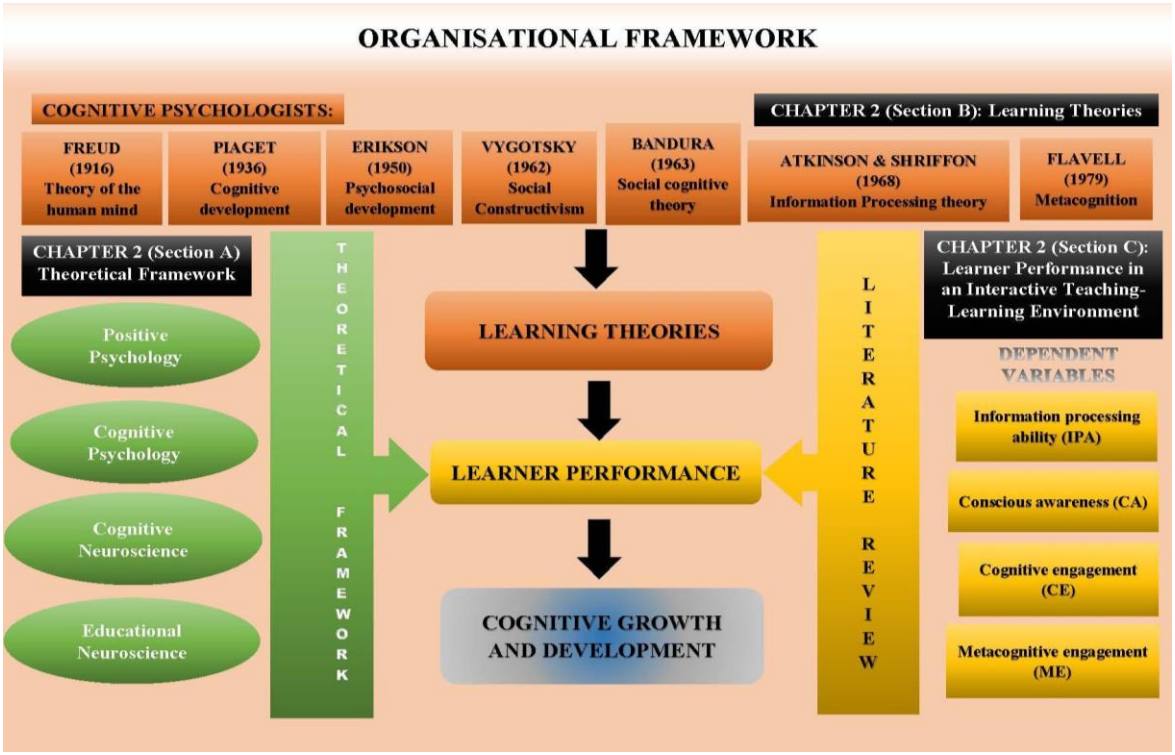

Figure 3: Organisational framework of the study

SECTION A

2.2 THEORETICAL FRAMEWORK

A theoretical framework provides scientific justification for the study and is both grounded in and based on scientific theory (Vinz, 2019). The theoretical framework of the study encapsulates the emerging field of educational neuroscience, conversant with cognitive psychology and cognitive development, as informed by Seligman's theory on positive psychology, and as influenced by cognitive neuroscience and neuroplasticity. This theoretical framework provided the foundation in which learning theories are subsequently explained and described (Ref. Chapter 3), and from where learner performance variables (Ref. Chapter 4) culminate in the cognitive growth and development of learner information-processing ability in the classroom.

Sinnott (2013) avers that positive psychology elucidates the study of cognitions, traits, and contexts of behaviour associated with optimal life-span development. Interpreting this from an educational perspective, Gaydarov (2014) asserts that teachers need to improve the psychological wellbeing of learners if they are to create meaningful learning environments that cultivate increased learner performance. This implies that teachers should include the principles of cognitive psychology and positive psychology in their teaching approaches in creating optimal learning environments.

Researchers have started to cooperate and interact with neuroscientific findings of the brain and the interdisciplinary researches in which education is included. Howard-Jones (2007) expanded on this by mentioning that it is considered that interdisciplinary research such as cognitive and educational neuroscience will contribute to the understanding of how learners can learn better.

2.2.1 Positive psychology

Chaudhary, Chaudhary and Chaudhary (2014) define positive psychology as a branch of psychology that employs scientific understanding and effective intervention to achieve a satisfactory life. Upadhyay and Arya (2015) claim that positive psychology intervention activities are specific, evidence based and intentional and aim to foster positive cognitions and behaviours towards the improvement of the well-being of an individual, which is ultimately linked to cognitive psychology within the field of educational psychology.

Figure 4 depicts a life model explaining the meta-theoretical conceptual map for applied positive psychology as underpinned by an ecological perspective. Positive psychologists would argue that psychology should also expand its focus to improve child education by making greater use of intrinsic motivation, positive affect and creativity; improve psychotherapy by developing approaches that emphasise hope, meaning and self-healing; improve family life by better understanding the dynamics of love, parenthood and commitment (Hefferon & Boniwell, 2011).

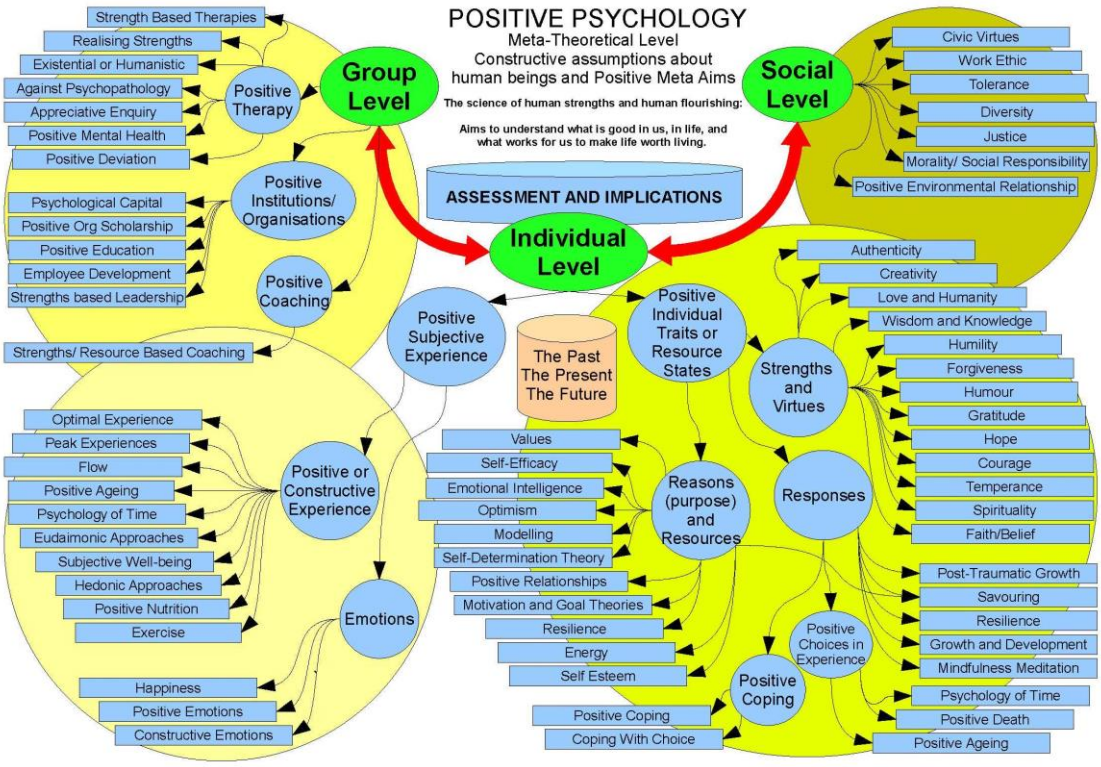

Figure 4: Mind map of positive psychology (Adopted from Smith, 2008)

Positive psychology has on three aims: how to optimise positive emotions; positive strengths or assets; and positive institutions or organisations (Donald, Lazarus & Moolla, 2014). Rusk and Waters (2013) allude that positive psychology has led to significant growth in education and other fields. The gains in research and practice of positive psychology have been substantial the past decade and a half due to the emphasis on a positivistic scientific approach.

Shaffer (2012) points out that research on utilising positive psychological perspectives to endorse brain plasticity in a positive direction is increasingly encouraging and empowering. Neuroplasticity is central to the brain and entails that the brain has the ability to change its

structure and patterns of activity in considerable demeanours and change can come about as a result of experiences we have as well as of purely internal mental activity, i.e. our thoughts (Davidson & Begley, 2012). Later studies confirmed the concept of neuroplasticity, the ability of synapses, neurons and whole brain areas to change depending on the activities we perform (Doidge, 2007).

2.2.2 Cognition

Huitt (2006) defines cognition as the act or process of knowing in the broadest sense; specifically, an intellectual process by which knowledge is gained from perception or ideas. Eggen and Kauchak (2014) instead, define cognition as the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses. Cognition encompasses many aspects of intellectual functions and processes to utilise existing knowledge to create new knowledge. The processes pertinent for analysis in this study are in the fields of cognitive psychology, neuroscience, and education. These fields combine with others in the field of cognitive science, which is a progressive academic discipline

2.2.2.1 Cognitive psychology

Cognitive psychology is the study of how people acquire and apply knowledge or information. The study is based on two assumptions: firstly, cognitive psychology postulates that human cognition can be revealed by the scientific method fully, that is, the individual components of mental processes can be identified and understood. Secondly, that internal mental processes can be described in terms of rules or algorithms in information (Lu & Dosher, 2007).

Anderson (2015) explains that cognitive psychology is the science of how the mind is apprehended in the brain and organised to produce intelligent thought. He further elaborates that cognitive psychology is a dynamic science producing many interesting discoveries.

Frank and Badre (2015) assert that cognitive psychology overlaps with cognitive neuroscience where cognitive neuroscience attempts to link latent cognitive processes with the neural mechanisms that generate them. Education is about enhancing learning, and cognitive neuroscience is about understanding the mental processes involved in learning (Frith, 2011). This entails that education can indeed be transformed by science. Educational neuroscience is an emerging scientific field that connects cognitive neuroscience and cognitive psychology (Centre for Educational Neuroscience, n.d.).

Cherry (2019c) similarly explains that as cognitive psychology involves the study of internal mental processes, and cognitive neuroscience attempts to link latent cognitive processes with the neural mechanisms in the brain that generate internal mental processes, it is superior when discussing cognitive processes (i.e. learning, memory and information processing) from a neuroscientific perspective, to include neuroplasticity. Hannan (2013) defines neuroplasticity as the manner in which the brain cells change in response to experience and serves important functions, such as learning and memory.

A supporting view was expressed by Lu and Dosher (2007) on cognitive psychology. They state that it is the scientific investigation of human cognition, with reference to all our mental abilities, which include perceiving, learning, remembering, thinking, reasoning, and understanding. McLeod (2015b) concludes that cognitive psychology is the scientific study of the mind as an information processor and that cognitive psychologists try to build up cognitive models of the information processing that goes on inside people's minds, including perception, attention, language, memory, thinking, and consciousness. Determining the properties and mechanisms of the mind is what cognitive psychology is about (Goldstein, 2011).

2.2.2.2 Cognitive development

Cognitive development refers to changes in our thinking that occur because of learning, maturation and experience (Eggen & Kauchak, 2014). O'Donnell et al. (2009) add that cognitive development is also strongly influenced by physiological changes that occur in our brain. Duchesne and McMaugh (2018) support this view by indicating that the brain directs the course of overall development and responds to environmental stimuli to promote its own growth. Krause et al. (2009) indicate that the brain directs the course of overall development and responds to environmental stimuli to promote its own growth. In turn, Fuchs (2011) comment that the brain appears to be the creator of the mind and the experienced world of the learner.

According to Ormrod (2008), the brain's role in cognitive development includes, *inter alia*, developmental changes in the brain, which enable increasingly complex and efficient thought; many parts of the brain work in harmony to enable complex thinking and behaviour, and the brain remains adaptable throughout life (i.e. neuroplasticity). The brain directs the course of overall development and responds to environmental stimuli to promote its own growth. O'Donnell et al. (2009) assert that the human brain is the part that learns, thinks, remembers, and solve problems. On the contrary, Ormrod (2008) states that even as researchers gradually pin

down how the brain works and develops, current knowledge of brain physiology does not tell us very much about how best to foster learners' learning and cognitive development. He further explains by and large, if we want to understand the nature of human learning and cognitive development, we must primarily look at what psychologists and neurologists have discovered.

Krause et al. (2009) agrees by adding that the process of brain development is important in the teaching and learning process. Various literatures address the importance of cognitive development of learners if classrooms are to be environments of meaningful learning. Understanding how learners' brains work, and applying relevant research about the brain is the single most powerful choice teachers can make to improve learning in the classroom (Jensen, 2008).

Cognitive developmental theories by Piaget, Vygotsky, Bandura, and Flavell have been especially influential, and have provided considerable guidance about how best to foster learners' cognitive growth and development.

2.2.2.3 Cognitive neuroscience

Researchers have started to cooperate and interact in the field of neuroscience and the interdisciplinary researches in which education is included. Dündar and Ayvaz (2016) expanded on this by mentioning that it is considered that interdisciplinary researches such as cognitive and educational neuroscience will contribute to the understanding of how one can learn better. Laxman and Chin (2010) propose that new cognitive neuroscience and neuropsychology findings are increasingly being incorporated in education to gain new insights into the interdisciplinary connections between the brain, the mind and education. Willis (2012) concludes that the neuroscience research implications for teaching are an invaluable classroom asset and instruction in the neuroscience of learning must be included in professional teacher education.

Voss, Thomas, Cisneros-Franco and de Villiers-Sidani (2017), similarly clarify that neuroplasticity is the brain's amazing capacity to change and adapt. It refers to the physiological changes in the brain that happen as the result of our interactions with our environment. From the time the brain begins to develop in utero until the day we die, the connections among the cells in our brains reorganise in response to our changing needs. This dynamic process allows us to learn from and adapt to different experiences. In the same vein, Shaffer (2012) indicates that

neuroplasticity can be defined as the natural tendency of the brain architecture to shift in negative or positive directions in response to intrinsic and extrinsic influences.

Consistent with Hannon (2013), Besson (2016) significantly confirmed the existence of strong connections between fluctuations of emotional states and brain functions. Inevitably, the researcher attached meaning to the interrelatedness of neuroplasticity and positive psychology based on Besson's (2016) study and Shaffer's (2012) findings where recent research on neuroplasticity considers the several ways in which positive psychologists can facilitate brain plasticity in a positive direction at any age.

2.2.3 Educational neuroscience

Dehaene and Changeux (2011) claimed that "human cognitive neuroscience has made enormous strides in understanding the specific cerebral circuits underlying the particular domain of education, such as mathematics, reading, and language acquisition". Correspondingly, Galaburda (2011) states that "Knowledge from neuroscience also lends itself to applications to education and I would hypothesize that the predictive value of neuroscience data to learning is opt to be greater than that of genetic data".

Feist and Rosenberg (2012) explain that studies have indicated that learning and memory contribute to neuroplasticity, which in turn regard the significance thereof in early development of the brain structure and functioning. Frith (in Lalancette & Campbell, 2012) further argue that educational neuroscience is evolving at the interface of neuroscience, cognitive sciences, and education. The authors argue that even if education focuses solely on enhancing learning, and neurosciences solely on the brain mechanisms that is involved in learning, the future of education and the neurosciences are inextricably intertwined, and educational practices are being and will continue to be transformed by science.

Tandon and Singh (2015) indicate that there are two main streams of knowledge which link neuroscience to education. The first knowledge stream claims that the brain structures are responsible for various educational processes like reading, attention, memory, calculation, and language acquisition. The second stream of knowledge regards the manner in which educational processes affect brain structure and function. Over the last few years, extensive research has demonstrated the role of these educational processes in learning, more specifically in the field of literacy and education. For instance, learning to read is also one of the most elegant examples of

the neuroplasticity of the brain. While brain research may not yet tell us how to teach *per se*, it does inform teaching, learning, and school reform. We are at the beginning of a new vision in which scientists, educators, and the hybrid educational neuroscientist can all work together toward school reform (Zadina, 2015). In order to be able to attend to the educational needs of the diverse groups of learners in the modern society, Tandon and Singh (2015) indicate that teachers need to adjust their teaching knowledge from brain research.

SECTION B

2.3 LEARNING THEORIES

Learning theories are entrenched in a branch of psychology that is called educational psychology. The various learning theories focus on theoretical and empirical knowledge about teaching. They enrich teachers on how to apply that knowledge in the classroom to foster rich learning experiences for learners. Reflection on any act of teaching, demands that teachers think about the individual differences, assessment, development, the nature of the subject matter being taught, problem solving, and transfer of learning by learners (Zeichner, 2008).

Thus, in order to understand learning and perception, teachers have to understand how knowledge is encoded, stored, and retrieved in the information-processing system we call the human mind. As emphasised, by Krause et al. (2009), to teach is to act with a certain purpose and effective teaching therefore recognises all of the possible influences on a learner's cognitive development.

This section discusses the literature on the learning theories by prominent educational psychologists. The learning theories considered help to conceptualise the organisational framework of this study by making connections from the learning theories to educational objectives in an interactive environment conducive to teaching and learning. The theories of choice are of Sigmund Freud (psychoanalysis), Jean Piaget (cognitive development), Erik Erikson (psychosocial development), Jean Lev Vygotsky (social constructivism), Albert Bandura (social cognitive development), and John Flavell (metacognition).

2.3.1 Theory of the mind

Sigmund Freud (1856–1939)

Freud's cognitive theory is conceptualised as the theory of the mind. Sigmund Freud, an Austrian neurologist, was the founding father of psychoanalysis (a movement that popularised the theory that subconscious motives control behaviour) and believed that events in childhood have a great influence on adulthood and shaping one's personality (McLeod, 2018b). A primary assumption of Freudian theory is that the unconscious mind governs behaviour to a greater degree than people suspect. The unconscious mind plays an important role in influencing behaviour (Cherry, 2018a).

Freud developed a topographical model of the mind by using the analogy of an iceberg to describe the features, structure, and function of the mind. According to Freud, the mind consists of three levels – the conscious, the subconscious, and the unconscious. According to Porter (2016), consciousness is a subjective sensation. Figure 5 depicts the three levels of the mind according to Freud.

Based on the topographical representation of the model of the mind, which consists of thoughts and all mental processes that we are aware of, the focus is on our attention, i.e. our conscious thoughts (seen as the tip of the iceberg). The preconscious consists of all that can be retrieved from memory and contains thoughts and feelings that one is not currently aware of, but which can with ease be brought to levels of consciousness. The third and most significant region of the mind is the unconscious, which comprise mental processes that are inaccessible by the consciousness, but influence our judgements, feelings, or behaviour - it hosts the processes that underlie behaviour (the massive bulk of the iceberg that lies invisible and unseen below the surface of the water).

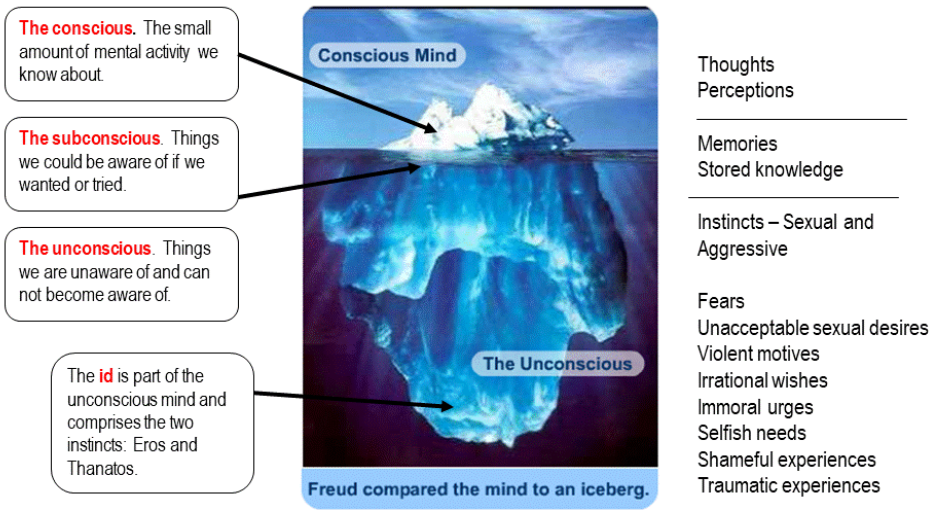

Figure 5: The human mind (Adopted from McLeod, 2018a)

The concept of three levels of mind is nothing new. According to Freud, the conscious mind is associated with thoughts and perceptions, and bringing it into perspective with the information-processing model, depicts stages of the sensory and working memory. The subconscious and unconscious mind evolves around the notion of long-term memory where information is stored.

Freud later (1923) developed a more structural model of the mind (see Figure 6) including the entities *id*, *ego*, and *superego* which do not represent physical areas within the brain, but rather hypothetical conceptualisations of important mental functions which are essential parts of the human personality (McLeod, 2016d). This model of the human personality has stood the test of time for many of the terms Freud introduced, such as *id*, *ego*, and *superego* and the subconscious are still used in contemporary psychology. McLeod (2015a) asserts that the id is regarded as entirely unconscious whilst the ego and superego have conscious, preconscious, and unconscious aspects.

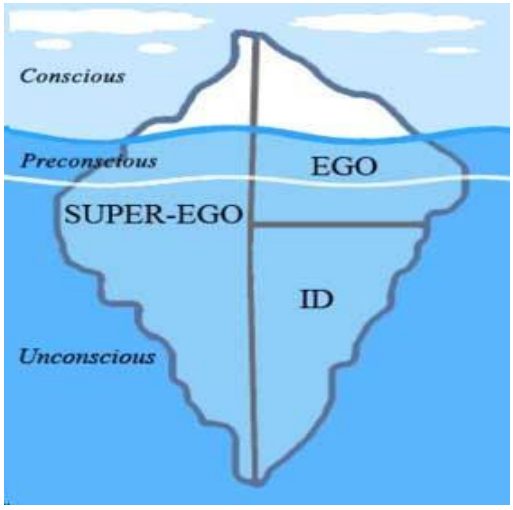

Figure 6: Freud's topographical model including the id, ego, and superego (Adopted from McLeod, 2018a)

McLeod (2016d) contends that the id is the primitive and instinctual part of the mind that contains sexual and aggressive drives and hidden memories and operates in the unconscious level of the mind with the goal of seeking pleasure; the id represents primary process thinking - our most primitive need-gratification-type thoughts. The id comprises two kinds of biological drives, which Freud referred to as *eros* (life instinct) and *thanatos* (death instinct) as derived from Greek mythology. The superego, McLeod (2016d) continues, operates as a moral conscience (based on the internalisation of parents' attributes, beliefs and standards) representing our conscience, and counteracts the id with moral and ethical thoughts. The ego is the realistic part (the rational, logical, problem-solving component of personality) that mediates between the desires of the id and the superego and stands in between both to balance our primitive needs and our moral/ethical beliefs. A healthy ego provides the ability to adapt to reality and interact with the outside world in a way that accommodates both id and superego.

Figure 6 depicts the interrelatedness of the conscious, preconscious, and subconscious in relation to the id, the ego, and the superego.

Cherry (2019d) explains that according to Freud, the id is the only component of the personality that is present from birth. The ego develops from the id (during the first year) and ensures that the impulses of the id can be expressed in a manner acceptable in the real world, whereas the superego begins to emerge at around the ages three to six. Notably, the superego develops at a crucial time that the child leaves home for schooling to experience the bombardment of information pertinent to his or her cognitive growth and development. The next section discusses the dimensions of the mind (conscious, subconscious, and unconscious) and learning in the classroom.

Learning processes mainly refer to the interconnections between perception, memory, language, imagery, emotion, and motivation which allow learners to mentally build connections between information (i.e. verbal and pictorial) patterns, or between new and prior memories, and integrate them with relevant knowledge structures in long-term memory (Mayer & Moreno, 2003). Kuldas, Ismail, Hashim, and Bakar (2013) argue that an understanding of human learning processes should not be restricted to conscious learning only. Learning processes and outcomes, on the contrary, can be conscious and/or unconscious. The unconscious learning processes range from registering information in the sensory memory to mentally forming associations within or between information patterns and activating associative memory networks, including individual expectations, beliefs, and desires (Kowalski & Westen, 2005). The unconscious learning process can be conducive to the acquisition, access, and application of knowledge without deliberate and controlled attention (Ashby & Maddox 2005; Dienes & Perner, 1999; Evans, 2008).

On the contrary, Kuldas et al. (2013) state that a conscious learning process is activated by intentionally paying attention to instructional materials, noticing similarities and differences between words and their particular meanings with the help of relevant prior experience, thereby mentally building coherent connections between them and organising them into new knowledge structures. Thus, either conscious or subconscious learning is principally a combination of mental processes, referred to as an acquisition process of knowledge, conveying memories into the mind, forming associations, retaining, and using them (Mayer & Moreno, 2003). A permanent change in mental associations in long-term memory or a potential change in human behaviour is considered to be learning (Ormrod, 2009). Learning as a subconscious process, can compensate for the limited capacity of the conscious learning processes, thereby laying the

foundation of human learning. Learning processes should contain a subconscious, implicit, unintentional, intuitive, experiential, or automatic processing phase, mainly due to the limited conscious processing capacity (Kuldas et al., 2013).

2.3.2 Psychosocial theory

Erik Erikson (1902–1994)

Erik Erikson mainly focused on learning through social interaction and development. Erikson's psychosocial theory (called Psychosocial Development Theory) relates to principles of psychological and social development, to which Slavin (2009) explains that Erikson's theory on personal and social development is an edition of the developmental theories of the great psychiatrist Sigmund Freud. McLeod (2013) supported the views of the latter by elaborating that Erikson's ideas were greatly influenced by Freud, going along with Freud's (1923) theory regarding the structure and topography of personality.

Erikson extends on Freudian thoughts by focusing on the adaptive and creative characteristic of the ego. Whereas Freud was a psychologist focusing on the id, Erikson was an ego psychologist who emphasised the role of culture and society, and the conflicts that can take place within the ego itself. Whereas the conflict between the id and the superego was emphasised by Freud, Erikson explained that the ego develops as it successfully resolves crises that are distinctly social in nature.

Erikson's psychosocial theory relates to principle that as learners improve their cognitive skills, they are also developing self-concepts, ways of interacting with others, and attitudes toward the world (Slavin, 2009). Eggen and Kauchak (2014) reiterate that Erikson's psychosocial theory integrates personal and social development, and that psychosocial development occurs in stages.

O'Donnell et al. (2009) proposes that an understanding of the personal and social developments is critical to the teacher's ability to motivate, teach, and successfully interact with learners at various ages. Cherry (2019e) postulates that understandings of childhood development have gone through many changes since the 20th century, where many influential thinkers and psychologists who have developed theories to help us understand how a child's brain thinks and processes the world. Figure 7 describes the psychosocial developmental stages in detail with particular reference to the developmental year, the psychosocial crises accompanied by the basic virtue at each developmental stage.

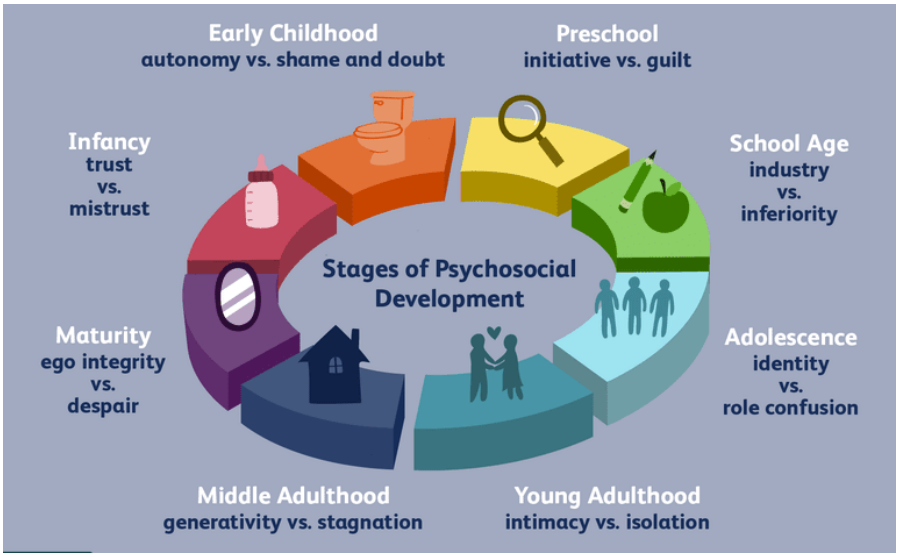

Figure 7: Erikson's stages of psychosocial development (Adopted from Cherry, 2019g)

Erikson and Piaget's theories have a profound impact on how we understand the growth and the development of learners both cognitively and emotionally. Their theories are highly useful in informing teaching methods, i.e. the best practices to teach, lead and educate learners. It is equally important to recognise that it is nurture, and not nature, that develops the personality (Thompson, 2018). This is because they believe that the environment (familial and social) shapes personality. The two theorists promote the idea that learners get enthused by their surroundings during the learning process. As learners improve their cognitive skills, self-concepts, ways of interacting with others, and attitudes toward the world are equally developed. The following section briefly explains child development from the cognitive stance of Jean Piaget.

2.3.3 Cognitive theory

Jean Piaget (1896–1980)

McLeod (2018a) states that Piaget was the first psychologist who conducted a systematic study on cognitive development. Piaget's theory (called Cognitive Development) entails contributions that include a theory of child cognitive development. Krause et al. (2009) agree by adding that Piaget's theory has had a profound influence on contemporary views of learning, thinking, and cognitive development.

O'Donnell et al. (2009) state that Piaget viewed learners as naturally curious explorers who constantly try to make sense of their surroundings. Piaget described this need for understanding

as the drive to maintain cognitive equilibrium, which is a state in which new experiences make sense because of our existing understanding. Eggen and Kauchak (2014) add that in trying to make sense of their surroundings, children's thought processes are adopted in response to new experiences.

Ormrod (2008) concurred that Piaget has given insights into the nature of learners' learning and thinking, and that Piaget's work forms an essential basis for understanding learners' cognitive development. There are three basic components to Piaget's cognitive theory which include schemas (building blocks of knowledge), the adaptation process (equilibrium, assimilation, and accommodation), and the stages of development (McLeod, 2018a).

Lefa (2014) explains that schemas are categories of knowledge (both the mental and physical actions involved) that help learners to interpret and understand the environment and are constructed through the process of assimilation and accommodation. McLeod (2018a) further explains that schemas are the basic building blocks of cognition (intelligent behaviour) and enable us to form a mental representation of the world. Eggen and Kauchak (2014) state that experience is a huge factor in cognitive development, and when learners are confronted with new experiences, the process of adaptation occurs whereby learners interpret these new experiences with the existing schemas (the process of assimilation) or change the existing schemas (process of accommodation).

Cherry (2019e) acknowledges that Piaget believed that all children try to strike a balance between assimilation and accommodation, which is achieved through a mechanism Piaget called equilibration. As children progress through the stages of cognitive development, it is important to maintain a balance between applying previous knowledge (assimilation) and changing behaviour to account for new knowledge (accommodation). Equilibration helps explain how children can move from one stage of thought to the next. Lefa (2014) maintains that because of equilibrium, a learner moves towards more complex and effective ways of organising knowledge. In the equilibrium, the assimilation and accommodation interact continuously, and accommodation opens up the possibility of assimilation and vice versa in an ever-expanding cycle. McLeod (2018a) explains that equilibrium occurs when a learner's schemas can deal with the newest information through assimilation. However, an unpleasant state of disequilibrium occurs when new information cannot be fitted into existing schemas (assimilation).

Weisz (2018) highlights that Piaget's theory proposed four childhood development stages: the sensorimotor stages (0–2 years); the pre-operational stage (2–7 years); the concrete operational stage (7–11 years); and the formal operational stage (11–19 years). The various stages of cognitive development according to Piaget are briefly outlined in Figure 8.

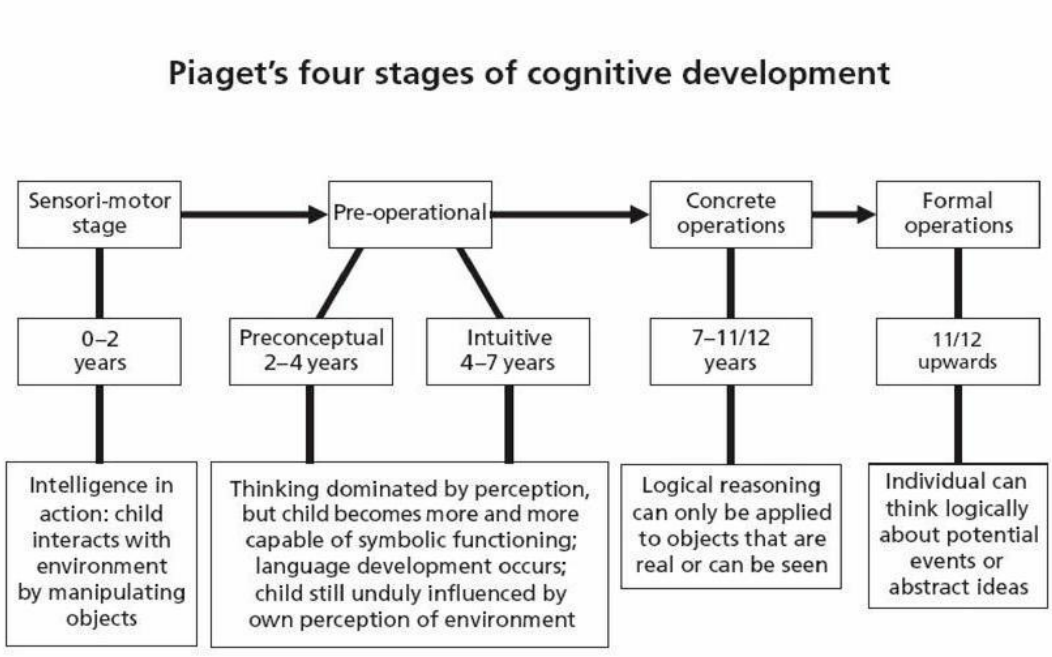

Figure 8: Piaget's stages of cognitive development (Adopted from Rice, 2011)

McLeod (2018a) avers that because Piaget's theory is based on biological maturation and stages, the notion of 'readiness' is important where readiness concerns when certain information or concepts should be taught. According to Piaget's theory, children should not be taught certain concepts until they have reached the appropriate stage of cognitive development. O'Donnell et al. (2009) confirm that by investigating Piaget's theory, teachers become aware of what to expect in terms of learner's thinking across different ages. Subsequently, teachers can offer learners activities that are developmentally appropriate, and classroom environments that are stimulating, interesting, and interactive to develop learners' higher order thinking.

O'Donnell et al. (2009) add that teachers need to be sensitive to learners' individual differences, motivate learners by stimulating their curiosity, and promote discovery-based learning in the classroom. There are varieties of perspectives in cognitive psychology that are currently impacting educators' thinking about how to improve the teaching/learning process. Eggen and Kauchak (2014) highlighted the importance of the teacher's role in promoting learners' cognitive active roles in the classroom.

Conversely put, in relation to Piaget, Vygotsky is of the view that sociocultural activity is the engine of cognitive development and for a child to develop new cognitive structures, he/she must first learn to use the cultural tools that the environment provides, in shared activity with other, more skilled people. Piaget was a seminal psychologist in the constructivist movement. He originally presented the idea of constructing knowledge from a biology perspective and thereby laid the groundwork for future biologists and psychologists (Vong, 2017). Vygotsky's theory implies that our thoughts are the internalised product of a social-historical culture and for Vygotsky, learning precedes development (Selepe, 2016). Constructivism has become one of the most important learning theories in modern education (Eberwein, 2015). The next section focuses on Vygotsky as the sociocultural cognitive psychologist.

2.3.4 Socio-constructivist theory

Lev Vygotsky (1896 - 1934)

Vygotsky's theory of learning is called social constructivism because it emphasised the importance of society and culture in promoting cognitive growth from a sociocultural perspective. Slavin (2009) recalls that Piaget's theory suggests that development precedes learning and specific cognitive structures need to be developed before certain types of learning can take place. In contrast to Piaget, Vygotsky's theory suggests that learning precedes development and that cognitive development is strongly linked to input from others (O'Donnell et al., 2009). Vygotsky proposed that cognitive development is strongly linked to input from others. Like Piaget, however, Vygotsky believed that the acquisition of sign systems occurs in an invariant sequence of steps that is the same for all learners, and that learning involves the acquisition of signs by means of instruction and information from others. Ormrod (2008) supports this view by stating that Vygotsky believed that the adults in a society foster children's' cognitive development in an intentional and somewhat systematic manner.

Slavin (2009) further contends that Vygotsky's work is based on two key ideas. Firstly, he proposed that intellectual development could be understood only in terms of the historical and cultural contexts of learners' experience. Secondly, he believed that development depends on the sign systems that individuals grow up with – the symbols that cultures create to help people think, communicate, and solve problems. Eggen and Kauchak (2014) postulate that Vygotsky provided a sociocultural theory of development, which emphasises the role of social interaction, language and culture on the learner's developing mind as displayed in Figure 9.

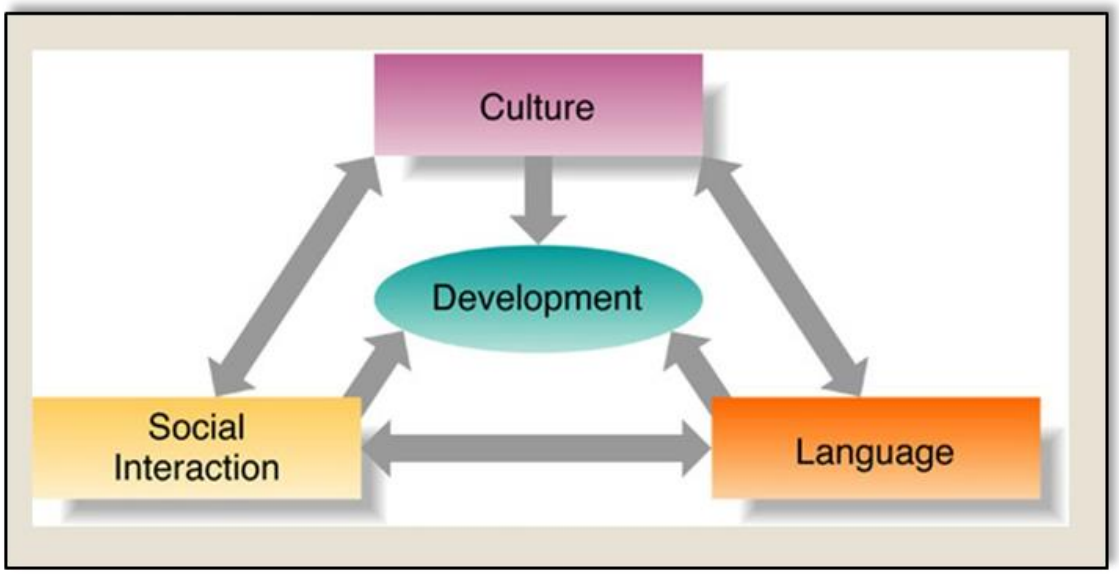

Figure 9: Learning and developing in a cultural context (Adopted from Eggen & Kauchak, 2014)

Vygotsky's developmental theory has highlighted the important contribution of social, interpersonal, and linguistic factors in facilitating children's mental development. Vygotsky observed that very young children tend to talk out loud as they problem-solve and try to learn a new mental task. This external dialogue helps children guide themselves through tasks. By middle childhood, as children become more efficient and skilled at various mental operations, these out-loud comments transform to become the internalised thoughts familiar to that of adults (Ormrod, 2008).

McLeod (2018c) explains that like Piaget, Vygotsky claimed that infants are born with the basic abilities for intellectual development but Piaget focuses on motor reflexes and sensory abilities and Vygotsky refers to elementary mental functions, which include attention, sensation, perception, and memory. Eventually, through interaction within the sociocultural environment, these are developed into more sophisticated and effective mental processes or strategies, which he refers to as higher mental functions.

Social development theory argues that social interaction precedes development, and consciousness and cognition is the product of socialisation and social behaviour (David, 2014). Hence, Vygotsky's theory is one of the foundations of constructivism. It asserts three major themes regarding social interaction, the more knowledgeable other, and the zone of proximal development. Due to the fact that Vygotsky regards the influence of adults (more knowledgeable

others) as the source of cognitive development, it is integrally related to an important principle of Vygotsky's theory – the zone of proximal development (ZPD).

The ZPD is an important concept that relates to the difference between what a child can achieve independently and what a child can achieve with guidance and encouragement from a skilled partner (McLeod, 2018c). In other words, according to Vygotsky, the ZPD is "[The] distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978). Cherry (2018b) points out that essentially, this zone is the gap between what a child knows and what he does not yet know. The process of acquiring that information requires skills that a child does not yet possess but can do with the help of a more knowledgeable other.

McLeod (2018c) explains that the ZPD has become synonymous in the literature with the term 'scaffolding' where scaffolding consists of the activities provided by the educator, or more competent peer, to support the learner as he or she is led through the ZPD. Support is tapered off (i.e. withdrawn) as it becomes unnecessary, much as a scaffold is removed from a building during construction. The learner will then be able to complete the task again on his own. It is important to note that the terms 'cooperative learning', 'scaffolding', and 'guided learning' all have the same meaning within the literature. The ZPD is depicted in Figure 10.

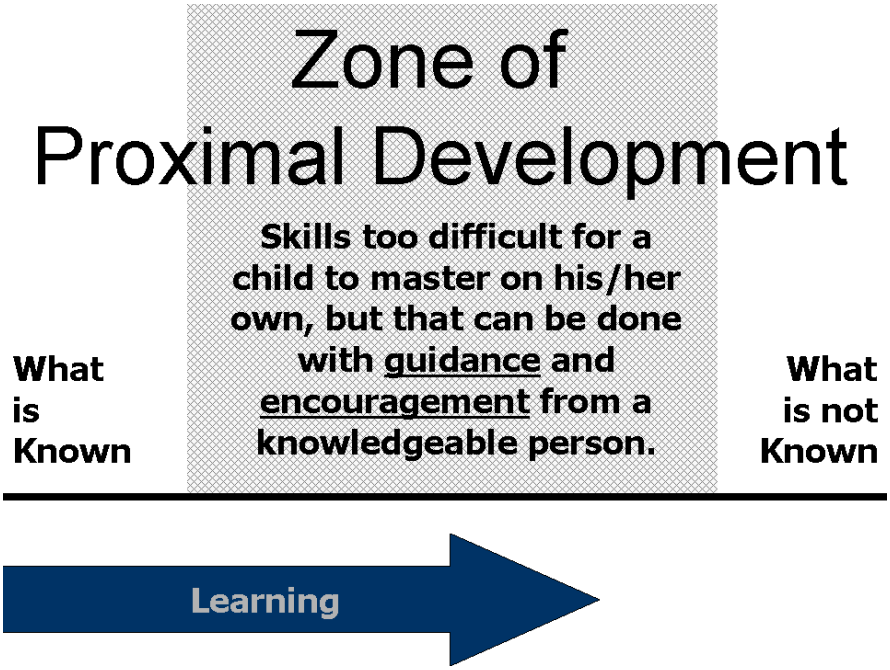

Figure 10: Vygotsky's Zone of Proximal Development (ZDP) Adopted from McLeod, 2018c)

By examining Vygotsky's theory, teachers become assertive about cognitive growth which refers to a socially-mediated activity that occurs in a social interaction milieu. Teachers can thus offer learners social guidance to assist them to develop the kind of thinking they need to become effective participants in the classroom through the application of the ZDP process. Understanding the levels of the ZPD can be helpful for teachers. In classroom settings, teachers may first assess students to determine their current skill level. Once this has been ascertained, educators can then offer instruction that stretches the limits of each child's capabilities. At first, the learner may need assistance from an adult or more knowledgeable peer, but eventually their ZPD will expand (Cherry, 2018b).

From a Vygotskian perspective, the teacher's mediating role is to support the learner's learning activity as they share knowledge through social interaction. Vygotsky views interaction with peers as an effective way of developing skills and strategies. He suggests that teachers should employ cooperative learning strategies where learners who are less competent, develop (with the assistance from more skilful peers) within the zone of proximal development. Scaffolding is a key learning technique for effective teaching, where the teacher recurrently adjusts the level of assistance in response to the learner's level of performance. In the classroom, scaffolding can include modelling a skill, providing valid examples, and adapting material or activities according to the learners' prior knowledge (Alber, 2014).

2.3.5 Social cognitive theory

Albert Bandura (1925 – Age 93)

In a similar vein as Vygotsky, Bandura explains that behaviour is learned from the environment through the process of observational learning and that learning can be seen as a mediating process that occurs between stimuli and response (McLeod, 2016c). Vygotsky as well as Bandura, suggested that learning is a socially interactive process. Vygotsky believed that children construct their knowledge from their immediate social environments and use adults as a tool to solve their knowledge problems. In comparison, Bandura believed that good role models would produce better behaviour than negative role models would.

Bandura's social learning theory is also known as modelling or vicarious learning. The social learning theory maintains that thought is influenced by internal processes involving attention, memory, and motivation, which might not be as readily observable as behaviour and its consequences (David, 2014). The key features of Bandura's theory include reciprocal determinism, self-efficacy, and self-regulation (Nguyen, 2015).

Bandura's social cognitive theory is based on the assumption that learning and behaviour are of triadic reciprocity, the view that personal, behavioural, and environmental factors influence each other in a bidirectional, reciprocal manner (Zhou & Brown, 2017). Figure 11 below illustrated the interdependence of the environment, behaviour, and personal factors in learning.

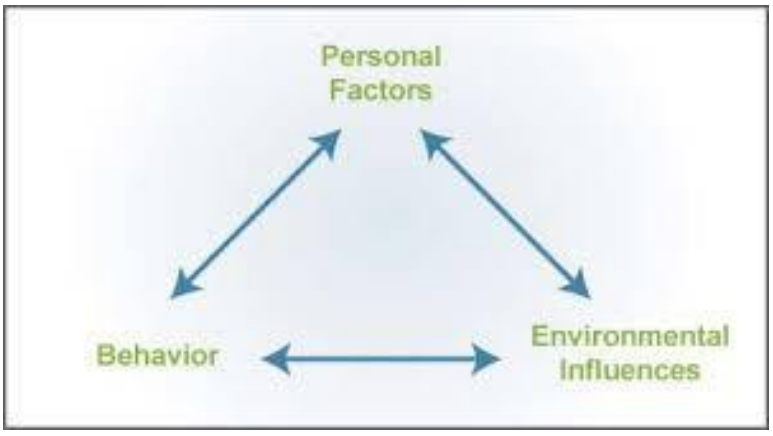

Figure 11: Reciprocal determinism (Adopted from Glanz, n.d.)

In the classroom, learning is shaped by factors within the academic environment, especially the reinforcements experienced by oneself and by others. At the same time, learning is affected by

students' own thoughts, self-beliefs, and their interpretation of the classroom context. Cherry (2019b) elaborates further on the three core concepts at the heart of social learning theory Firstly, people can learn through observation. Secondly, the internal mental states are an essential part of this process. Thirdly, the theory recognises that just because something has been learned, it does not mean that it will result in a change in behaviour (vicarious learning). Van der Merwe (2013) shares that Bandura's theory has many implications for education wherein teachers can be highly influential models in modelling problem-solving strategies and conduct amongst others.

According to Bates (2016), for learners to successfully imitate the behaviour of a role model, the learners must be encouraged to pay attention to the behaviour of the role model, be exhorted to remember what was seen or heard, have the capacity to reproduce the behaviour, and have the motivation to want to reproduce it. Bandura specified that learner self-efficacy would enhance learners' receptiveness to modelling good behaviour.

Bandura (1986) defines self-efficacy as the central, ubiquitous kind of thought, or self-referent thought, which "mediates the relationship between knowledge and action" and leads to perceived self-efficacy. Bandura (1986) defines perceived self-efficacy, as "people's judgements of their capabilities to organise and execute courses of action required attaining designated types of action." In other words, it is an individual's judgement whether he/she can successfully execute the behaviour necessary to produce the desired outcome in a given task.

Perceived self-efficacy is a sense of mastery and is concerned not with the skills one has, but with the judgements of what one, and not others, can do with whatever skills one possesses. Self-efficacy, therefore, can be viewed as part of reciprocal determinism, bearing upon a person's environment, behaviour, cognition, as well as other personal variables (Bandura, 1986). In literature, the terms 'self-efficacy', 'efficacy expectation's, and 'perceived self-efficacy' are used interchangeably.

Self-efficacy clearly is a cognitive construct. Nguyen (2015) defines cognition as "a method of processing information," which refers to "all the processes that enable an individual to represent and deal with the external environment symbolically or imaginably." Nguyen (2015) states that rather than reacting to environmental stimuli directly, people's behaviour is guided by interpretations of these stimuli. This is the reason why Nguyen (2015) contends that Bandura has pointed out that, human beings are capable of anticipating much of their behaviour, of producing

selected outcomes or consequences, of evaluating these outcomes, and thus largely regulating their behaviour. Figure 12 shows the conditions Bandura deems should be present for successful modelling.

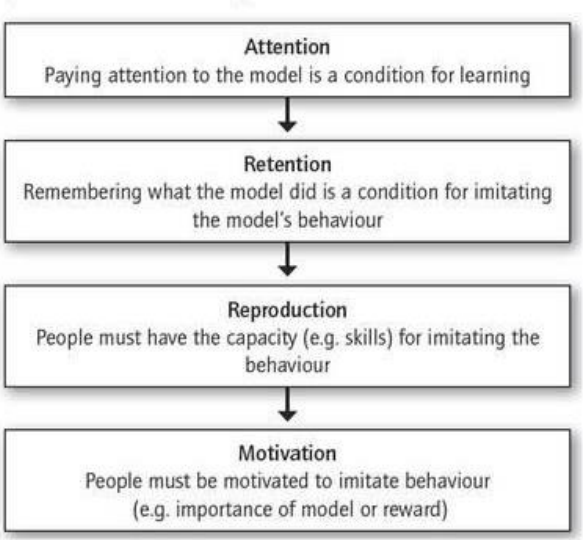

Figure 12: Bandura's modelling process (Adopted from Psychology Wizard, n.d.)

Cherry (2019b) points out that there are three core concepts at the heart of social learning theory. First is the idea that people can learn through observation. Next is the notion that internal mental states are an essential part of this process; explained part of the processes of development. Finally, this theory recognises that just because something has been learned, it does not mean that it will result in a change in behaviour due to factors that could affect both the model and learner. Bandura identified three basic models of observational learning which include: firstly, a live model (actual individual demonstrating or acting out a behaviour); secondly, a verbal instructional model (descriptions and explanations of a behaviour); and thirdly, a symbolic model (real or fictional characters displaying behaviours in books, films, television programmes, or online media). McLeod (2016c) points out that the mediational processes involved in observational learning and the modelling process are referred to as the internal mental states that are an essential part in this process of social cognitive learning.

All teachers are role models. As such, teachers are expected to meet the expectations of being effective and efficient role models. By doing so teachers could help develop and shape children in a way that is beneficial to their learning and development. Observing a teacher behaving in a particular way and their responses in different situations can help to encourage learners to behave in the same way. Another less obvious application of this theory is to encourage learners to

develop their individual self-efficacy through confidence building and constructive feedback – a concept that is rooted in social learning theory.

2.3.6 Metacognitive theory

John Flavell (1928–)

According to John Flavell (in O'Donnell et al., 2009) metacognition refers to a learner's knowledge concerning his/her own cognitive processes. Moreover, Flavell (in Livingstone, 2003) adds that higher order thinking of learners, which he calls metacognition, involves active control over the cognitive processes engaged in learning by an individual. Van Kraayenoord (2010) maintains that Flavell's influential work on metacognition provided a definition of the concept in which learners' perceptions of the functioning of their own memory are considered.

Flavell defined metacognition as the knowledge that is necessary for the process of monitoring cognitive activity and subsequently proposed a model focused on this process. The model proposed by Flavell (Figure 13) focused on the process of cognitive monitoring which he suggested occurs through an interaction of metacognitive knowledge, metacognitive experiences, goals and actions.

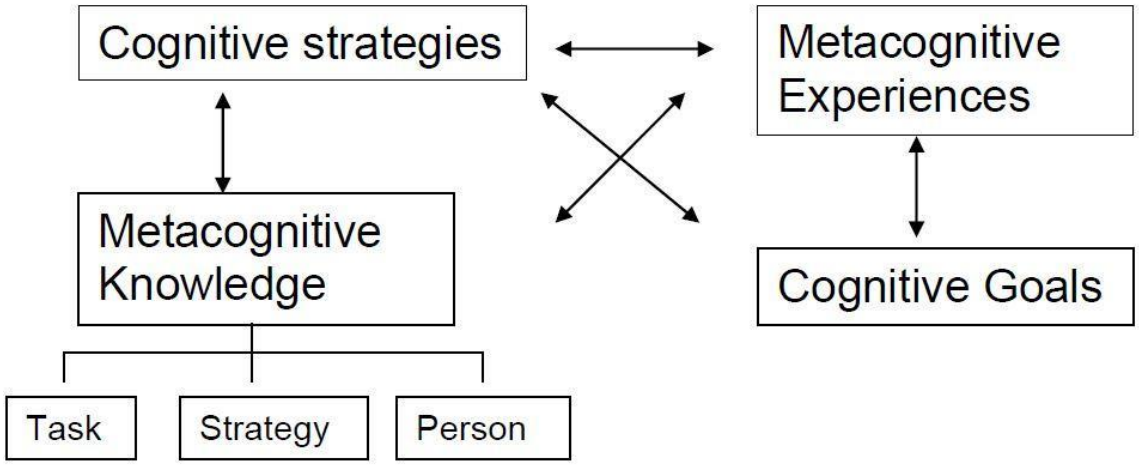

Figure 13: Flavell's model of metacognition (Adopted from Djudin, 2017)

As is evident from figure 13, metacognitive knowledge is knowledge or beliefs that an individual holds regarding the way in which specific variables (person, task and strategy category) might interact to affect the outcome of a situation. The person category includes an individual's beliefs

regarding the nature of their and others' cognitive processing. The task category includes information available in the course of encountering a specific problem. This information may be incomplete or inaccurate and Flavell suggested that it is the ability to recognise that information is incomplete which is crucial. Flavell suggested that all of the elements of metacognitive knowledge could be activated implicitly or explicitly (Peteranetz, 2016).

Latief and Dar (2014) explain that learning depends, in part, on the effective use of basic cognitive processes such as memory and attention, the activation of relevant background knowledge, and the deployment of cognitive strategies to achieve particular learning goals. The knowledge component encompasses what one knows about cognition, including knowledge about oneself as a learner, about aspects of the task, and about strategies needed to carry out the task effectively. To ensure that the basic processes are used effectively, that the activated knowledge is indeed relevant, and that appropriate strategies are being deployed, learners need to have awareness and control of their cognitive processes.

According to Frenkel (2014), metacognitive strategies are designed to monitor cognitive progress. Metacognitive strategies are ordered processes used to control learners own cognitive activities and to ensure that cognitive goals have been met. A learner with good metacognitive skills and awareness uses these processes to oversee his own learning process, plan and monitor ongoing cognitive activities, and to compare cognitive outcomes with internal or external standards. Flavell indicated that a single strategy could be invoked for either cognitive or metacognitive purposes and to move toward goals in the cognitive or metacognitive domains (Flavell, 1979).

Research has shown the importance of a combination of factors in the learning process, which suggests that learners must be able to draw simultaneously on a range of resources. Breed (2013) espouses that some of these resources are concerned with knowledge about how to process information (cognitive resources) and awareness of different available learning strategies (metacognitive resources). Figure 14 contains an overview of the various theoretical perspectives on metacognitive knowledge popular in the field of developmental psychology, making links between the various taxonomies and the terminologies that were used by different research lines.

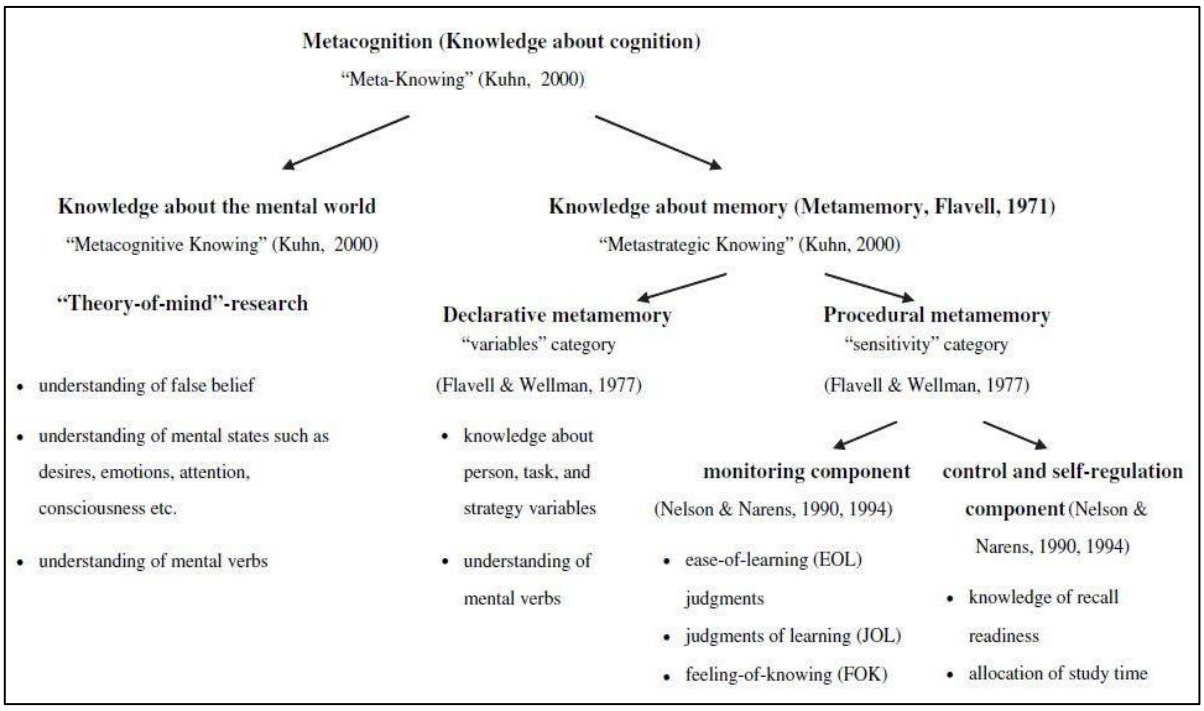

Figure 14: Taxonomy of metacognition components (Adopted from Schneider, 2008)

As highlighted in section 2.3.6, Schneider (2008) explains that teachers need to understand the information-processing model in order to teach for metacognitive awareness amongst learners effectively. Flavell contends that children develop an increasingly complex theory of mind and mental processes, and that this development is enabled by their increasing capacity for abstract thought (Krause et al., 2009). Fang and Cox (in Krause et al., 2009) stipulated that since metacognition requires self-reflection and the awareness of mental processes, it is therefore, intangible, and requires the ability to reflect on abstract processes. Kuhn (in Krause et al., 2009) states that while research found some evidence of metacognition in younger children, however Price-Mitchell (2015) states that the ability to think about one's thinking increases with age, where research shows that most growth of metacognitive ability happens between the ages 12 and 15.

2.4 CONCLUSION

In conclusion, Section A of this chapter discussed the conceptual framework of the study in outlining how the theoretical underpinnings informed the study as well as the literature regarding the learning theories. Each learning theory was explained and concluded on some educational implications of the theory. A detailed clarification of some guidelines on practical examples in

the classroom will be rendered in Chapter 5. A juxtapositioning of the theories was undertaken succinctly. An amplification of the juxtaposed theories will be accentuated in Chapter 5 on "Discussion."

The next section brings these learning theories into perspective by juxtaposing them, and illustrates how they inform the study, inclusive of the theoretical underpinnings. The study has produced a SEM model in which the four dependent variables of the study described how an interactive learning environment is enhancing learner information processing abilities through conscious awareness, cognitive and metacognitive engagement of learners. The SEM model is illustrated in Figure 15. A brief overview of how the interrelated learning theories and theoretical underpinnings pertain to the SEM model is also indicated below. A comprehensive explanation is provided in Chapter 4.

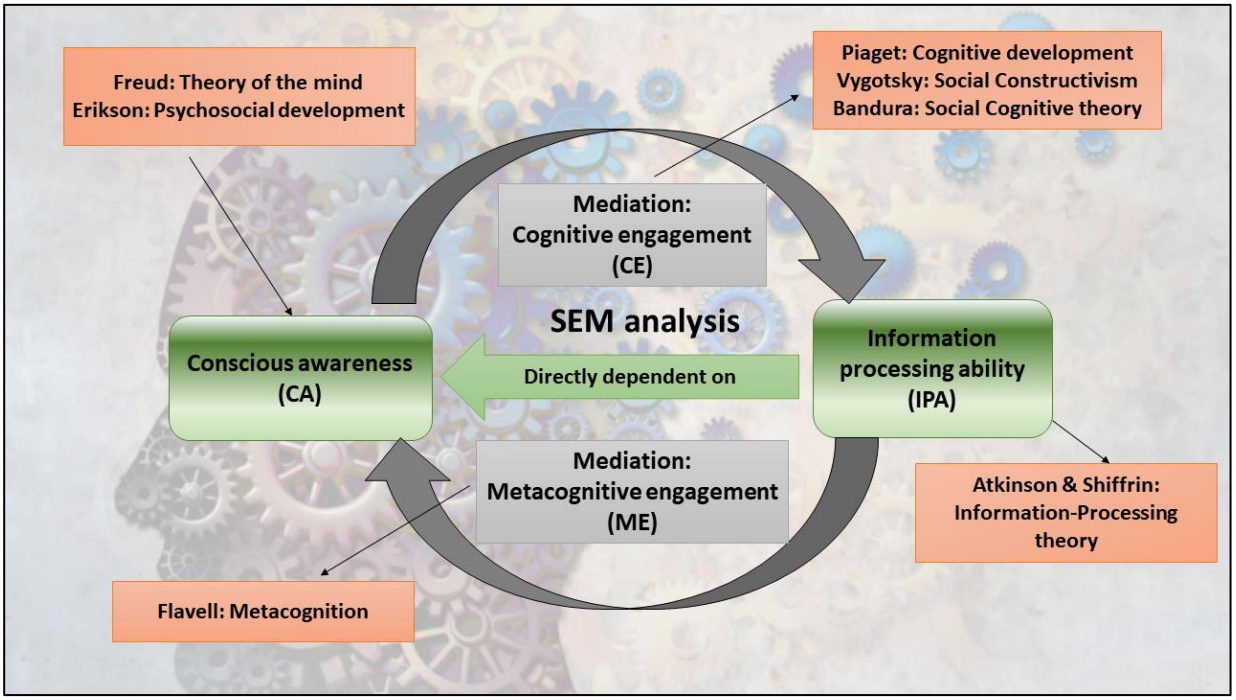

Figure 15: Juxtaposed Learning Theories as applied to the Structural Equation Model (SEM)

SECTION C

2.5 LEARNER PERFORMANCE IN AN INTERACTIVE TEACHING–LEARNING ENVIRONMENT

This section encapsulates the impactful capability by teachers to maximise learning. The researcher opines that teacher capacity to apply such a consolidated knowledge-based perspective simultaneously when teaching, would facilitate for the equality and ease of information processing by learners. The section explains the human memory model, followed by teaching-learning interactive environments, which after various learning theories as discussed in section B of this chapter are juxtaposed. The chapter further highlights the four DVs of the study which include information processing ability (IPA), conscious awareness (CA), cognitive engagement (CE) and metacognitive engagement (ME) concluded by the educational implications of these to classroom teaching and learning.

2.5.1 Introduction

Zaky (2015) states that one of the oldest and most central theoretical debates within psychology concerns whether learning and development is a result of nature (genetic inheritance) or the influence of the environment (nurture). Subsequently, as explained previously in this study, both genetic and environmental factors play vital roles in learning and development of which early child development deeply impacts social, emotional and cognitive development of learners.

In a classroom, an effective and knowledgeable teacher is an important school-related factor that facilitates the learning process, and who is responsible for learning (Schacter & Thum, 2004). Sousa (2011) contends that teachers try to change the human brain every day and the more they know how it learns, the more successful they can be. Teachers are in the only profession in which their job is to change the human brain every day. Jensen (2008) postulates that as the brain continues to be the new frontier, the old ways of schooling is fading as fast as our understanding of the brain increases, and it is the most relevant understanding for teachers to have.

The researcher is firmly of the belief that related learning theories, knowledge of how learners learn, how information is processed in the human brain, and the influence of interactive teaching and learning environments can greatly influence the effectiveness of teachers in South African schools. The researcher is also convinced that teacher training at tertiary institutions should

incorporate brain research into their modules for the advancement of teacher training programmes.

Too often, the ineffectiveness of the instructions provided by the teacher is not regarded as influential in ineffective learning (Nuthall, 2004). Within the professional culture of teaching and learning, it is generally believed that if material is taught, it is automatically learned by the learners. If the material is not learned, then the problem is presumed to lie with the inadequacy of the learner's ability, motivation, or persistence. Grösser (2007) is of the opinion that effective teachers regard how learners learn and subsequently carefully plan instruction towards creating a successful learning environment.

Figure 16 indicates how Grösser views learning. The figure illustrates the important role that the teacher plays in developing certain learning functions, which in turn assist the learner in the learning process and in the ideal realisation of learning goals and learning outcomes. These learning functions refer to the manner in which new information is linked to prior knowledge, how to organise information effectively, and how to acquire cognitive learning strategies as well as metacognitive learning abilities.

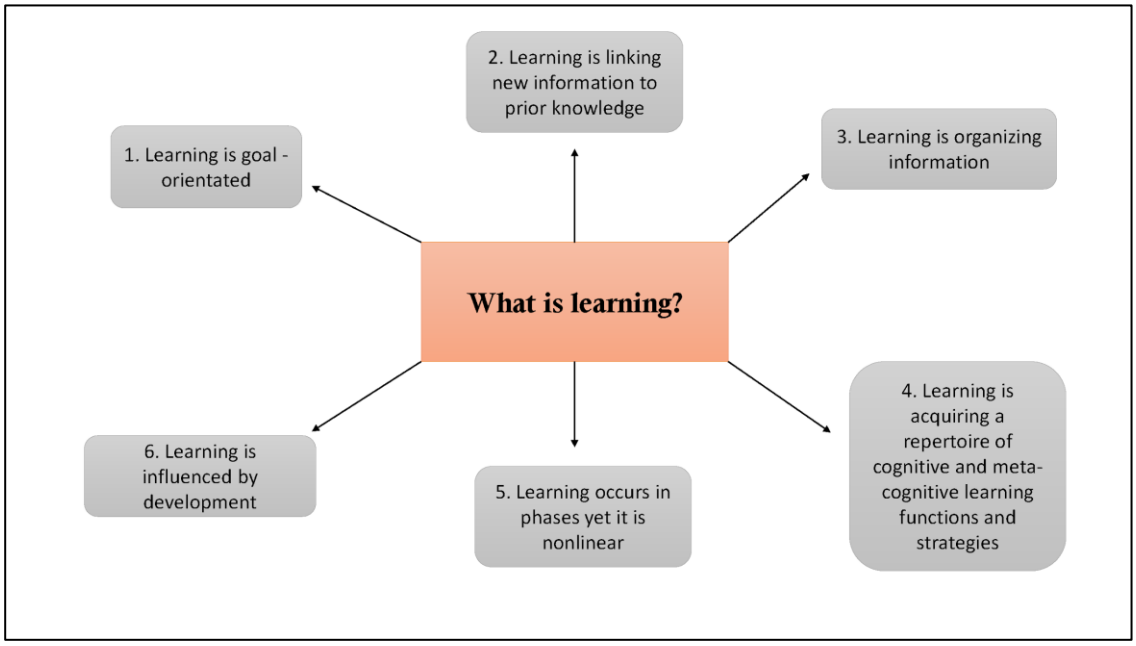

Figure 16: What is learning? (Adopted from Grösser, 2007)

Grösser (2007) contends that teachers should not merely teach learners content, but also the strategies required for learner engagement with the content to realise an interactive learning process. Teaching practices should be expanded to be more developmental in nature, and to encourage a kind of learner self-reflection inclusive of a perceptual shift that define higher orders

of consciousness. If teaching is only experienced as a process, whereby learners believe that the expectation of them is only to focus on fixed predetermined procedures of recollection and reproduction information, then the aim of education is defeated (Kotze, 2002).

As Kandarakis and Poulos (2008) explain, in terms of the information-processing model, and how learners learn, learning presents the process of gathering information (retrieving it from the environment) and organising it into mental schema. Jensen (2008) explains that brain-based learning or education is best understood in three words: engagement, strategies, and principles; and encapsulates that brain-based education is the engagement of strategies based on principles derived from an understanding of the brain. It explains learning in accordance with the way the brain is naturally designed to learn and considers how the brain learns best. Teachers who understand how this theory contributes to learners' information-processing ability and that the learning environment has specific effects on academic achievement, select appropriate learning strategies to improve retention and retrieval of learning. The following section explains the human memory model.

2.5.2 The human memory model

2.5.2.1 Introduction

Slavin (2009) contends that the human mind is the maker of meaning and from the first moment you see, hear, taste or feel something, a process of deciding what it is, how it relates to what you already know, and whether it is important to keep in your mind or should be discarded, is initiated. In the same vein, Flobakk (2015) explains that researchers in the fields of cognitive neuroscience, education and developmental psychology have discovered some amazing phenomena about how the human brain works, how our minds are naturally configured to develop skills, think creatively and has the ability to continuously learn (with reference to the brain's neuroplasticity). Kuldas et al. (2013) add that a permanent change in mental associations or a potential change in human behaviour is considered learning. According to Kuldas et al. (2013), learning is primarily a combination of mental processes, a knowledge acquisition process, bringing memories into the mind, forming associations, retaining, and using them either consciously or subconsciously. The brain processes different types of learning through different pathways, for words, text, pictures, and input to the brain arrives from the senses or it may be generated internally (Jensen, 2008).

Kandarakis and Poulos (2008) intone that whilst learning is defined as the process of acquiring new information, memory is defined as the persistence of learning that can be assessed later. Researchers throughout history have been fascinated by memory. Ormrod (2008) explains memory as the learner's ability to save things previously learned mentally. He further elaborates on the term 'storage', which refers to the process of putting what is being learned into memory. Krause et al. (2009) agree to the latter by stating that thinking is portrayed as a highly rational process and the capacity to remember information lies at the heart of information processing theories.

Eggen and Kauchak (2014), state that the human memory model is composed of three major components. Each memory component has its own memory storage systems. The first storage systems consist of the Sensory Memory, the Working Memory, and the Long-term Memory Systems. The second memory storage system is the cognitive processes (attention, perception, rehearsal, encoding and retrieval), and the third memory storage system is Metacognition (the cognitive mechanism for monitoring and regulating both the storage of information and how the information is transferred from one memory to the other).

2.5.2.2 Information processing theory: Richard Atkinson (1929–) and Richard Shiffrin (1942–)

The structure of human memory was initially proposed by Atkinson and Shiffrin (1968), and is often described in the framework of information processing theory (Eggen & Kauchak, 2014). Woolfolk (2007) elaborates on the information-processing theory by mentioning that processing involves encoding (gathering information and organising it in relation to what is already known), storage (holding information), and retrieval (getting the information when needed). Figure 17 shows the information-processing model proposed by Atkinson and Shiffrin in 1968.

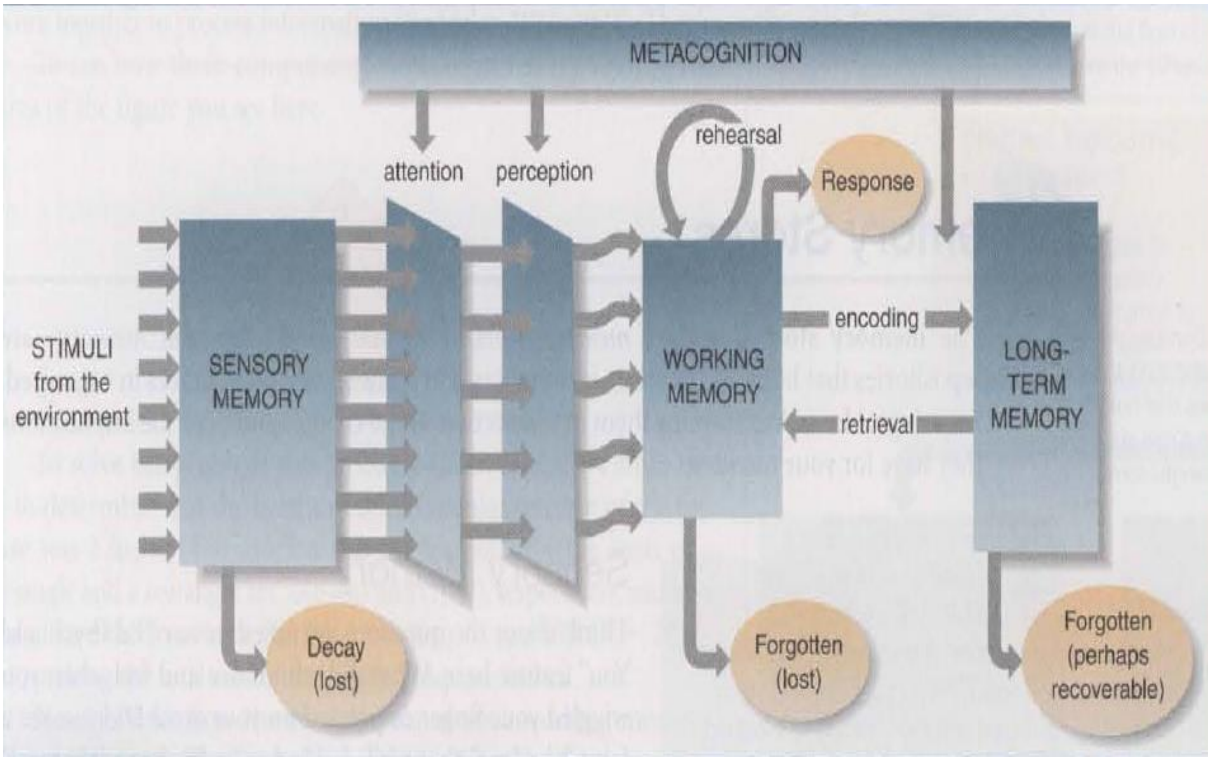

Figure 17: Model of human memory (Adopted from Eggen & Kauchak, 2014)

2.5.2.3 Memory storage systems as the first component of human memory

Consistent with Atkinson and Shiffrin's theory, Hedge (2013) concedes that the memory stores can be functionally divided into three systems, namely: sensory memory (SM), working memory (WM) and long-term memory (LTM).

i. *Sensory memory (SM)*

Eggen and Kauchak (2014) state that SM is important due to the fact that it is the starting point for further processing, where SM holds the information until we attach meaning to it and transfer it to WM. Thus, learning and development depend on experience and it is a principle of cognitive learning theory, as we acquire experience through our SM. Mastin (2018) explains that SM is associated with senses and functions to hold sensory information in memory very briefly, just long enough for information to be processed further. Cherry (2019a) explains that the senses are consistently taking information from the environment and while this information is important, one could simply not remember each and every detail about your experiences. Instead, your SM creates a snapshot of the world around you, allowing you to focus your attention on relevant details briefly. Marchetti (2014) adds that SM is affected by attention and that attention causes information to be transferred to the WM. Cherry (2019a) postulates that different senses have

different types of sensory memory. The different types of sensory memory have also been shown to have slightly different durations. The different types of SM are shown in Figure 18.

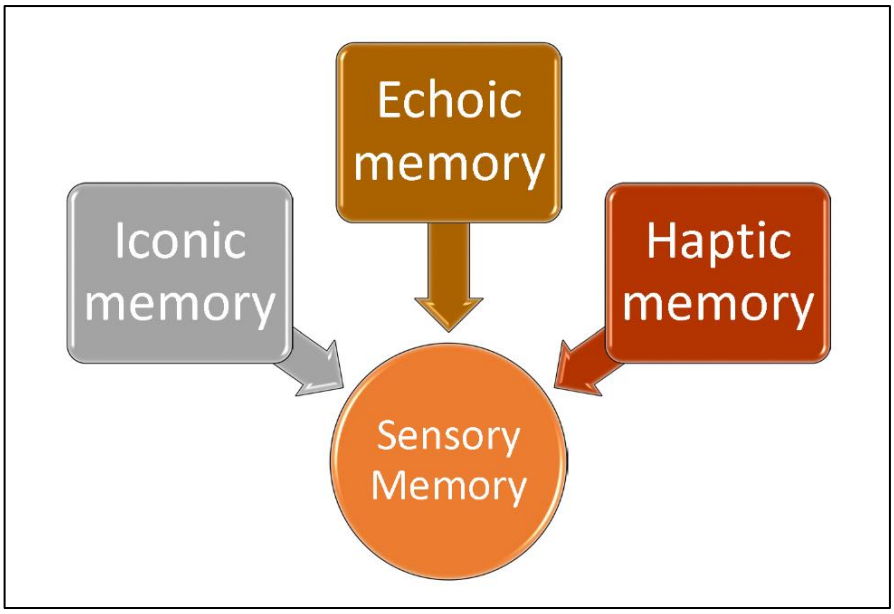

Figure 18: Types of sensory memory

In explaining the various types of SM, according to Cherry (2019a), reference is made to the following.

i. *Iconic memory* is also perceived as visual sensory memory, and involves a very brief image and lasts for about one-quarter to one-half of a second.
ii. *Echoic memory*, also known as auditory sensory memory, involves a very brief memory of sound, almost like an echo. This type of sensory memory can last for up to three to four seconds.
iii. *Haptic memory*, known as tactile memory, involves the very brief memory of a touch. This type of sensory memory lasts for approximately two seconds.

The importance of SM and attention in the classroom cannot be overstated. By understanding that certain sensory stimulus has a longer duration than others, teachers can easier select a combination of appropriate content so that learners can draw attention to it. Without attention, teachers cannot teach, as learners will not be able to store information in their working memory (Jaeger, Shipley & Reynolds, 2017).

ii. *Working memory (WM)*

Malamed (2010) describes WM as being mentally online. Similarly, Eggen and Kauchak (2014) explain that WM is the workbench of the memory system, the conscious component where our

thinking occurs and where we try to make sense of our experiences by linking it to our existing understanding. McLeod (2012) argues that researchers today generally agree that working memory is made up of a number of subsystems, which is supported by considerable experimental evidence, and has replaced the idea of the unitary working memory model as suggested by Atkinson and Shiffrin (1968). The working memory applies to real-life tasks inclusive of reading (phonological loop), problem solving (central executive), and navigation (visual and spatial processing) of which all function on a conscious level of information processing. These processes work together in order to be able to process information in the prefrontal cortex (PFC) area of the brain (Figure 19).

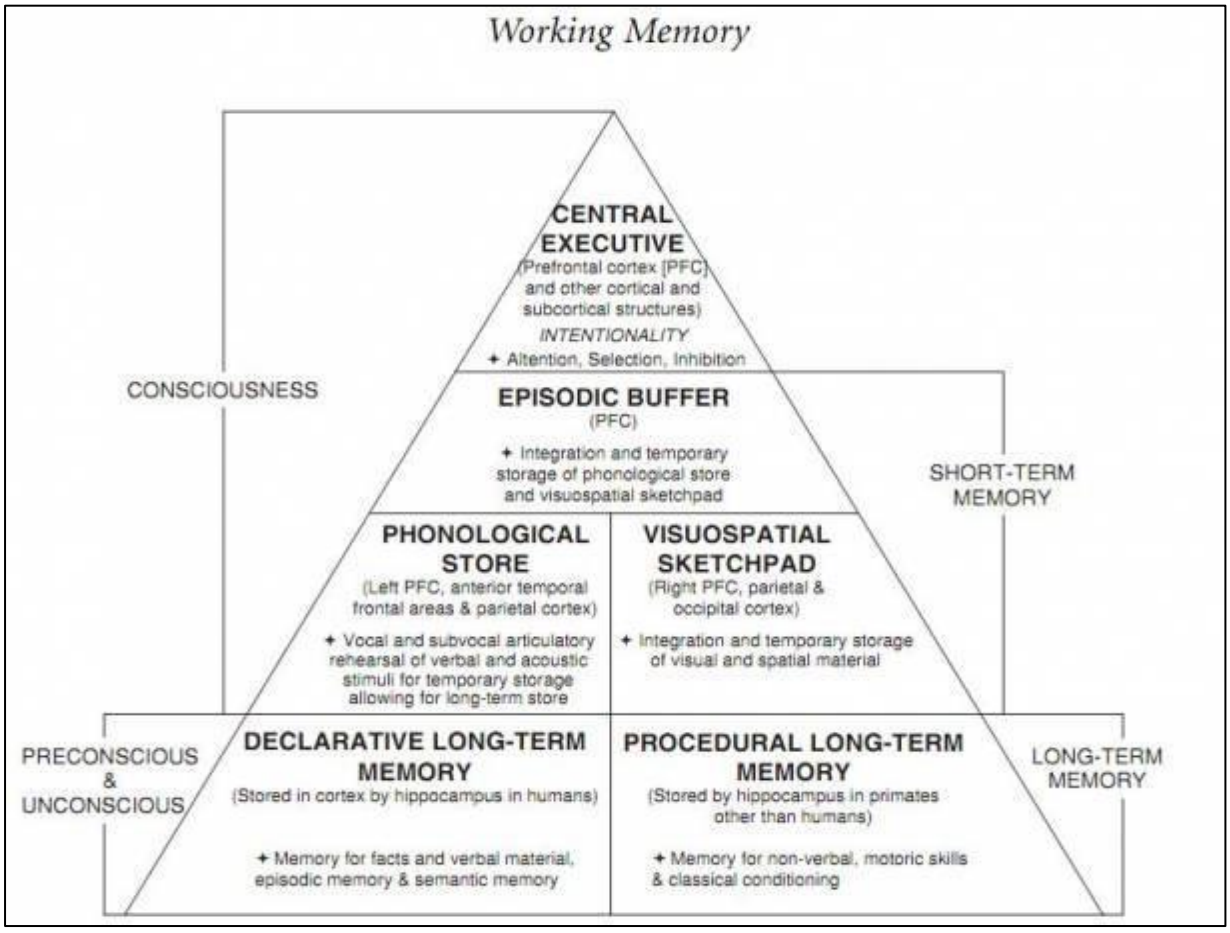

Figure 19: Extended model of working memory (Adopted from Learning Theories, 2012)

The central executive functions include attention and focusing, an active inhibition of stimuli, maintenance, and integration of information received from the phonological loop and visuospatial sketchpad. The episodic buffer has the role of integrating the information from the phonological loop and visuospatial sketchpad, but also from long-term memory. It serves as the

storage component of the central executive, where information integration would not be possible. According to Baddeley (2002), the phonological loop consists of two components: a sound storage, which lasts just a few seconds, and an articulatory processor, which maintains sound information in the storage by vocal or sub-vocal repetition. Verbal information seems to be automatically processed by phonological loop and it plays an important, maybe even key role in language learning and speech production. It can also help in memorising information from the visuospatial sketchpad.

This construct according to Baddeley (2002), enables temporary storing, maintaining, and manipulating of visuospatial information. It is important in spatial orientation and solving visuospatial problems. Studies highlighted by Gathercole (2008), have indicated that the visuospatial sketchpad might actually be containing two different systems: one for spatial information and processes, and the other for visual information and processes. The WM model originally proposed by Atkinson and Shiffrin (1968) were extended by Baddeley (2002). Figure 19 illustrates the extended model on working memory.

Eggen and Kauchak (2014) explain that the most important processes in learning is to construct meaningful knowledge and it takes place in the memory component that is the most limited. This limitation of the WM is explained by the concept ‘cognitive load’. Paas and Ayres (2014) add that cognitive load has certain assumptions, which indicate that human memory is divided into WM and LTM. Schemas represent how information is stored in LTM, and that processing new information results in cognitive load on the WM which affects learning outcomes. Cognitive load theory (CLT), originally developed by educational psychologist John Sweller in the 1980s, explains the cognitive processes related to learning and strategies that could increase the likelihood of teachers to teach more effectively (Paterson, 2017). CLT identifies three broad categories of thinking, or cognitive loads, that include (i) intrinsic thinking that derives meaning from new information and how it is connected. Dealing with information not related to what you are learning is called (ii) extraneous thinking. Finally, (iii) germane thinking is building mental models (or schema) that encode the meaning of the information and how it is connected. Figure 20 shows the process of cognitive load.

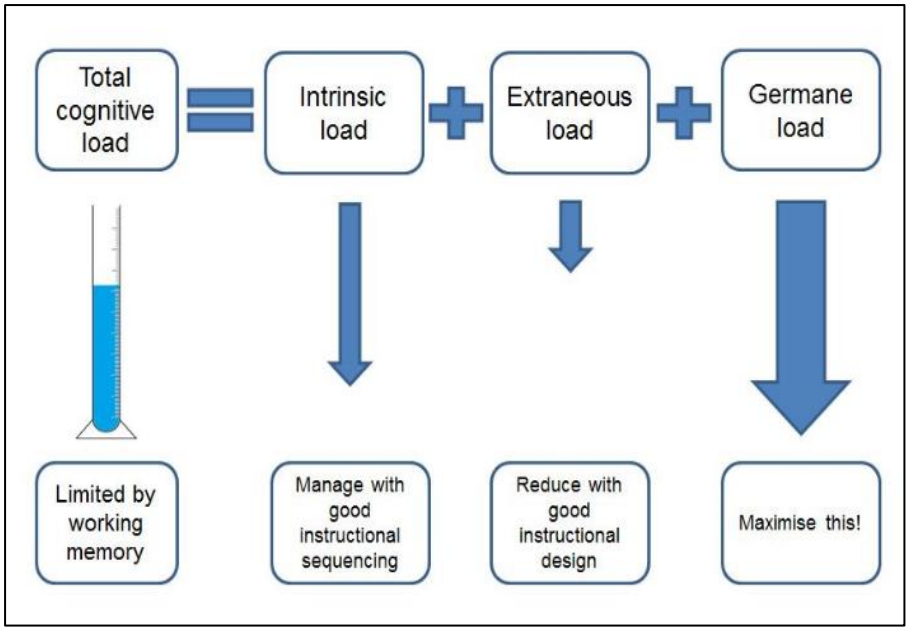

Figure 20: Cognitive load (Adopted from Paterson, 2017

Hall (2016) contends that teachers should not overlook the role of learning in the classroom and cognitive load could be effectively managed in terms of working memory to aid learning. Similarly, Heick (2017) postulates that learning experiences should be designed in a manner that reduce WM load in order to promote schema acquisition by being specific, not only about the what and sequence of learning, but also the nature of what is being learned. Eggen and Kauchak (2014) suggest three strategies to reduce cognitive load that include: chunking, automaticity and distributed processing. Chunking involves the process of mentally combining separate items into larger and more meaningful units; and automaticity is the ability to perform mental operations with little awareness or conscious effort. It is therefore essential, according to the researcher, that teachers not only teach content to learners, but also the skillset involved during the learning process. Once the skill is learned, learners can conduct the skill with a minimal amount of conscious thought and allows learners to use their active intellect to deal with real cognitive matters.

Eggen and Kauchak (2014) also explain that when, for example teachers effectively interact with learners, questioning skills should be a by-product of automaticity. When employing distributed processing, Eggen and Kauchak (2014) provide the example related to the phonological loop and the visual-spatial sketchpad in WM, whereby they operate independently, meaning that each can perform mental work without taxing the resources of the other. In doing so, distribution of the processing load across the two components takes place, and it suggests that learners could learn

more if verbal explanation and visual representation are combined. The visual processor supplements the verbal processor and vice versa.

Alloway (2006) asserts that working memory plays a substantial role in supporting the learning process. He added that working memory provides a resource for the learner to integrate knowledge from long-term memory with information in the working memory. In an attempt to strengthen the capacity of the working memory, Alloway (2006) suggests that teachers assist learners by encouraging them to ask for forgotten information where necessary, training in the use of memory aids, and encouragement to continue with complex tasks, rather than abandoning them even if some of the steps are not completed due to memory failure. Arming the learner with such self-help strategies will promote their development as independent learners able to identify and support their own learning needs.

In a similar vein, Willis (2012) explains that for young brains to retain information, they need to apply the information. Information learned by rote memorisation will not enter the sturdy long-term neural networks in the prefrontal cortex unless learners have the opportunity to actively recognise relationships to their prior knowledge and/or apply new learning to new situations. According to Willis (2012), teachers should employ brain-based teaching strategies to build executive function in learners which includes providing learners the opportunities to apply learning, introduce activities to support the development of the executive function, and to model higher thinking skills inclusive of judgement, prioritising, setting goals, providing self-feedback and monitoring progress, prior knowledge activation and transfer opportunities, and metacognition.

The following sections are adopted from Willis (2012), in explaining the different teaching strategies that could be applied in the classroom involved in *developing the executive function*.

a) Provide opportunities to apply leaning

The first teaching strategy that teachers should employ refers to the provision of meaningful and authentic learning experiences for learners in the classroom. To strengthen meaningful environments, teachers should also allow for continuous formative assessments that are accompanied by effective and efficient feedback from the teacher. Neural networks in the brain are engaged through the provision of these meaningful and authentic learning experiences. Furthermore, related information (i.e. prior knowledge) to these learning experiences are linked

together through the process of neuroplasticity. New information is integrated by these extensive neural circuits when the neural circuits are, a) simultaneously activated, and b) when the circuits recognise neural information patterns in common. Learning is thus consolidated into neural networks by the expansion of related types of information (Piaget's schema) through executive function activities. These networks can be activated when learners are incited to use new learning to solve problems or create new knowledge. This transfer process further promotes network activation with the resulting neuroplasticity to construct long-term memory. Without these opportunities for strengthening, any memories learned by rote are simply pruned away after the test due to disuse.

b) *Introduce activities to support developing executive function*

Learners need to be unequivocally taught how to strengthen their executive function by given opportunities to them in order to practice using executive functions. These opportunities include strategies on how to learn and study optimally, and how to participate actively in the classroom discussions by means of organising, prioritising, and reviewing existing knowledge. Activities that can support the development of the executive function that teachers can include in their teaching and learning approaches refer to comparing and contrasting new information or knowledge, providing new examples of an existing concept, employing a spiralled curriculum, engaging learners in group collaboration and open-ended discussions. Additionally, executive function is developed when learners summarise and symbolise new learning into new formats, such as through the arts or writing across the curriculum.

Authentic and learner-centred activities would empower learners and give learners the opportunity to: i) make predictions, ii) solve a variety of types of problems, iii) pursue inquiries, iv) analyse what information they need, and v) consider how to acquire any skills or knowledge they lack to reach desirable goals. This type of approach where learners are prompted for information and skill seeking, strengthens their attitude about the value of learning. When learners are motivated to solve problems that are personally meaningful, they apply effort, collaborate successfully, ask questions, redo work, and seek the foundational knowledge teachers' need them to learn, and learners engage because they want to know what the teacher has to teach. When learners acquire desired facts, skills, or procedures to achieve authentic, valued goals, the information has a template (neural circuit) to which it can link itself. Foundational knowledge is not isolated. Learning is consolidated into related patterns, connected

in neural networks of long-term conceptual memory, and available for retrieval and transfer to solve future problems and investigate new ideas.

c) *Model higher thinking skills*

In planning instruction, teachers have to consider the manner in which they will model higher order thinking skills and provide opportunities for learners to activate their developing executive function networks throughout the learning process. These functions refer to judgement, prioritising, setting goals, providing self-feedback and monitoring progress, prior knowledge activation and transfer opportunities, and metacognition.

Cockcroft (2015) concurs that from empirical research on WM functioning in learners to the practical application and relevance for learning and education, the capacity of WM could be enhanced through targeted interventions, effective classroom management of WM load, and the teaching of specific strategies. The following section explains LTM as part of the information-processing model.

iii. *Long-term memory (LTM)*

McLeod (2010) explains that long-term memory (LTM) is the final stage of the information processing model proposed by Atkinson and Shiffrin (1968) and provides the lasting retention of information and skills. Krause et al. (2009) further explain that the LTM takes on many forms and is broadly divided into explicit (or declarative) and implicit (or procedural) knowledge. Eggen and Kauchak (2014) contend that LTM contains three kinds of knowledge: declarative, procedural and conditional (self-regulatory). Mastin (2018) explains that declarative memory ('knowing what') is memory of facts and events and refers to those memories that can be consciously recalled (or 'declared'). It is sometimes called explicit memory, since it consists of information that is explicitly stored and retrieved, although it is more properly a subset of explicit memory. Declarative memory can be further sub-divided into episodic memory (recall of personal facts) and semantic memory (recall of general facts).

Mastin (2018) further explains that procedural memory ('knowing how') is the unconscious memory of skills, and how to do things, particularly the use of objects or movements of the body, such as tying a shoelace, playing a guitar, or riding a bike. These memories are typically acquired through repetition and practice, and are composed of automatic sensorimotor behaviours that are

so deeply embedded that we are no longer aware of them. Once learned, these 'body memories' allow us to carry out ordinary motor actions more or less automatically.

Procedural memory is referred to as implicit memory, because previous experiences aid in the performance of a task without explicit and conscious awareness of these previous experiences, although it is more properly a subset of implicit memory. Figure 21 illustrates the components of human memory.

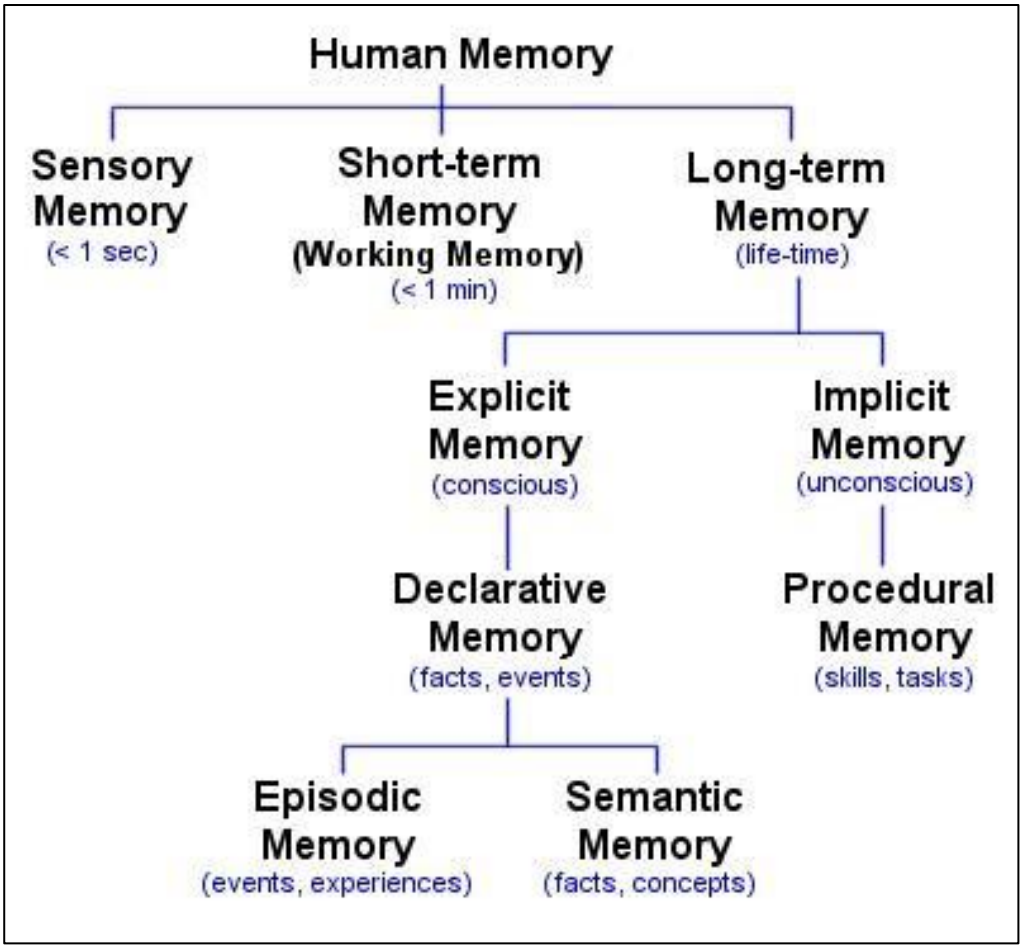

Figure 21: Types of human memory (Adopted from Mastin, 2018)

According to Reisberg (2013), cognitive psychologists, as well as teachers have a shared goal in understanding how to promote long-term learning and memory. Reisberg (2013) further asserts that performance during learning is a poor predictor of future performance because it reflects the momentary accessibility of knowledge (i.e. retrieval strength) rather than how well it has been stored in memory (i.e. storage strength).

Learners simultaneously process information on many different levels. At the most basic level, incoming information is processed by the nervous system in order to organise and understand sensory input. At higher levels, the information is processed with respect to existing knowledge in order to extract meaning. Busch (2017) avers that the ability to retain and recall information is central to improving memory, knowledge and learning. He postulates that the main findings in a study conducted by researchers from various international universities revealed that practice testing and distributed practice were rated as being very effective for improving LTM (Busch, 2017).

Practice testing refers to where learners have to generate an answer to a question. It can include past papers, multiple-choice questions, or doing practice essay answers. This technique has been extensively researched and is consistently found to be one of the most effective ways to improve learning. Distributed practice is sometimes referred to as 'spacing' and involves doing little bits of work often instead of a lot all at once (i.e. 'cramming'). Essentially, learners remember more if they spread out their learning; for instance, one hour a day for eight days rather than eight hours in one day.

Eggen and Kauchak (2014) refer to meaningfulness as the extent to which individual items of information are interconnected in LTM and are organised into a simple schema that makes sense to us. Forming meaningful, interconnected schemas is one of the most important aspects of the entire learning process due to the fact that they represent our understanding of the topics we study. As teachers teach, they should make a conscious effort to help learners identify and understand connections between information they teach in the classroom rather than teaching information in isolated pieces. Isolated information imposes a heavy cognitive load on the WM and by connecting ideas, not only reduces the cognitive load, but also makes the information more meaningful and increases learning by providing more places to attach new information (Eggen & Kauchak, 2014).

In view of the reciprocal relations between cognitive neuroscience and cognitive models, cognitive neuroscientists study how the brain implements cognitive processes, such as learning and understanding neural mechanisms could provide insight into models of cognition (Forstmann, Wagenmakers, Eichele, Brown, & Serences, 2011). The researcher believes that understanding the brain and its functionality, has the potential to alter the foundation of education, transform traditional classrooms to interactive learning environments, and promote better instructional approaches amongst teachers. Effective teaching strategies must consider

learners' stages of cognitive development, the status of their consciousness in learning, and their metacognitive ability awareness.

Visser (2018) agrees that teachers need to teach for engagement and from education literature it becomes evident that learner engagement is a prerequisite of learning, and for learning to be truly meaningful, learners have to be cognitively engaged. Van Amburgh et al. (2007) postulate that the concept of learner engagement and active learning is becoming more than just educational rhetoric. Active learning techniques have emerged as strategies for teachers to promote engagement with both discipline material and learning. Cognition is central to the development of psychology as a scientific discipline (Huitt, 2006). Cognition is a rather general term that refers to all mental processes, such as perception, thinking, memory, motivation, attention, emotions, the ability to understand the intentions and thoughts of other people, decision-making, and self-awareness (Cherry, 2019c). The next section explains cognitive processes.

2.5.2.4 Cognitive processes as the second component of human memory

Mastin (2018) avers that the overall process involved in the different stages of memory formation is referred to as cognitive processes of attention, perception, encoding, storage, and retrieval. Figure 22 depicts the cognitive processes involved in the formation of memory.

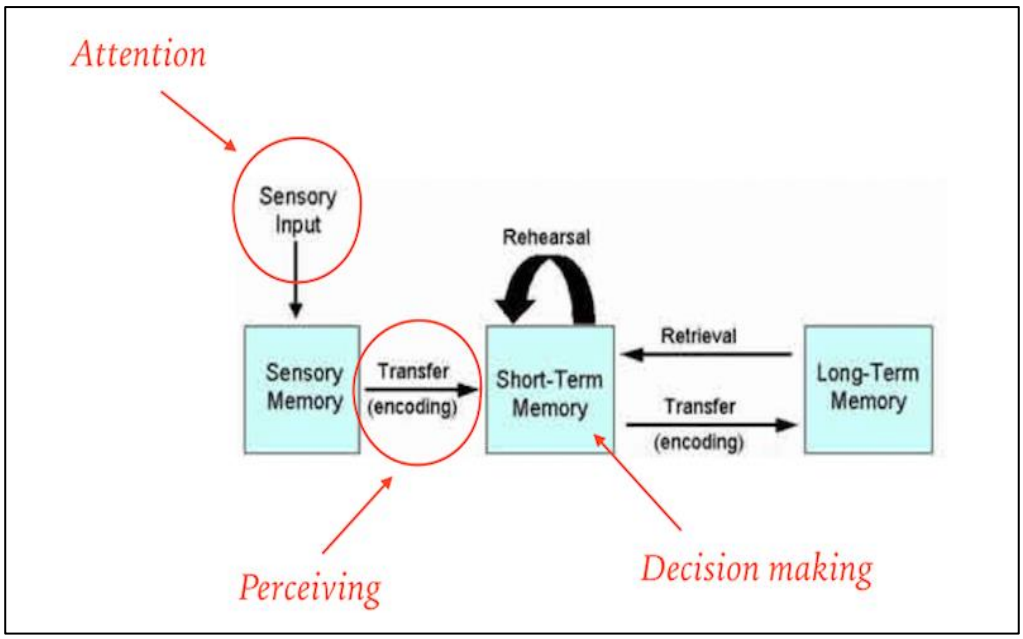

Figure 22: Cognitive processes and information processing (Adopted from DeStefano, 2018)

i. Attention

Learning and development depend on learners' experiences, which are gathered through stimuli from the environment (Eggen & Kauchak, 2014). The process of memory formation starts with attention that is regulated by the thalamus (Mastin, 2018). Nketsia (2013) defines attention as a cognitive process referred to as an awareness in a perceptive manner as well as the ability to choose and concentrate on relevant stimuli adapted from the environment. When regarding the neuroanatomy of attention, Filley (2002) asserts that attention is a complex neurobehavioral domain that is an essential prerequisite for all higher functions. Large areas of the brain are devoted to attention, reflecting its importance in the entire range of mental operations.

Cherry (2018b) further explains that attention is limited, selective and a basic part of the cognitive system. As discussed earlier in this chapter (Section 2.5.2.3), the sensory memory has three functions. Firstly, the iconic (visual) memory, secondly, the echoic (auditory) memory and thirdly, the haptic (tactile/touch) memory, where attention plays a vital role in the formation of these. Cherry (2018b) contends that the most accepted model for the attention sub-components is currently the hierarchical model of Sohlberg and Mateer (1987, 1989), which is based on clinical cases of experimental neuropsychology. According to this model, attention can be divided into the following parts.

i) Arousal: refers to our activation level and level of alertness, whether we are tired or energised.
ii) Focused attention: refers to our ability to focus attention on a stimulus.
iii) Sustained attention: the ability to attend to a stimulus or activity over a long period.
iv) Selective attention: the ability to attend to a specific stimulus or activity in the presence of other distracting stimuli.
v) Alternating attention: the ability to change focus or attention between two or more stimuli.
vi) Divided attention: the ability to attend different stimuli or attention at the same time.

When discussing the neuroanatomy of attentional systems, Peterson and Postner (2012) distinguish between three systems, the RAS, PAS and AAS.

i) *Reticular Activating System* (RAS) or Alert System: this system is mainly in charge of arousal and sustained attention. It is closely related to the reticular formation and some

of its connections, like the frontal areas, limbic systems, the thalamus, and the basal ganglia.

ii) *Posterior Attentional System* (PAS) or Orientation System: this system is in charge of focused attention and selective attention of visual stimuli. The brain areas related to this system are the posterior parietal cortex, the lateral pulvinar nucleus of the thalamus, and the superior colliculus.

iii) *Anterior Attentional System* (AAS) or Execution System: this system is in charge of selective attention, sustained attention, and divided attention. It is closely related to the prefrontal dorsolateral cortex, the orbitofrontal cortex, the anterior cingulate cortex, the supplementary motor area, and the neostriatum (striate nucleus).

Gupta (2017) explains that your RAS, actually located in the brain stem, takes a leading role in determining what is important and what is not when it comes to paying attention to various stimulations. They act like antennae. Your senses take in thousands upon thousands of stimuli in a day and it could not possibly pay attention to all of it, so it filters out what is not important and dumps it, while it sends information that you want to pay attention to, straight on to the WM section of the brain. Because we are so over-stimulated by what comes in through our senses, it is believed that we drop about 99% of what comes into the brain and only 1% is sent on to the WM (Wolfe, 2018). In some very rare visual stimulation situations, the information will go directly to long-term memory (Smith, 2005).

We would go insane if we tried to process all the data our brain receives. So, a properly working RAS is essential for learning. Information only remains in the sensory memory area for about one or two seconds before it is sent to the working memory, or discarded (Armstrong, 2008). Therefore, it is important for teachers to make sure the information learners need to know is part of the 1% sent to the WM. Eggen and Kauchak (2014) explain that attention has two important characteristics that have implications on teaching. Firstly, attention is limited in both capacity and duration. Secondly, attention is easily distracted. Attention is considered as a departure point of learning, and therefore attracting and maintaining learners' attention is essential for effective information processing (Curtindale, Laurie-Rose, Bennet-Murphy, & Hull, 2007). Rather than engaging learners through passive listening during a presentation, active involvement in learning activities is therefore essential. Some researchers claim that attention precedes perception, and that attention is necessary for perception. This entails that without attention, a human has no conscious awareness of sensory information (Bridewell & Bello, 2016).

ii. ***Perception***

The perceived sensations from environmental stimuli are decoded in the various sensory areas of the cortex, where the hippocampus is responsible for the combination of these into one single experience and the transferral into the LTM (Mastin, 2018). The hippocampus is the regulator where these experiences are compared and associated with prior knowledge or experiences and memory consolidation takes place. McLeod (2008) avers that psychologists differentiate between two types of processes in perception, which refer to bottom-up processing and top-down processing. Bottom-up processing is also known as data-driven processing, because perception begins with the stimulus itself. Processing is carried out in one direction from the retina to the visual cortex, with each successive stage in the visual pathway carrying out ever more complex analysis of the input (Gregory, 1970). Figure 23 depicts the bottom-up perception of processing.

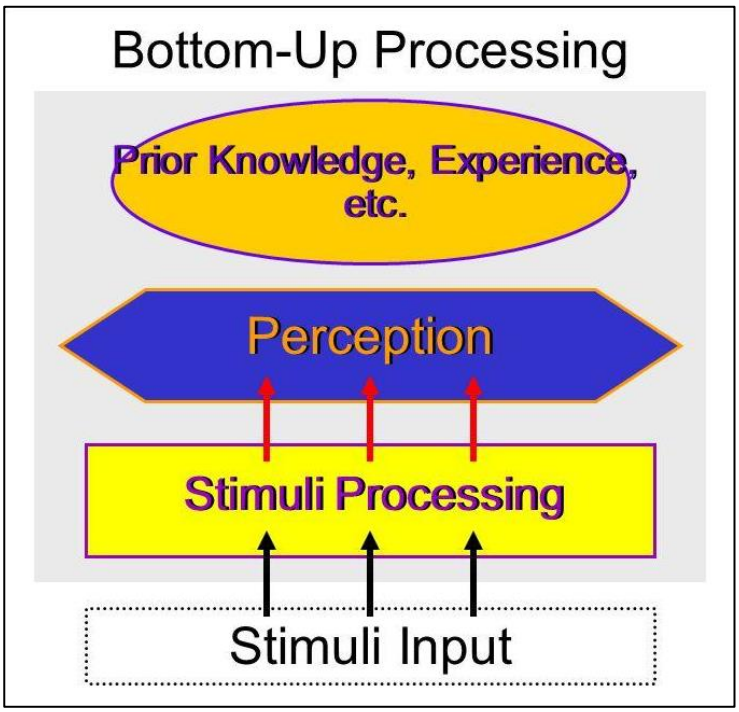

Figure 23: Bottom-up processing (Adopted from Zimmerman, 2014)

Top-down processing refers to the use of contextual information in pattern recognition (see Figure 24). For example, understanding difficult handwriting is easier when reading complete sentences than when reading single and isolated words. This is because the meaning of the surrounding words provides a context to aid understanding (Gibson, 1966).

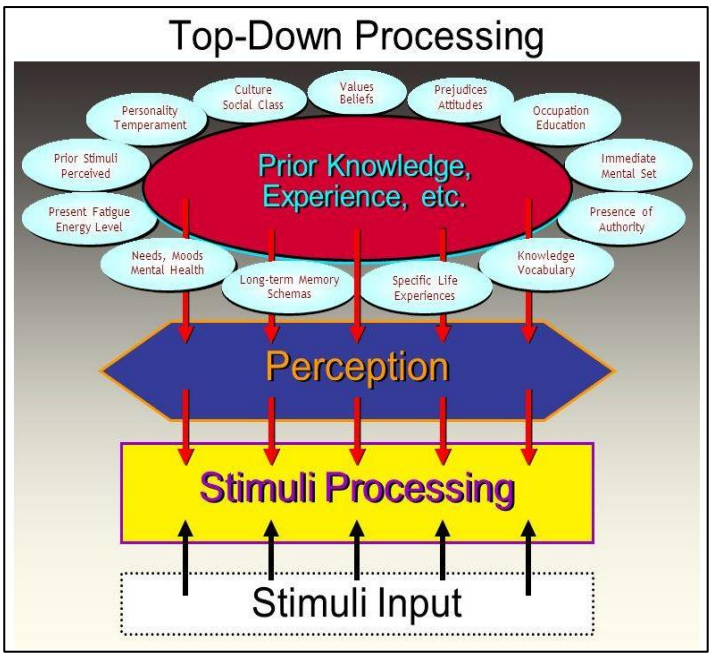

Figure 24: Top-down processing (Adopted from Zimmerman, 2014)

Accurate perception in learning activities are essential due to the fact that learners' perception of what they see and hear enter the working memory which implies that if these perceptions are inaccurate, the information ultimately stored in the long-term memory will also be inaccurate (Eggen & Kauchak, 2014). In order to ensure that learners accurately perceive the information, which is presented to them during a lesson presentation, teachers should establish prior knowledge and actively engage learners in the learning process.

iii. ***Encoding***

After learners attend to and perceive information, having information organised in the working memory as to make sense of it, the next step involves the encoding of information (Eggen & Kauchak, 2014). Encoding refers to the representation of information in the long-term memory. Encoding is a biological event and it begins with perception through the senses. According to Mastin (2018), there are four types of encoding.

i) Acoustic encoding is the processing and encoding of sound, words, and other auditory input for storage and later retrieval. This is aided by the concept of the phonological loop, which allows input within our echoic memory to be sub-vocally rehearsed in order to facilitate remembering. It is believed that encoding for WM relies on acoustic encoding.
ii) Visual encoding is the process of encoding images and visual sensory information. Visual sensory information is temporarily stored within the iconic memory before being encoded

into long-term storage. The amygdala (within the medial temporal lobe of the brain, which has a primary role in the processing of emotional reactions) fulfils an important role in visual encoding, as it accepts visual input in addition to input from other systems and encodes the positive or negative values of conditioned stimuli.

iii) Tactile encoding is the encoding of how something feels, normally through the sense of touch. Physiologically, neurons in the primary somatosensory cortex of the brain react to vibrotactile stimuli caused by the feel of an object.

iv) Semantic encoding is the process of encoding sensory input that has particular meaning or can be applied to a particular context, rather than deriving it from a particular sense. Encoding for long-term memory is more reliant on sematic encoding.

Hurley (2012) says that researchers and psychologists have attempted to search for the engram, the physical trace of memory. Mastin (2018) explains that three brain areas play significant roles in the processing and storage of different types of memories: cerebellum, hippocampus, and amygdala. The cerebellum's job is to process procedural memories; the hippocampus is where new memories are encoded; and the amygdala helps determine what memories to store, and also plays a part in determining where the memories are stored based on whether we have a strong or weak emotional response to the event. Strong emotional experiences can trigger the release of neurotransmitters, as well as hormones, which strengthen memory, so that memory of an emotional event is usually stronger than memories of a non-emotional event (Spielman, Dumper, Jenkins, Lacombe, Lovett, & Perlmutter, 2016).

Meaningful encoding connects new information to information already stored in the long-term memory and to enhance encoding successfully, teachers should carefully organise the information presented to learners together with cognitive activity with interactive teaching strategies (Eggen & Kauchak, 2014). Cherry (2018b) provides eleven research-proven strategies that can effectively improve memory, enhance recall, and increase retention of information which include:

- Focused attention
- Avoid cramming of information
- Structure and organise information
- Utilise mnemonic devices
- Elaborate and rehearse information
- Visualise concepts

- Relate new information to things already known
- Read out loud
- Pay extra attention to difficult concepts
- Vary study routine
- Get enough sleep

Similarly, Schellenberg, Negishi, and Eggen (2011), and Eggen and Kauchak (2014) explain that encoding strategies refer to learners' conscious attempts to encode information into long-term memory in ways that are meaningful to the individual. Four encoding strategies include:

a) Organisation: an encoding strategy that involves the clustering of related items of content into categories that illustrate relationships (Mayer, 2008).
b) Schema activation: a strategy that involves activating relevant prior knowledge so that new information can be connected to it (Mayer & Wittrock, 2006).
c) Elaboration: the process of increasing the number of connections among items of existing knowledge (Terry, 2006).
d) Imagery: the process of forming mental pictures (Schwartz & Heiser, 2006). Learners who consciously use encoding strategies are mentally (cognitively) active as they make decisions about how to make the information they are studying as meaningful as possible.

In contrast, simply reading a textbook, or memorizing information can be a passive process.

iv. ***Rehearsal***

Snowman and McCown (2015) contend that a severe limitation of WM means that information is quickly forgotten in the absence of further processing. Learners can only assign meaning to new learning if adequate time is allowed for processing and re-processing of new information, a process that is referred to as rehearsal (Sousa, 2011). There is almost no long-term retention of cognitive concepts without rehearsal as it is a critical component in the transference of information from WM to LTM.

Cognitive psychologists have found it useful and necessary to distinguish between two types of rehearsal: maintenance rehearsal and elaborative rehearsal (Snowman & McCown, 2015). Maintenance rehearsal is mostly effective at placing information in your short-term memory (such as a phone number) while elaborative rehearsal may be more effective at encoding it into your LTM (Heerema, 2018). Sousa (2011) elucidates that maintenance rehearsal or rote rehearsal

is the process that is used when the learner needs to remember information exactly as it is entered into WM. This is not a complex strategy, yet necessary to learn information or a cognitive skill in a specific form or sequence, e.g. remembering a poem, the melody of a song, multiplication tables and telephone numbers – all steps and procedures. Elaborative rehearsal is a method to encode information into your LTM by requiring the brain to process it in a more in-depth way. Elaborative rehearsal consists of making an association between the new information you are trying to learn and the information you already know (Heerema, 2018). Elaborative rehearsal can involve organising the information, thinking of examples, creating an image in your head of the information and developing a way to remember the information through a mnemonic device. Several mnemonic devices can facilitate elaborative rehearsal, such as using the first letter of a list of words to make a new word.

Wolfe (2018) suggested elaborative rehearsal strategies that will transfer learning into LTM and are explained below.

i. Reciprocal teaching: One of the goals of teaching is to help learners understand and retain what they have learned in class. Retention rate here refers to the amount of information retained from a lesson. The lower the rate, the less the person remembers about the lesson. Thus, the higher the rate, the greater chance the learner has of retaining or recalling the information. One way to increase retention rates is by activating more regions of the brain. One of the easiest ways to do this is to teach the lesson to someone else, thereby elaborating on what they had just learned. The more regions or lobes of the brain are actively involved in the learning process, the higher the retention rate and the greater chance one has in remembering and recalling the information taught (Whitaker, 2009). For example, the temporal lobe, the region of the brain dedicated to hearing, is activated when a person is listening to music.

   The occipital lobe, the region that processes visual stimulation, is activated when a person is looking at something, like a child looking at a picture book. When a person is speaking, the parietal lobe of the brain is stimulated which is the region of the brain dedicated to language, such as reading aloud in class. And when the person has to stop, think, and generate their thoughts, the frontal lobe comes into play. This region is concerned with higher order thinking such as judgment, creativity, planning, etc. This is the area activated when one is asked to answer a question in class (Carter, 1998). When a teacher is standing

up in front of the class teaching a lesson, he is looking at the class as well as writing notes on the board (occipital lobes). He is also listening to the learners as they answer his questions, and notes any learners whispering or not paying attention, etc. (temporal lobes). Because he must talk as he explains the lesson, the neurons in the parietal lobes are constantly firing getting the words out of his mouth. And when he has to stop and generate a question off the top of his head, has to create a diagram that visually explains a concept, or simply just construct a new thought he wishes to express, his frontal lobes are called into play. When he teaches a lesson, all regions of the brain become activated. So, if you really want to learn something, you have to teach it (Whitaker, 2018).

ii. Priming the mind: Priming is a nonconscious form of human memory concerned with perceptual identification of words and objects. It refers to activating particular representations or associations in memory just before carrying out an action or task (Psychology Today, 2018).

iii. Storytelling: One of the oldest forms of instruction is storytelling. Long before there were written words, people told stories to pass on their heritage through spoken language (Widrich, 2012). People have communicated with each other through stories, and stories are considered a powerful means for increasing retention and transfer as a teaching strategy. In an article by Rush (2014), Jennifer Aaker, a professor at Stanford University states that:

> Research shows our brains are not hard-wired to understand logic or retain facts for very long. Our brains are wired to understand and retain stories. A story is a journey that moves the listener, and when the listener goes on that journey they feel different and the result is persuasion and sometimes action.

iv. Hands-on-activities: A study from Stanford University indicates that students learn best by doing hands-on projects before watching online videos or reading texts. Blikstein, an assistant professor of education, states “We are showing that exploration, inquiry and problem solving are not just ‘nice to have’ things in the classroom. They are powerful learning mechanisms that increase performance by every measure we have” (Plotnikoff, 2013). Roy Pea, a Stanford professor of Education, states that teachers should first have students engage their prior knowledge and intuitions to investigate problems in a certain

learning domain, where after abstracted knowledge should be introduced. Pea feels this method creates a knowledge-building relevance to watching a video or reading a text (Plotnikoff, 2013).

v. Mnemonics: In ancient times, the Greeks used mnemonics to help them remember information. If a learner is trying to memorise the four major lobes of the brain for example, the learner takes the first initial of each word and then makes up some crazy sentence using those letters. The lobes are frontal, parietal, temporal, and occipital. The learners take the first letters, f, p, t, and o, and then make up a sentence such as, 'funny people toss oranges'. Since it is easier to remember this silly sentence, the learner can recall the sentence, taking the first initial of each word that will act as a trigger to help them remember the lobes of the brain.

The main purpose of any lesson is to get information into the LTM so it makes sense, is meaningful, and can be recalled when needed. When a learner can transfer their knowledge and apply it to new concepts and situations, this is when teachers realise that they have reached their teaching goal. Using elaborate rehearsal strategies will help transfer what the learners are learning into their long-term memory (Whitaker, 2018).

v. ***Retrieval***

Wolfe (2018) explains that learning is the act of making (and strengthening) connections between thousands of neurons forming neural networks or maps, while memory is the ability to reconstruct or reactivate the previously made connections. So, when we learn something new, we are actually creating new connections between our neurons. And when we want to remember something, we call on those neurons to become activated so we can recall what we have learned before. Without retrieval, a stored memory would have no useful purpose. Sousa (2011) postulates that the brain uses two methods to retrieve information from the LTM, referred to as recognition and recall. Recognition matches an outside stimulus with stored information, e.g. multiple-choice questions. Recall on the other hand describes the process whereby cues of hints are sent to the LTM, which must search and retrieve information from the long-term memory, then consolidate and decode it back again to WM.

Cherry (2018b) further explains that the process of retrieval involves accessing stored memories by means of a retrieval clue. She further elaborates that there are four basic ways to retrieve information from LTM and they include recall, recollection, recognition and relearning.

i) Recall: This type of memory retrieval involves being able to access the information without being cued. Answering a question on a fill-in-the-blank test is a good example of recall.
ii) Recollection: This type of memory retrieval involves reconstructing memory, often utilising logical structures, partial memories, narratives, or clues. For example, writing an answer on an essay exam often involves remembering bits of information and then restructuring the remaining information based on these partial memories.
iii) Recognition: This type of memory retrieval involves identifying information after experiencing it again. For example, taking a multiple-choice quiz requires that you recognise the correct answer out of a group of available answers.
iv) Relearning: This type of memory retrieval involves relearning information that has been previously learned. This often makes it easier to remember and retrieve information in the future and can improve the strength of memories.

Stanfield (2018) highlights that in order to strengthen memories, they must be accessed repeatedly. Memory is constructive, therefore each time you access and bring out a memory, the easier it becomes to access it in the future as more neural pathways are created and the memory becomes stronger. As teachers, we can encourage our learners to access memories by guiding them to actively recall or retrieve information. This can be done in various ways, including assessment discussion and feedback.

2.5.2.5 Metacognitive processes as the third component of human memory

The human information-processing model is regarded as logical, sequential, and largely governed by metacognition (Eggen & Kauchak, 2014). Metacognition refers to a person's awareness of and control over the way information is processed (Meltzer, Pollica, & Barzillai, 2007), and encoding is the process of representing information in long-term memory (Anderson, 2007). Eggen and Kauchak (2014) distinguish between metacognition (awareness of and control over cognitive processes), meta-attention (knowledge of and control over ability to pay attention), and metamemory (knowledge of and control over memory strategies).

Research indicates that metacognition has an important influence on the way learners learn, in general, and encode information, in particular (Pressley & Hilden, 2006). Learners who make conscious attempts to encode information consistently achieve higher than those who are less metacognitively aware meaningfully (Kuhn & Dean, 2004). Bada (2015) suggests that new, innovative, and creative ways are needed to engage learners in active and meaningful learning experiences to foster and promote the development of critical thinking skills. Wilson and Conyers (2016) assert that teaching learners to become more metacognitive, equips them with skills to drive their own brains and become self-directed learners. Reinforcing knowledge and skill development through repetition and practice strengthens neuronal connections formed in response to the thoughts, actions, and sensory input that occur during learning, and is referred to as synaptogenesis.

Haukas, Bjorke, and Dypedahl (2018) confirm that many studies recently indicated the benefits and effectiveness of metacognition in education, which implies the psychological study of the essence of the mind, form a scientific point of view. According to neuroscience, metacognitive functions are located in the most modern part of the brain: the cerebral cortex. Kuhn (2000) argues that metacognition has two important educational goals that include knowing how to use strategies to process information effectively, enhance awareness, and an understanding of own cognition. Blake (2016) asserts that learners receiving instruction on metacognition develop skills that will make them more successful in their academic and professional careers.

The better able a learner is to understand how he or she learns, remembers, and processes information, the more information he or she will ultimately retain. This ability is further linked to developing better memory skills, which is a predictor of future academic success. Arends, Winnaar, and Mosimege (2017) postulate that teachers play a very important role in the provision of quality education through the creation of interactive learning environments towards the enhancement of understanding concepts and improved learner performance. The following section discusses teaching-learning interactive environments (TLIE).

2.5.3 Teaching Learning Interactive Environments (TLIE)

2.5.3.1 Introduction

Traditional teaching and learning approaches centred on the teacher are mainly concerned with what is taught rather than the learner that is taught. The focus is teaching and not learning

(Warnich & Meyer, 2013). Today's classrooms look vastly different than they did a generation ago. Madrid (2000) has highlighted that indicative of proven research, learners regularly do not learn what teachers teach and this phenomenon has contributed to focus our attention from the teacher to the learner. In education today, a learner-centred approach is called for in which learners become more responsible for their own learning. The classroom becomes a Teaching-Learning Interactive Environment (TLIE). This means that learners have to be conscious about their individual learning process and the strategies they employ in the learning act (Madrid, 2000). Faasen (2016) explains that effective educational practice is benchmarked by the level of academic challenge, active and collaborative learning, teacher-learner interaction, and enriching educational experiences of which the importance of active learning is stressed. When teachers employ an interactive teaching and learning approach, they serve as facilitators and mediators of the learning process in which they allow learners to connect with the learning material in fascinating ways. Livingston, Schweisfurth, Brace and Nash (2017) maintain that teachers need to adapt their approach by the transformation of teaching methodology to influence teaching pedagogy.

The role of teacher is changing from keeper of knowledge to facilitator of learning which presents a challenge and an opportunity for educators to change the way their learners learn dramatically (Goh, 2014). Warnich and Meyer (2013) clarify that interactive teaching is all about instructing learners in such a manner that they become actively in their own learning process. Similarly, Wood (2015) explains that interactive classrooms are not limited to technology-based teaching spaces and that interactivity is a two-way flow of information that can benefit both teachers and learners. When teachers interchange information with learners and ask for participation, the result is deeper, mindful learning. Figure 25 illustrates an interactive learning environment (i.e. learner-centred), showing the learners divided into groups, others studying on their own, and the teacher moving from group to group to facilitate the learning process by asking and answering questions, clarifying concepts, motivating learners, and encouraging cooperative learning through a socio-constructivist teaching approach.

Figure 25: Teaching-learning Interactive Environment (TLIE) (Adopted from Humber, n.d.)

Bringing teacher practices and learning in line with brain functioning, Woolfolk (2007) confirms that the brain and learning are intimately related and implications for teachers include the following:

- *Many cognitive functions are differentiated – they are associated with different parts of the brain.* Thus, learners are likely to have preferred modes of processing (visual or verbal, for example) as well as different capabilities in these different modes. Using different modalities for instruction and activities that draw on different senses may support learning.
- *The brain is relatively plastic.* Thus, enriched active environments and flexible instructional strategies are likely to support cognitive development in learners.

In a study done by Arends et al. (2017), insights were gained into the association between learner performance and teacher classroom practices. The results revealed that teachers who are collaborative and confident in what they know and are able to engage learners, adapt lessons to ensure that all learners remain interested, who are able to answer all content-related questions that learners may have and give effective feedback led to increased learner performances. Interactive teaching techniques have been found to be significantly more beneficial to the learning process of the human mind (Interactive Tutors Limited, 2011). The benefits of TLIE gained from the literature, can be summarised as follows. TLIE:

- enables the capturing and maintaining of learners' interest and subsequent attention to anticipate conscious awareness in the learning process;
- creates active participants in the teaching-learning process fostering learner engagement;
- fosters social collaboration amongst teachers and learners;
- promotes self-directed learning;
- facilitates authentic learning;
- reduces behavioural problems in the classroom, thus promoting effective classroom management;
- improves class attendance;
- facilitates cognitive and metacognitive engagement;
- enhances information processing ability of learners;
- facilitates a learning environment that foster long-term memory retention; and
- ultimately leads to increased learner performances.

As Bates (2015) points out, there is still a transitional gap from theory to practice in creating TLIE, resulting in teachers' experiencing various challenges in the classroom application. Amongst these challenges, it was evident that classroom facilities and appropriate teaching materials are lacking, learners have poor background knowledge, and there is a lack of understanding about implementing active learning. As deduced from the aforementioned, principles of active learning remain a challenge for teachers and this study attempted to outline these challenges and provided thoughtful insights for the creation of TLIE in South African schools as part of chapter five of the study. Discussions evolved around, and included aspects pertaining to various aspects inclusive of attention, conscious awareness, prior knowledge, information-processing ability, cognitive dissonance, cognitive and metacognitive engagement, feedback, and reflection.

2.5.3.2 Enhanced memory as an effect of active learning

Markant, Ruggeri, Gureckis, and Xu (2016) suggest that active learning leads to better outcomes than passive forms of instruction because of the following aspects: the formation of distinctive sensorimotor associations, the elaborative encoding due to goal-directed exploration, improved co-ordination of selective attention, and encoding, adaptive selection of material based on existing memory, and metacognitive monitoring.

Active learning does not involve just doing activities, there must be opportunity for learners to reflect, evaluate, analyse, synthesise, and communicate on or about information (Fink, 2003). Research suggests that active learning leads to a variety of positive outcomes including better learners' attitudes (Bleske-Rechek, 2002), greater motivation (Watson, Kessler, Kalla, Kam, & Ueki, 1996), improvements in learners' thinking and writing (Bonwell & Eison, 1991), memory for information taught (Cherney, 2008), and improved exam performance (Yoder & Hochevar, 2005)

2.5.3.3 Juxtaposed learning theories

Educationalists have long recognised that the transfer of learning is the most significant issue in teaching and learning (Adams, Hartnett, & Clough, 2015). Table 1 encapsulates the impactful capability by teachers to maximise learning. The researcher opines that teachers' capacity to apply such a consolidated knowledge-based perspective simultaneously when teaching, would facilitate for the ease with which the quality of information processing by learners is enhanced. Table 1 juxtaposes the three categories of cognitive learning theories, i.e. putting them side by side to compare and contrast for purposes of identifying the impact of each theory, with each category specifying the theorists who have contributed to the category. The categories are placed side by side to accentuate the parallels, and the similarities and differences within and between them. The comparisons and contrasts are based on characteristics, such as definitions of category of the learning theory, theorists, basic assumptions, key processes, etc.

Table 1: Juxtaposed learning theories

Characteristics	 **Behaviourism**	 **Cognitivism**	 **Constructivism**
Definition	Learning is a process of reacting to external stimuli	Learning is a process of acquiring and storing information	Learning is a process of constructing knowledge through personal understanding from meaningful and shared experiences
Theorists	Skinner, Bronfenbrenner, Freud, and Erikson	Piaget, Flavell, Atkinson and Shiffrin	Vygotsky, Bandura
Basic assumptions	Emphasis on producing observable and measurable outcomes, use cues to prompt response association	Feedback guides and supports accurate mental corrections	Modelling, learners construct their own understanding and validate it via social interaction
Key processes	Response stimuli, positive and negative reinforcement	Equilibration, adaptation	Scaffolding, ZDP

Learning context & process	Classical and operant conditioning	Emphasis on thought process/mental process. Critical role of the environment. Perception, behaviours are rooted in experiences and a thought process	Sociocultural environment
Influencing factors	Nature of reward, punishment, stimuli	Existing schema, previous experiences	Engagement, participation, social, cultural, most knowledgeable others (MKOs)
How learning occurs	Learning is sequential, content-orientated, solely focussed on observed behaviours	Learning is structured. Information processing from SM to WM to LTM. Process of adaptation: accommodation and assimilation	Learning is scaffolded through the zone of proximal development
Role of memory	Memory is hardwiring of repeated experiences, where reward and punishment are most influential	Cognitive processes: encoding, storage, retrieval Metacognitive processes: attention, perception, rehearsal	Prior knowledge linked to current context
Knowledge	external	internal	internal
Role of the learner	Instinct-driven individual	Conscious individual	Conscious individual
Role of the teacher	Focus on the environment and behaviour of learners	Focus on the cognitive processes of learners	Focus on the cognitive processes of learners with special reference to prior knowledge

Types of learning	Task-based, instructional cues, practice, reinforcement	Reasoning, clear objectives, problem-solving, active involvement (cognition and metacognition), connections to prior knowledge	Social negotiation, discussion, debate, collaborative learning, situated learning and problem-solving
Stages of development		Four stages: sensorimotor, pre-operational, concrete operational, formal operational	
Teaching implications	Good behaviours are modelled through positive reinforcement – offer rewards for good behaviours; bad behaviours are eliminated through negative reinforcement – punishment for bad behaviours	Active role of teachers to adapt teaching strategies to cognitive developmental stage of learners, acknowledge effort and achievement	Evaluate learners' prior knowledge, MKOs, scaffolder learning experiences through ZDP

2.5.4 Learner performances

2.5.4.1 Information processing ability of learners

Kim and Lee (2014) espouse the idea that it is more useful for learners to select knowledge and information by thought than to simply memorise what is provided to them. Learners should possess more than simply a quantity of knowledge (i.e. how much they know) but instead, possess information-processing abilities (i.e. new knowledge can be constructed using existing information – this is ultimately what teachers should be developing in interactive teaching and learning environments).

One method in enhancing the information-processing ability of learners is through the application of problem-based learning (PBL) as a teaching strategy. According to Beitzel (2012), principles of effective learning, i.e. improving information-processing ability of learners include the activation of prior knowledge (a constructivist approach to learning), organising of the learning content (behaviourist approach to learning), deep processing of information (metacognitive strategy) and distributed practice in terms of learning (no cramming of information).

According to the Academic Success Center (2011), metacognition can enhance the information processing ability of learners due to the fact that learners should be able to monitor their own learning process. The following strategies seem to be directed towards learners for the advancement of their information processing abilities.

- Learners should pay attention to only a few things at a time.
- Practice ignoring things to which they want to pay attention, as well as attending to those things to which they do not want to pay attention. Sometimes not paying attention to irrelevant events and information is more important than paying attention to relevant information.
- Try to combine information into a smaller number of items if learners find it necessary to deal with several new pieces of information at one time. Learners can often do this by ‘chunking’ - that is, by grouping similar pieces of information together while they study them.

- Use notes, pictures, or diagrams to help them keep the information actively available in the mind if they find it necessary to deal with several new pieces of information at one time.
- Become as active as they can be in the learning process. By becoming more active, they will automatically find more ways to connect the new information with what they already know. The following are some good ways to become active while learning.
    - Underline selectively while studying.
    - Draw diagrams while studying.
    - Outline important ideas studying.
    - The learner can ask themselves questions before they read part of a textbook, and then see if they can answer them after reading that part of the book.
    - Look for ways to apply what they are studying in one class to issues in another class or to problems outside the school setting.
- Study with a friend. Explain ideas to friends and listen to friends' ideas. Tell one another what they think is right or wrong about the summaries or applications. If a learner study with a friend, he/she may let the friend do all the thinking. When applying these strategies, remember that it is crucial that you become an active thinker.
- Learners should ensure that they understand the information clearly and correctly before they practice it. (Otherwise, they may have to unlearn the wrong information before you can learn the correct information.)
- Once learners think they have learned something, practice it even a little longer than they deem necessary to master it.
- Learners should attempt in finding out what skills are basic - that is, what skills will be important to help them understand later information. Learners should practice these until these skills become "second nature" to them.
- Learners should not study simultaneously things that they are likely to confuse with one another.
- When learners learn something new that resembles something they already know, learners should focus their attention briefly on both the aspects that are similar and the aspects that are different.

2.5.4.2 Conscious awareness in the classroom

In cognition, cognitive functions are those mental processes that lead to the acquisition of knowledge through the information-processing model. Jefferson (2018) explains that in cognitive functions, cognitive control is a construct from contemporary cognitive neuroscience that refers to processes that allow information processing and behaviour to vary adaptively from moment to moment, depending on current goals, rather than remaining rigid and inflexible. Cognitive control processes include a broad class of mental operations including goal or context representation and maintenance, and strategic processes such as attention allocation and stimulus-response mapping.

Cognitive control is closely linked to consciousness (Kunde, Reuss, & Kiesel, 2012). Consciousness usually requires some form of selective attention and a short-term storage of information. This statement/section echoes the statement by Madrid (2000) in Section 1.4.3.1 in explaining that with reference to the cognitive theory, the learner should initially be conscious aware of the learning process by paying attention until the learner has reached the stage where the skill has been acquired, especially in gaining procedural knowledge. When associating consciousness and WM, Stein, Kaiser and Hesselmann (2016) point out that WM is intricately interwoven with conscious awareness. It is difficult to imagine a situation in which we are not consciously aware of the stimuli that enter WM from the SM and that connection between consciousness and WM is consistent with the long history within consciousness studies of assuming that many or even all high-level mental activities require consciousness (Persuh, LaRock, & Berger, 2018).

To enhance the understanding of how human learning occurs and what leads to the challenges of conscious learning, the subconscious learning processes also need to be brought to light (Kuldas et al., 2013). Kowalski and Westen (2005) explain that the subconscious processes range from registering information in the sensory memory to mentally forming associations within or between information patterns and activating associative memory networks, including individual expectations, beliefs, and desires.

Kuldas et al. (2013) state a conscious learning process starts by deliberately paying attention to instructional materials, noticing similarities and differences between words and their particular meanings with the help of relevant prior experience, thereby mentally building coherent connections between them and organising them into new knowledge structures. Thus, either

conscious or subconscious learning is primarily a combination of mental processes, referred to as a knowledge acquisition process, bringing memories into the mind, forming associations, retaining, and using them (Mayer & Moreno, 2003). Kuldas et al. (2013) uphold that the subconscious can conduce to the acquisition, access, and application of knowledge without deliberate and controlled attention. A permanent change in mental associations in long-term memory or a potential change in human behaviour is considered to be learning (Ormrod, 2008).

Furthermore, in many cognitive studies, consciousness is either taken for granted or labelled with its own set of synonyms, such as explicit cognition, focal attention, and awareness. Rosenthal (2012) states that, as defined by Sigmund Freud, the conscious is the conception that is present to our consciousness. We are aware of our consciousness. It therefore means that the subconscious is the conception of which we are not aware but are able to obtain and convey consciously. Moreover, since the 1970s, even cognitive scientists have acknowledged the existence of unconscious perception and subliminal information processing, e.g. as with selective attention (I see only what I like), inattention (I do not see what I do not like), and automatism (I do not notice what I do). An abundance of research has suggested that cognitive schemas can guide awareness while remaining out of awareness (Carson, Paolini, Ziglear, & Fox, 2009).

Neuroscience is beginning to provide evidence for many principles of learning that have emerged from laboratory research, and it is showing how learning changes the physical structure of the brain and, with it, the functional organisation of the brain (Bransford, Brown, & Cocking, 2000). In general, the psychoanalysts argue that, in order to be existentially authentic, teaching, and learning must involve the teacher and learner in all their psychodynamic complexity as emotional and ethical beings (Mayes, 2010). What happens consciously in the classroom is the secondary, cognitive tip of the iceberg (Figure 5). What is happening subconsciously in the learner both in and outside of the classroom is the total iceberg (Mayes, 2012), that may exert an impact of contrasting demands on the conscious level.

2.5.4.3 Cognitive engagement in the classroom

As mentioned in Section 2.5.2.3, Van Amburgh et al. (2007) postulate that the concept of learner engagement and active learning is becoming more than just educational rhetoric. Active learning techniques have emerged as strategies for teachers to promote engagement with both discipline material and learning. The next section focuses on metacognition, a strategy that refers to our knowledge about attention, recognition, encoding, storage and retrieval and how these operations

might be used to achieve a learning goal. Metacognitive knowledge develops with age, experience, and instruction and has a profound influence on classroom practices (Schneider, 2008).

Effective teaching strategies must consider learners' stages of cognitive development, the status of their consciousness in learning, and their metacognitive ability awareness. Solis (2008) agrees that teachers need to teach for engagement and from education literature it becomes evident that learner engagement is a prerequisite of learning, and for learning to be truly meaningful, learners have to be cognitively engaged. Van Amburgh et al. (2007) postulates that the concept of learner engagement and active learning is becoming more than just educational rhetoric.

Active learning techniques have emerged as strategies for teachers to promote engagement with both discipline material and learning. Solis (2008) suggests what teachers should do to foster engagement.

- Express high expectations and create personal human relationships between teachers and learners.
- Link to prior knowledge and experience and review frequently.
- Do continual assessment and feedback.
- Seek evidence of participation and flow and ensure all students are always doing something.
- Articulate rules for participation and use a variety of interaction modes.
- Structure tasks in rigorous, active, and accountable ways.

2.5.4.4 Metacognitive engagement in the classroom

Human learning is ultimately made possible through the information processing theory as discussed in an earlier section (2.5.4.1). Because of the information processed, higher order thinking occurs which involves metacognition. As Schneider (2008) explains in section 2.3.6, teachers need to understand the information-processing model to teach effectively for metacognitive awareness amongst learners.

Research suggests that teachers have a significant role to play in raising learners' metacognitive awareness (Price-Mitchell, 2015). Cubukcu (2009) elaborates that researchers argue that the capacity to self-regulate is central to our assumptions about learning, decision-making, problem solving, and resource management in education, and that they are researching assessment

instruments and intervention programmes to promote self-regulation and make learners use their metacognitive strategies.

2.5.4.5 Educational implications

The fields of neuroscience, psychology and education are being brought together to explore effective teaching and learning practices in the light of current knowledge about basic learning processes and factors that influence successful learning. This field of research, often referred to as the 'science of learning,' is developing rapidly, and has the potential to enhance our understanding of learning processes significantly, and their implications for teaching (Australian Council for Educational Research, 2013).

By bringing cognitive development in line with education, Laxman and Chin (2010) claim that the brain, being the organ of learning, must be understood if classrooms are to be places of meaningful learning. A quite similar view is expressed by Cozolino (2013) who is of the opinion that admitting that a one-size-fits-all model of education is doomed to fail the majority of learners and teachers. He also adds through understanding how learners' brains actually work and using that knowledge to benefit classroom learning, may enable us to positively influence classroom education and prepare learners to better face unknowable futures (Cozolino, 2013).

2.6 CONCLUSION

Chapter 2 presented literature on the theoretical underpinnings included as part of this study. Positive psychology, cognitive psychology and cognitive development, cognitive neuroscience and neuroplasticity and educational neuroscience were discussed. This theoretical framework provided the foundation in which learning theories were subsequently explained and described and from where learner performance variables culminate the cognitive growth and development of learner information-processing ability in the classroom.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

According to Archer, Sharp, Stones and Woodiwiss (1999), all realism rests on the same ontological assumption, namely, that reality exists independently of our thoughts about it. The consequence of this is that research is therefore a mandatory requirement for all realists. In pursuance of the latter exhortation, this chapter describes the research methodology used to investigate the information-processing ability of learners as influenced by the juxtaposed learning theories for cognitive growth and development.

3.2 RESEARCH PARADIGM

This study is ensconced within the post-positivist research paradigm. According to Kuhn (1977), the term paradigm refers to a "research culture with a set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research. A paradigm is a worldview or a set of assumptions about how things work." A research paradigm is intrinsically associated with concepts of ontology (the manner in which truth and reality is defined), epistemology (the process of ontology), and methodology (the method used in conducting the investigation) as outlined by Guba and Lincoln (1988).

Creswell (2013) points out that the post-positivist approach represents thinking after positivism. Positivism challenges the traditional notion of the absolute truth of knowledge. Post-positivism recognises that we cannot be positive about the claims of knowledge when studying the behaviour and actions of human beings. Furthermore, post-positivism holds a deterministic philosophy in which causes determine effects or outcomes, and is reductionistic in that the intent is to reduce the ideas into small, discrete sets for testing, such as the variables that comprise hypotheses and research questions.

The knowledge that develops through a post-positivist perspective based on careful observation and measurement of the objective reality that exists "out there" in the world is evident. Thus, developing numeric measures of observations and studying the behaviour of individuals becomes paramount for a post-positivist.

3.3 RESEARCH DESIGN

According to Leedy (1993), the nature of the data and the research problem dictate the research methodology. For educational research, therefore, the specification of the problem and limiting of the data of any phenomenon – substantial or insubstantial – imposes that such research follows any of the following three standards, namely: qualitative, quantitative or triangulated design.

Leedy and Ormrod (2010) purport that a quantitative research design mainly studies the understanding of the underlying perceptions, conceptions, and comprehension by respondents, gaining insight into the setting of the problem and formulating hypotheses to uncover prevalent trends, ideas, and opinions of respondents. Creswell (2009) points out that quantitative design is "confirmatory and deductive in nature" and thus post-positivistic and common to modern researchers which enables the researcher to specify the phenomena under study and to quantify the relationships between and within variables of the study.

This study employed a quantitative research design. A quantitative design entails testing objective theories by examining the relationship among variables. Instruments measure these variables, so that numbered data can be analysed using statistical procedures. The final written report has a set structure consisting of introduction, literature and theory, methods, results, and discussion. Like qualitative researchers, those who engage in this form of inquiry have assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalise and replicate the findings (Creswell, 2013).

There are two types of quantitative research designs, namely: the experimental, and the non-experimental quantitative research designs. Researchers employ experimental research designs primarily in laboratories only because of, *inter-alia*, ethical reasons, and non-experimental research designs in natural settings such as in education. Figure 26 provides and outline of the research designs and numerous research methods/approaches that could be applied in each design available to researchers (Leedy & Ormrod, 2010).

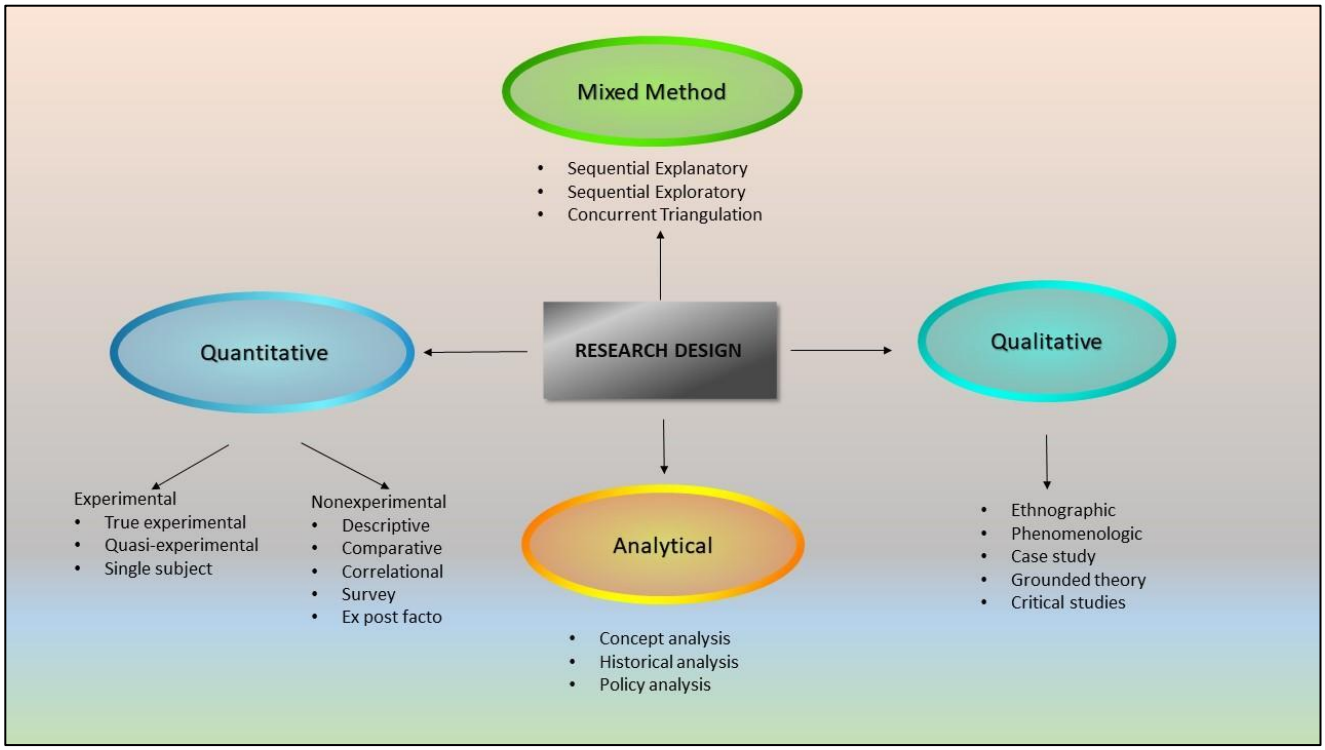

Figure 26: Research designs (Adopted from McMillan & Schumacher, 2010)

3.4 RESEARCH METHOD

The research followed a nonexperimental research design in this study. From within the ambit of the non-experimental research design, the researcher chose the survey method (or the survey approach – as different researchers use the terms method and approach interchangeably). The survey method describes attitudes, beliefs, opinions, and other types of information (McMillan & Schumacher, 2010). During survey methods, the researcher selects a sample of respondents from a target population and administers a questionnaire to collect information on variables of interest. McMillan and Schumacher (2010) explain that surveys in education enable accurate information obtained for large numbers of people. Most surveys describe the incidence, frequency, and distribution of the characteristics of an identified population. In addition, it explores relationships between variables by employing inferential statistics. The researcher investigated the attitudes, perceptions, and opinions of learners and teachers regarding the four dependent variables of the study inclusive of information-processing ability, conscious awareness, cognitive and metacognitive engagement.

3.5 POPULATION AND SAMPLE

A population of the study is a targeted and accessible group of subjects from which the researcher draws a group of respondents. A population is a group of individuals such as teachers of a particular grade or standard in an educational setting that conforms to specific criteria. The researcher wishes to collect the required information from the whole group of individuals in such a category in order to address the research questions, objectives, or hypothesis from the population. However, due to the sometimes overwhelming numbers in any given population of study, Siegle (2012) supports the view that a group of respondents (sub-group called a sample) is statistically selected from the population. The results of the study from the sample obtained through inferential statistics, are interpreted to draw inferences about the population.

3.5.1 The population

The target population comprises all the FET teachers and Grade 11 learners in the Fezile Dabi Education District of the Free State Province in South Africa.

3.5.2 The sample

A probability sample for this study was selected through a multistage cluster-sampling procedure. McMillan and Schumacher (2010) explain that selecting a probability sample from the population should be done in such a way that probability of selecting each member of the population is expressed. Probability sampling efficiently provides estimates of what is true for a population from a smaller group of subjects. A cluster sampling method, specifically multistage-cluster sampling, involves the selection of respondents in naturally occurring groups existing in two or more levels or clusters.

The sample size refers to the number of people needed to represent the target population accurately with reference to the homogeneity of the population (Miller, McIntire & Lovler, 2013). The homogeneity of the population refers to how similar the people are in the population to one another. The more similar the members in the population, the smaller the sample that is necessary; the more dissimilar the members of the population, the larger the sample that is necessary to have this variation represented in the sample. However, the smaller the sample, the likelihood of a sampling error is evident (i.e. a statistic that reflects how much error can be attributed to the lack of representation of the target population by the sample of the respondents chosen).

The sample for this study consists of schools within the district, classrooms within schools, and learners and teachers within classrooms. Classification of the learner sample in schools within the district focused on schools in urban and rural locations, Grade 11 classroom of learners, and language of instruction (LOLT) as Afrikaans or English. The teachers were sampled based on schools within the district by location of the schools (urban and rural); and post level of teachers (PL 1 [classroom teachers], 2 [Heads of Departments], and 3 [Deputy Principals]), teaching various FET subjects.

To account for possible dissimilarities in the target population, and to avoid the likelihood of a sample error, the researcher included a big sample. The sample consisted of 840 Grade 11 learners and 140 FET teachers that represented 20 schools of the 65 schools in the district. The total sample cohort consisted of 980 respondents (Appendix J).

One statistic important to all research studies refers to the response rate (i.e. the number of individuals who responded to the questionnaire) divided by the total number of respondents to whom the questionnaire was administered. The response rate pertaining to the learners reported 77, 4% (650/840 x 100), and to that of teachers 72, 1% (101/140 x 100).

3.6 DATA COLLECTION PROCEDURES

Permission to conduct this research was at the outset, requested (Appendices B and C) and obtained (Appendices D and E) from the Free State Department of Education. Letters to the principals of sampled schools were subsequently sent for permission to distribute questionnaires to the teachers and learners (Appendices B and F). The principals expressed positive regard and enthusiastic response to the research and, in some instances even telephoned to verify and endorse total support by all and sundry. A letter to the Research Ethics Approval committee of CUT (Appendix A); DEd letters of consent to learners (Appendix G), parents (Appendix H), and teachers (Appendix I); DEd questionnaires for learners (Appendix K), and for teachers (Appendix L) are attached.

According to Johnson and Christensen (2008), a questionnaire is a list of questions presented in written format and the respondents indicate their responses on a form, mailed or completed in a particular place. For this study, data collection was done by a nine-page questionnaire for the learners and a ten-page questionnaire for the teachers. In each case, the questionnaire was a one-week take home exercise in order to circumvent encroachment upon the teachers and learners'

territoriality of schooling activities. This arrangement was in response to the document on information regarding undertaking research in schools by the Free State Province Department of Education and Culture.

3.6.1 Data collection instrument

This study employed a closed-ended questionnaire as the data collection instrument. The questionnaire consisted of two sections. Section A contained the demographic variables of the sample (consisting of approximately 20 questions). Section B consisted of approximately 80 questions, the response on each on a four-point Likert-type scale ranging from Strongly Disagree (1), Disagree (2), Agree (3), to Strongly Agree (4); and contained items pertaining to the four dependent variables of the study.

The Likert-type scale is a popularly used multiple-item scale survey questionnaire that employs summated ratings, to determine the strength of the attitude measured, and attempts to quantify constructs, which are not directly measurable. The Likert-type scale's invention in 1931 is attributed to Rensis Likert who described this technique for the assessment of attitudes (Gliem & Gliem, 2003). In analysing responses, identical response categories used for several items intended to measure a given variable. This helps to score each item in a uniform manner.

3.6.2 Levels of measurement

Accuracy of claims made about the results of psychological tests depends largely on the levels of measurement (Miller et al., 2013). There are four levels of measurement, which are nominal, ordinal, interval, and ratio scales. Nominal scales report categorical data using frequency tables. The number assigned to categorical data is indicative only of a specific category, e.g. male and female. Section A of the questionnaire consisted of the demographic variables of the sample, and was collected using nominal scales, and reported in frequency tables and graphs.

Ordinal scales have all the attributes of nominal scales, but the numbers assigned to responses are ordinal (i.e. order or rank). The number in ordinal scales thus has meaning. Likewise, interval scales have all the qualities of the nominal and ordinal scales, but in addition, their raw scores express the assumption that each number represents a point that is an equal distance from the points adjacent to it. Likert-type rating scales represent interval scales as researchers assume that each point on the Likert-type scale represents an equal distance or amount of the construct.

The assumption is that respondents have the same understanding of what *strongly disagree* and *disagree* represent as well as the distance between the two. The advantage of equal interval scales is that means and standard deviations are calculated for these scores, whereas these statistics allow for comparison of the performance of one group with the performance of another group. Section B of the questionnaire measured the dependent variables/constructs on a four-point Likert-type scale.

3.7 VALIDITY AND RELIABILITY

The goal of measurement is to capture dependent variables with precision, sufficient variability, and sensitivity to proposed relationships and/or differences (Lee & Pickard, 2013). Validity and reliability of the measurement instruments influence the probability of obtaining statistical significance in the data analysis, and the extent to which meaningful conclusions are drawn from data (Tirivangana, 2013). Reports of validity and reliability estimates were necessary to determine the adequacy of the psychometric properties of the Likert-type questionnaire. Prior to analysis, the researcher conducted tests of validity and reliability of the research instrument and reported accordingly.

3.7.1 Validity

Miller et al. (2013) and McMillan and Schumacher (2010) explain that there are different sources of evidence of validity. They include the following.

- Face validity: This validity is only concerned with how respondents perceive the attractiveness and appropriateness of the questionnaire.
- Content validity: This validity entails that the content of the measuring instrument is evaluated to determine whether it is representative of the concepts that the test is designed to measure.
- Construct validity: It refers to inferences that are made from the nature of the measurement and interventions used to the constructs they purportedly represent; i.e. construct validity considers the match between theoretical constructs and actual interventions.
- Criterion-related validity: This concept of evidence of validity tests how well the test scores correlate with the observed behaviour, i.e. test scores predict behaviour. The measure of performance that we correlate with test scores is the criterion.

The face and content validity of the questions were tested by subjecting the questionnaire items to a panel of three judges to verify the validity. Factor analysis was computed to obtain evidence of construct validity. Firstly, exploratory factor analysis (EFA) took a broad look at test data to determine how many underlying components were possible. Secondly, confirmatory factor analysis (CFA) is a method used to test theoretical predictions about underlying variables or factors that make up a construct, and the process of CFA involved proposing underlying factors and then verifying their existence using statistical procedure of factor analysis. Criterion-related validity was not tested in this study.

3.7.2 Reliability

Reliability is one of the most important standards for determining how trustworthy data derived from a psychological test are. Hence, reliability is the most important attribute of a measurement instrument. Reliability reports the consistency of results and derives from three factors (Miller et al., 2013). Firstly, reliability within the test (internal consistency); secondly, reliability across time (test-retest reliability); and, lastly reliability across respondents (inter-rater reliability). The reliability coefficient provides a quantitative estimate of a test's consistency of measurement.

Internal consistency is a measure of how related the items (or group of items) are to each other. The communality measures similar attributes, and therefore we can say that the test is internally consistent. Cronbach (1951) proposed a formula called coefficient alpha that calculates internal consistency for questions that have more than two possible responses. When items or group of items on the questionnaire are not homogeneous (i.e. measuring only one construct), but rather heterogeneous (measuring more than one construct), it is recommended that the internal consistency test is conducted and reported for each homogeneous subset or construct.

The Cronbach's alpha test which measures the internal consistency reliability of the research instrument for this study, was used as the reliability coefficient for the Likert-type scale in section B of the questionnaire. A Cronbach Alpha on each of the four dependent variables/constructs was calculated. The coefficient confirmed reliability in the local context. Reliability is a characteristic of the test itself, and validity depends on the inferences made from the test scores.

The test-retest method implies that respondents complete the same questionnaire on two different occasions. A correlation analysis determines whether correlation between scores exist. If a questionnaire can only be administered once, the third method (inter-rater reliability) for testing

reliability could be employed which refers to the test for external consistency of the measuring instrument. This refers to the degree to which different respondents give consistent estimates of the same behaviour. The statistical measure used to test for inter-rater reliability is the intra-class correlation coefficient (ICC). It is a score of how much homogeneity, or consensus, there is in the ratings given by various respondents. The researcher tested for inter-rater reliability by reporting the ICC statistic.

3.8 DATA ANALYSES

3.8.1 Research questions

As elucidated in Chapter 1 (section 1.3), the research questions of the study were presented.

The main research question for the study is:

What is the simultaneous impact of juxtaposed learning theories in the classroom on learner information-processing ability towards learner cognitive growth and development?

The sub-questions for this study include:

i. What are the opinions of the ***learners*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom?
ii. What are the opinions of the ***teachers*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom?
iii. According to ***learners***, is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information-processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom?
iv. According to ***teachers***, is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information-processing ability of learners in the classroom?

3.8.2 Research aim and objectives

The aim of the study is to ascertain the simultaneous impact of juxtaposed learning theories (behaviourism, cognition, and constructivism) in the classroom, on learner information-processing ability towards learner cognitive growth and development.

The objectives of the study are as follows:

i. To determine the opinions of the ***learners*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom.
ii. To obtain the opinions of the ***teachers*** regarding the simultaneous impact of juxtaposed learning theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom.
iii. To find out what the relationship is between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information-processing ability of learners in the classroom, according to ***learners.***
iv. To determine what the relationship is between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information-processing ability of learners in the classroom, according to ***teachers.***

3.8.3 Research hypotheses

The Hierarchical Linear Modelling (HLM) research hypotheses formulated for learners are the following.

1. There is no significant statistical difference between age and learner performance (IPA, CA, CE and ME).
2. There is no significant statistical difference between home language and learner performance (IPA, CA, CE and ME).
3. There is no significant statistical difference between LOLT and learner performance (IPA, CA, CE and ME).

4. There is no significant statistical difference between grades repeated and learner performance (IPA, CA, CE and ME).
5. There is no significant statistical difference between average obtained and learner performance (IPA, CA, CE and ME).
6. There is no significant statistical difference between learners' class size and learner performance (IPA, CA, CE and ME).

The Structural equation modelling (SEM) research hypothesis formulated for learners is: there is no significant statistical relationship between IPA, CA, CE, and ME.

The Hierarchical Linear Modelling (HLM) research hypotheses formulated for teachers are the following.

1. There is no significant statistical difference between age and learner performance (IPA, CA, CE and ME).
2. There is no significant statistical difference between highest qualification and learner performance (IPA, CA, CE and ME).
3. There is no significant statistical difference between experience and learner performance (IPA, CA, CE and ME).
4. There is no significant statistical difference between post level and learner performance (IPA, CA, CE and ME).
5. There is no significant statistical difference between learners' class size and learner performance (IPA, CA, CE and ME).

The Structural Equation Modelling (SEM) research hypothesis formulated for teachers is: there is no significant statistical relationship between IPA, CA, CE, and ME.

3.8.4 Statistical assumptions

Garson (2012) asserts that all statistical procedures have underlying assumptions. An expected component of quantitative studies is establishing that the data of the study meet these assumptions of the procedure. Similarly, Shumba (2013) outlines the importance of meeting the conditions of a particular statistical procedure before conducting data analysis. Parametric tests are significant tests, which assume a certain distribution of the data (usually a normal distribution), assume an interval level of measurement and assume homogeneity of variances when comparing two or more samples. Most common significance tests are parametric (Garson,

2012). However, moderate violations of parametric assumptions have little or no effect on substantive conclusions in most instances as quoted by Cohen (in Garson, 2012). The researcher conducted these statistical assumptions tests before analysing data.

3.8.5 Statistics

Descriptive statistics formed part of the inferential statistics in this study. The sample was described by the presentation of descriptive statistics of the demographic variables (calculating means of central tendency, inclusive of frequency distributions, means, standard deviations, and percentages) displayed in tables and graphs.

Multilevel modelling analysis explained the multilevel association between learners' information-processing ability, conscious awareness, cognitive and metacognitive engagement as well as the teaching approaches teachers employed in enhancing learner cognitive growth and development because of learner abilities in the classroom. The analysis of data in this study employed inferential statistics, specifically HLM and SEM.

3.8.5.1 Multilevel models – hierarchical linear models (HLM)

Multilevel models (MLMs; also known as hierarchical linear models or random coefficient modelling) are widely used to analyse clustered data structures (Rights & Sterba, 2018). Popularised by education research, HLMs are defined as a generalisation and extensions of regression models, but also developed from an analysis of variance (ANOVA) perspective, from which HLM attempts to model or explain variability across levels (Raudenbush & Bryk, 2002). HLM can account for interactions across levels (e.g. schools or classes), whereas the application of multiple regression and ANOVA will limit the analysis due to the fact that data analysis only occurs at the individual level (e.g. learner level). HLM is thus a statistical modelling technique that accounts for variation at multiple levels. HLM is also a random effects model, where the random effects are parts of the model not estimated, but rather summarised via their variances and covariance directly (Niehaus, Campbell, & Inkelas, 2014).

Research questions, hypotheses, and data in educational research are almost continuously and intrinsically nested or clustered. In education, for example, we may be interested in factors that affect learners' cognitive growth and development at various levels. This nested effect reflects interest in and provides an understanding of the dynamics between and within educational levels, e.g. learners and teachers as they are in classrooms, and in the schools (Niehaus et al., 2014).

Broadly, we may theorise factors associated with the school (specific learning environment created, average class size, school location, socio-economic status of most of the school families), the teachers (effectiveness of the teacher, learner-teacher relationships, teaching approaches), and learners themselves (learning styles, cognitive and metacognitive engagement, conscious awareness and information-processing ability). Each of the factors that might be associated with the cognitive growth and development of learners could be conceptualised as different levels of nesting – learners (at level 1) in schools and classrooms (at level 2), in which each level potentially affects learner performances.

Fath (2014) asserts that applied statisticians have mathematically established that multilevel analysis provides accurate results for multilevel data. Raykov, Marcoulides and Akaeze (2017) outline that multilevel studies have become an integral part of educational research over the past twenty years due to the nature of data collected in behavioural and social research being hierarchical. When data is hierarchical, it means that some variables cluster within other variables (Field, 2009). This entails that learners grouped together in different classes and in different schools, and taught by different teachers. The classroom or school becomes a contextual variable in the hierarchy and subsequently advances dependency in the data, which means that there will be correlated residuals (Field, 2009). Research has constantly demonstrated that individuals within a particular group or context tend to be more similar to each other in terms of an outcome or dependent variable than they are to individuals in a different group or context (O'Connell & McCoach, 2008).

Subsequently this describes the situation that if learner performance would only be analysed as if learners all exist independently in one environment (e.g. one school or classroom) they tend to display similar traits. As a result, it would provide less information than if the same number of learners taught separately by separate teachers are clustered together in different contexts (Niehaus et al., 2014). In support of this, Van der Berg (2008) confirms that there are large variations in performance levels between schools in South Africa.

HLM has the advantage over ordinary least-squares (OLS) regression analyses for accounting for the non-independence of observations and for dealing with cross-level interactions, for example, classroom-level variables having associations with individual-level variables (Gilliam, Maupin & Reyes, 2016). Similarly, Woltman, Feldstain, MacKay, and Rocchi (2012) postulate that HLM is indeed a complex form of OLS regression that is used to analyse variance in the dependent variables when the predictor (independent) variables are at varying hierarchical levels

and accounts for the shared variance in hierarchically structured data. Multilevel techniques, including hierarchical linear modelling, provide reliable estimates of slopes and intercepts, because it takes into account the multilevel data structure (Fath, 2014).

In this regard, only conducting a single-level analysis (simple linear regression) of the nested data entails that the slopes and intercepts may vary across schools. The HLM technique accurately estimates lower-level slopes (e.g. learners) and their implementation in estimating higher-level outcomes (e.g. school level). Huta (2014) elaborated on this by also stating that the HLM method is an expanded form of regression. Thus, analysis that employs HLM conserves the multi-level or hierarchical nature of the data, and subsequently has several advantages over a single regression performed on the data. Huta (2014) postulates that the greatest advantage of HLM analysis is that a grouped analysis protects the researcher against inflated Type I error. Huta (2014) continues that in addition to HLM methods that sometimes apply to grouped data, there are also repeated-measures analyses (such as mixed design ANOVA) and SEM or its simpler version path analysis.

In the same vein, Farquharson, Tambyraja, Logan, Justice, and Schmitt (2015) assert that when data are nested or clustered, regression analysis becomes redundant due to the fact that a fundamental assumption is not met which refers to the independence assumption. The independence assumption presumes that respondents' scores do not relate to each other and are not influenced by the same, unmeasured, external factors. When this assumption in regression is violated, the standard errors used to estimate significance are smaller than they should be, resulting in an increased possibility of a Type I error (finding significance where none exist). Independent observations are no longer evident when data is nested or hierarchical (McNeish, 2014). Any statistical model used, must accommodate for these dependencies by allowing for a more general covariance structure, in which observations from the same group or individual correlate (McNeish, 2014).

Rights and Sterba (2016) furthermore explain that nested data are analysed with MLMs in which heterogeneity between clusters is modelled continuously and normally distributed in random intercepts and/or slopes. Regression-based derivation of HLM entails that HLM beginning with a micro-level regression model, and then adding in additional mini regressions to model the varying intercepts in the varying slopes. Random effects models are developed out of ANOVA for cases in which relevant factors represent a random draw from a larger population. LaHuis, Hartman, Hakoyama and Clark (2014) emphasise that "explained variance measures provide a

useful summary of the magnitude of effects and may be particularly useful in multilevel studies where unstandardized coefficients are reported often." Not accounting for nested data structures generally leads to aggregation bias, misestimate standard errors, and heterogeneity of regression (Raudenbush & Bryk, 2002).

Fath (2014) also mentions the term 'ecological fallacy' in which she explains that Robinson (1950) was one of the earliest to publish on the problem of cross-level inferences. In a study conducted by Robinson, he found that statistical relationships measured at group (ecological) level, using correlation analysis, did not hold for the individual level. Robinson concluded that ecological correlations could not validly be utilised as substitutes for individual correlation.

Field (2009) points out, that variance accounted for at group level is often referred to as the intra-class correlation (ICC), where it represents the proportion of total variability in the outcome variable that is attributable to a certain class or school. The ICC is therefore a good indication whether the contextual variable has a significant effect on the dependent variable or outcome. ICCs with values around 0.05 or higher are often taken as an indication of substantial clustering of observations within level two units (e.g. schools or classrooms).

Hierarchical regression allows for better exploratory analysis and testing complex theories and since HLM statistical models have parameters that vary on more than one level, it therefore implies that learners' cognitive growth and development and teacher' approaches can vary on individual levels of measurement as well as on school levels of measurement within which the learners and teachers can be grouped. When data are organised on more than one level – nested or clustered data becomes relevant. The units of analysis are usually individuals at a lower level who nested within contextual units at a higher level. Thus, the HLM approach enables the researcher to identify the extent of variance in the information processing ability, conscious awareness, cognitive and metacognitive engagement of learners between schools, and subsequently factors at learner level and school level explain the variance. HLM also provides an understanding for teachers' teaching approaches varying amongst classrooms and schools. The selection of a multilevel data structure reflects both theoretical and practical considerations.

The benefit of multilevel models lies in that, if the statistical assumptions listed below are not met, Field (2009) suggests that it would still be appropriate to use the HLM.

- Homogeneity of regression slopes: With analysis of covariance, we have to assume that the relationship between the covariate and DV is the same across different groups that conclude our IV. HLM models the variability in regression slopes.
- Independence of data: When conducting an ANOVA, we have to assume that the different cases of data are independent as well as independent observations in multiple regression. Multilevel models allow modelling these relationships between cases.
- Missing data: Multilevel models expect missing data, in contradiction to regression and analysis of variance.

3.8.5.2 Structural Equation Model (SEM)

Structural Equation Modelling (SEM) is a collection of statistical techniques that allow a set of relationships between one or more independent variables, either continuous or discrete, and one or more dependent variables, either continuous or discrete, to be examined (i.e. a series of multiple regression equations). SEM is also referred to as a hybrid of multiple regression, MANOVA, and factor analysis (Schreiber, Nora, Stage, Barlow & King, 2006).

Although a vast majority of correlational research is concerned with only relationships, some statistical techniques (e.g. path analysis) use multiple correlations to investigate cause-and-effect questions. Path analysis uses the correlations of several variables to study causal patterns. A causal model based on theory, expresses the cause sequence with arrows. The correlations between the variables in the model provide empirical evidence of the proposed causal links. Blunch (2008) asserts that such a model consists of two parts. Firstly, the structural model describing the casual connections amongst latent variables, and mapping these connections is the main purpose of the analysis. Secondly, the measurement model describing the connections between the latent variables and their manifest indicators. McMillan and Schumacher (2010) explain that SEM attempts to investigate relationships amongst many variables, and analyse complicated casual models.

SEM allows complex path models with direct and indirect effects. Blunch (2008) highlights that SEM can incorporate unobserved (latent) variables (i.e. sometimes called factors) and mediating variables, as well as observed (measured) variables. The latent variable results from combining multiple measures, which enhances reliability. SEM involves imposing a theoretical model on a set of variables to explain their relationships. With path analysis, all observed variables have some type of mediation variable that exists. CFA accounts for a latent variable that is measured

by several indicator variables. Statistical tests reveal how good the theoretical model fits our proposed (structural) model and significance values obtained for each of the paths between variables becomes evident. In SEM, the significance of fixed coefficients' (regression coefficients, factor loadings and path coefficients) tested, using their standard errors, are imperative.

SEM has been described as a combination of exploratory factor analysis and multiple regression (Ullman, 2001). In SEM, researchers use their scientific knowledge to guide decisions, and this especially applies to model selection. SEM, in comparison with CFA, extends the possibility of relationships among the latent variables and encompasses two components: i) a measurement model implying how the constructs are related to measured variables (essentially the CFA), and ii) a structural model meaning what the relationships are between the constructs.

In SEM analysis, the independent variable is expressed as the exogenous variable, and the dependent or outcome variable is expressed as the endogenous variable. These variables can be observed or unobserved, depending on the model being tested. Within the context of structural modelling, exogenous variables present those constructs that exert influence on other constructs, and are not influenced by other factors in the quantitative model. The constructs identified as endogenous are affected by exogenous and other endogenous variables in the model. In SEM, the focus is on estimating relationships among hypothesised latent constructs whereas direct, indirect, and total effects among latent constructs are reported.

The study employed SEM to gain a holistic understanding of how the four dependent variables are casually connected and mapped. A path analysis to understand learners' cognitive growth and development as derived from their information processing ability, conscious awareness in the classroom, as well as cognitive and metacognitive engagement, is evident from the discussions in Chapter 4.

Combining SEM and HLM allow for the advantage of being able to model both the hierarchical structure of the data and the complex relationships between variables and subsequently lead to more accurate and reliable models.

3.8.6 Magnitude of effect

McMillan and Schumacher (2010) explain that one of the most important issues that creates confusion in the interpretation of statistics is the decision about whether the results are

meaningful (i.e. how much difference will the results make in the real world?); and whether the results are educationally significant, not just statistically significant? When a finding is reported as statistically significant, the magnitude of the mean difference should also be taken into account.

Magnitude of effect measures either the strength of association or the effect size (ES) (i.e. the difference between two means expressed in standard deviation units). Measures of association used to estimate proportions of variance held in common, such as the coefficient of determination (r^2), R^2, eta-squared (η^2), or omega-squared (ω^2). ES, in a generalised form, reports the ratio of the difference between the means of groups divided by the estimated standard deviation of the population. According to Cohen (1988), the ES index may then provide an indication of the practical or meaningful difference. ES and magnitude of effects is evident from the reporting in Chapter 4 as part of the statistical analysis.

3.9 SUMMARY

This chapter described the research methodology used throughout this quantitative study. Discussions including the research paradigm, research design, and the research method applied in the empirical investigation outlined the chapter. The focus was on the questionnaire as a research instrument in collecting the relevant data. Chapter 4 presents the findings of the study.

CHAPTER 4

RESULTS AND FINDINGS

4.1 INTRODUCTION

This chapter presents the results and findings of the study. Data gathered through a non-experimental quantitative design, following the survey method, is analysed through the application of descriptive and inferential statistics. The researcher upholds the view of Pearson (1900) in stating that statistics is the grammar of science. The latter inspired the researcher to conduct a quantitative research study by employing inferential statistics to provide insights into the cognition of learners from a scientific stance. Furthermore, the literature review explained the theoretical underpinnings of cognition and its relationship to educational neuroscience from a positive psychological viewpoint. Various learning theories encapsulated the essence of how to engage learners cognitively and metacognitively in an effective manner to create interactive teaching-learning environments conducive to information processing ability. Ultimately, the study sought to improve cognitive growth and development of learners in the classroom.

4.2 PURPOSE OF THE STUDY

The study attempted to establish how the information-processing ability of learners is influenced by learners' conscious awareness in the classroom, how it is simultaneously mediated by cognitive engagement and metacognitive engagement, and how this ultimately influence learner performance in the classroom. Subsequently, this study examined whether statistically significant associations existed between learners from various contexts and their information-processing ability, conscious awareness, cognitive engagement, and metacognitive engagement in the classroom. The conceptual framework presented in Figure 27 provides a holistic view of the structure and methods employed in an attempt to answer the main research question: W*hat is the simultaneous impact of juxtaposed learning theories in the classroom on learner information-processing ability towards learner cognitive growth and development?*

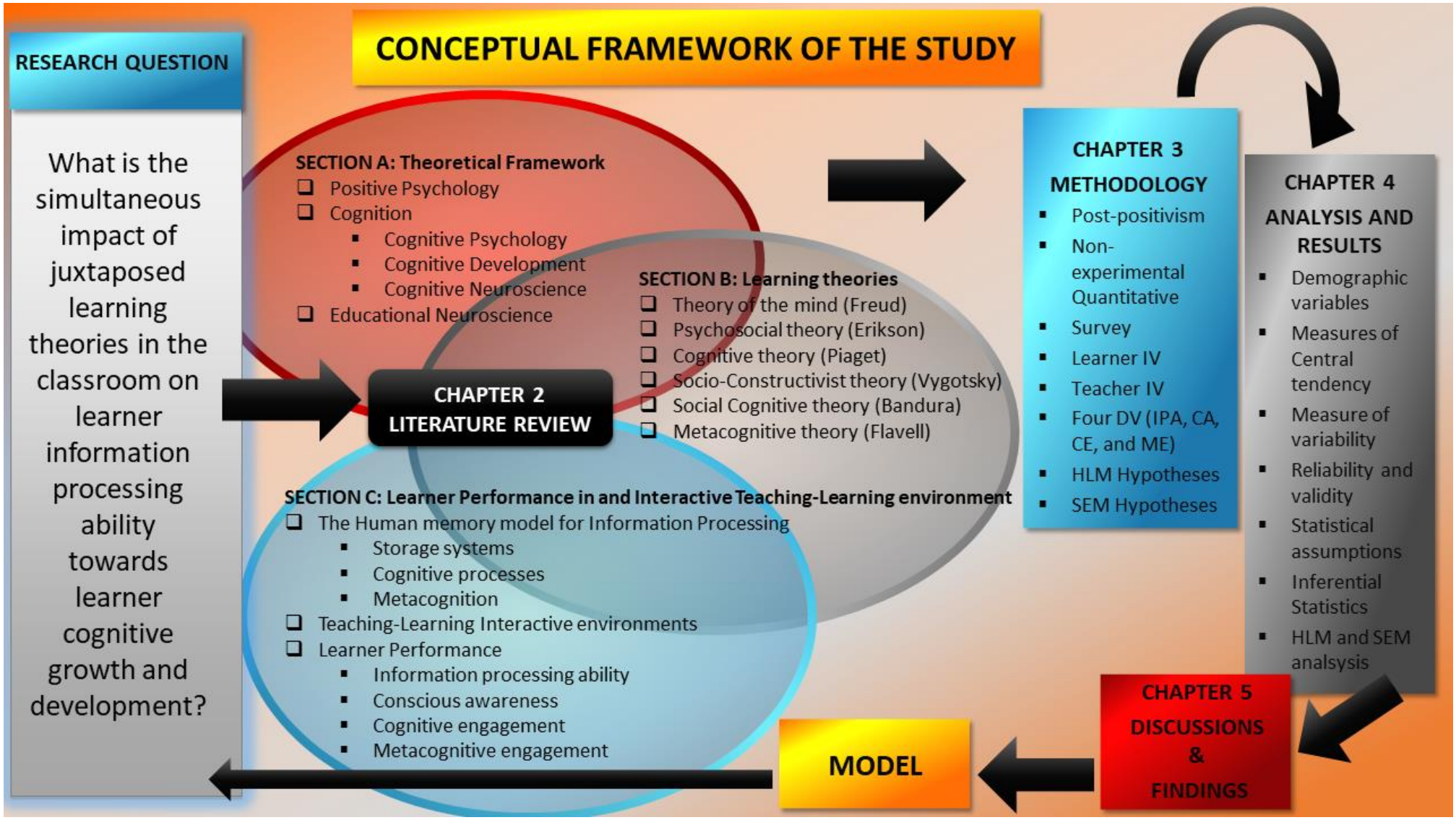

Figure 27: Conceptual framework

4.3 VARIABLES INCLUDED IN THE STUDY

A variable is a noun or characteristic that represents numerical or categorical variation (Trochim, 2006). A variable is further described as a distinguishing property or attribute of a concept that takes on different values. Such variables have numbers, values or symbols assigned to them, and are classified as either independent or dependent (Ross, 2005). Inferential statistics were employed to test the statistical relationship between the independent variables (IVs) and the dependent variables (DVs) of the learners and teachers respectively. The variables identified in this study are discussed next.

4.3.1 Independent Variables (IVs)

According to Siegle (2012), an independent variable refers to that factor which is measured, manipulated, or selected by the researcher to determine its relationship to an observed phenomenon. An independent variable (or variables) is thought to influence other variables in a particular study, and predictions can be formulated based on it (Tirivangana, 2013). In a research study, independent variables are perceived as antecedent conditions that are recognised to influence a dependent variable. The researcher manipulates or observes the independent variables so that the independent values can be related to that of the dependent variable. The following IVs identified for learners are:

- Age
- Home language
- Language of learning and teaching (LOLT)
- Grades repeated
- Average obtained
- Class size

The IVs for teachers comprise:

- Age
- Highest qualification
- Experience
- Post level
- Class size

4.3.2 Dependent Variables (DVs)

Siegle (2012) states that the dependent variable is referred to as the observed variable and is measured to determine what effect the independent variable exerts, i.e. that factor that appears, disappears, or varies as the researcher introduces, removes, or varies the independent variable. In a research study, the dependent variable delineates a primary focus of research interest. It is the resulting variable that is affected by one or more predictor variables ostensibly, that are either manipulated by the researcher or observed by the researcher and regarded as antecedent conditions that determine the value of the dependent variable. The dependent variable(s) is the reputed effect, which varies concomitantly with changes or variation in the independent variable(s) (Bryman & Liao, 2004). Dependent variables are not manipulated by the researcher, and as a result, prediction can be made about them as well. The DVs for the learners are:

- Information processing ability (IPA)
- Conscious awareness (CA)
- Cognitive engagement (CE)
- Metacognitive engagement (ME)

The DVs for teachers are:

- Information processing ability (IPA)
- Conscious awareness (CA)
- Cognitive engagement (CE)
- Metacognitive engagement (ME)

4.3.3 Demographic variables

The demographic variables of the respondents, identified as the independent variables as part of the analysis, are summarised in Table 2 to 12. In the figures that follow, a graphical representation of each independent variable pertaining to the demographic variables of the respondents is offered. Section 4.3.3.1 depicts the demographic variables pertaining to learners, and Section 4.3.3.2 shows the demographic variables of teachers.

4.3.3.1 Demographic variables of learners

4.3.3.1.1 Age Group

According to the policy on admission of learners to public schools in South Africa (DBE, 1998), a learner will start attending Grade 1 at the age of 7; resulting in taking Grade 11 at approximately seventeen years of age. From Table 2, it is apparent that 219 learners (34%) are older than 17, which implies that these learners may have repeated a previous grade in their schooling years, experienced a delayed progression from one grade to the other because of unforeseen circumstances, or had enrolled at a later age for schooling. This descriptive statistic is further explained in the next section on grades repeated in the past. This entails that only 66% (n = 425) of learners are not older than 17 years. The frequency percentages are displayed in Table 2.

Table 2: Frequency analysis of learners' age groups (N=650)

Independent variable AGE	**f**	**%**
15 years	16	2.5
16 years	152	23.6
17 years	257	39.9
18 years	141	21.9
19+ years	78	12.1
Total	644	100

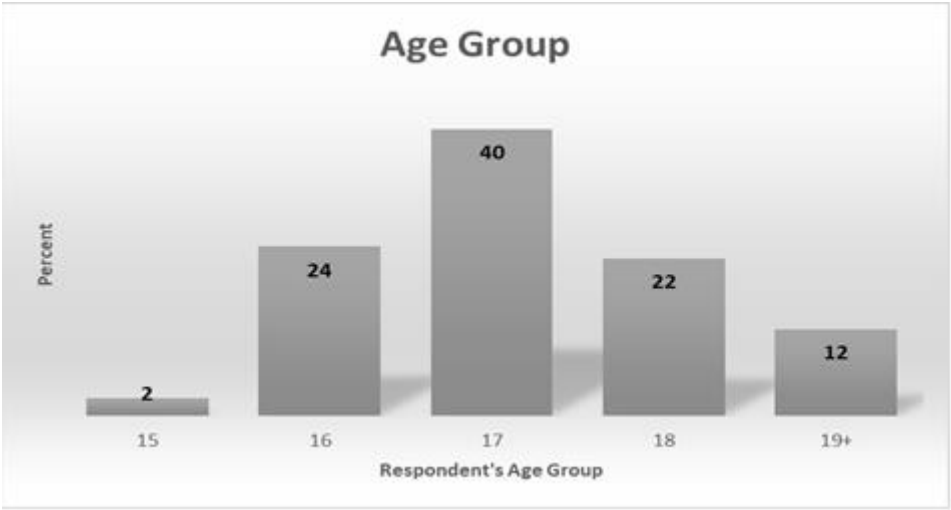

Figure 28: Age group composition of learners (N=650)

4.3.3.1.2 Grades repeated in the past

This section elaborates on the previous section which indicated the average age of the Grade 11 learner in the sample. Table 3 highlights that some learners repeated Grade 9 (n=79; 12.5%), but mostly Grade 10 (n=104; 16.5%). The table further indicates that only 368 learners (58.4%) never repeated a previous grade.

Table 3: Frequency analysis of learners who have repeated grades in the past (N=650)

Independent variable GRADES REPEATED IN THE PAST	**f**	**%**
Grade 8	20	3.2
Grade 9	79	12.5
Grade 10	104	16.5
Other	59	9.4
Never repeated	368	58.4
Total	630	100

This descriptive statistic implies that almost 40% of the learners in the sample have repeated a grade at some stage in their high school career; barring failure in Grade 11 and/or Grade 12. This failure rate of 40% is indicative of the inclusivity of the 34% of the above seventeen years old learners plus an additional 6% of those learners categorised as the 66% appropriate age for Grade 11.

The policy document on the promotion requirements (DBE, 2012) states that, in order for a Grade 10 learner to be promoted to Grade 11, the learner has to pass the seven subjects that are offered in the curriculum for Grade 10. The minimum pass percentage of the seven subjects is stipulated as follows: the learner is expected to obtain a minimum of 40% in three subjects, with one of the three subjects being an official language at Home Language level. Of the remaining four subjects, the learners should obtain a minimum of 30%. There is no percentage pass mark specified to be obtained for the seventh subject of the Grade 10 curriculum. However, obtaining a percentage mark below 30% results in failure of that subject. The policy, nevertheless, specifies that a teacher's consideration of the learner's component of the School-Based Assessment in the latter subject that has been failed, will determine whether a learner passes or fails Grade 10.

Table 4 outlines the Grades repeated in the past for different learners' age groups. It is evident that the percentage learners in the age groups 18 (71%) and 19+ (84%) have repeated Grade 9 and Grade 10 significantly more than learners in the age groups 15 (6%), 16 (5%), and 17 (34%). The descriptive statistics also implies that these learners in the age groups 18 and 19+ could have repeated more than one grade in the past. Figure 29 provides a pictorial display of the results.

Table 4: Cross tabulation of age and grades repeated in the past for learner data (N=650)

Independent variable GRADES REPEATED IN THE PAST	**Learners' Age Group**					
	15	**16**	**17**	**18**	**19+**	**Total**
Grade 8	1	1	11	7	0	20
Grade 9	0	0	20	33	26	79
Grade 10	0	2	37	40	25	104
Other	0	4	19	20	16	59
Never repeated	15	147	169	34	3	368
Total	16	154	256	134	70	630

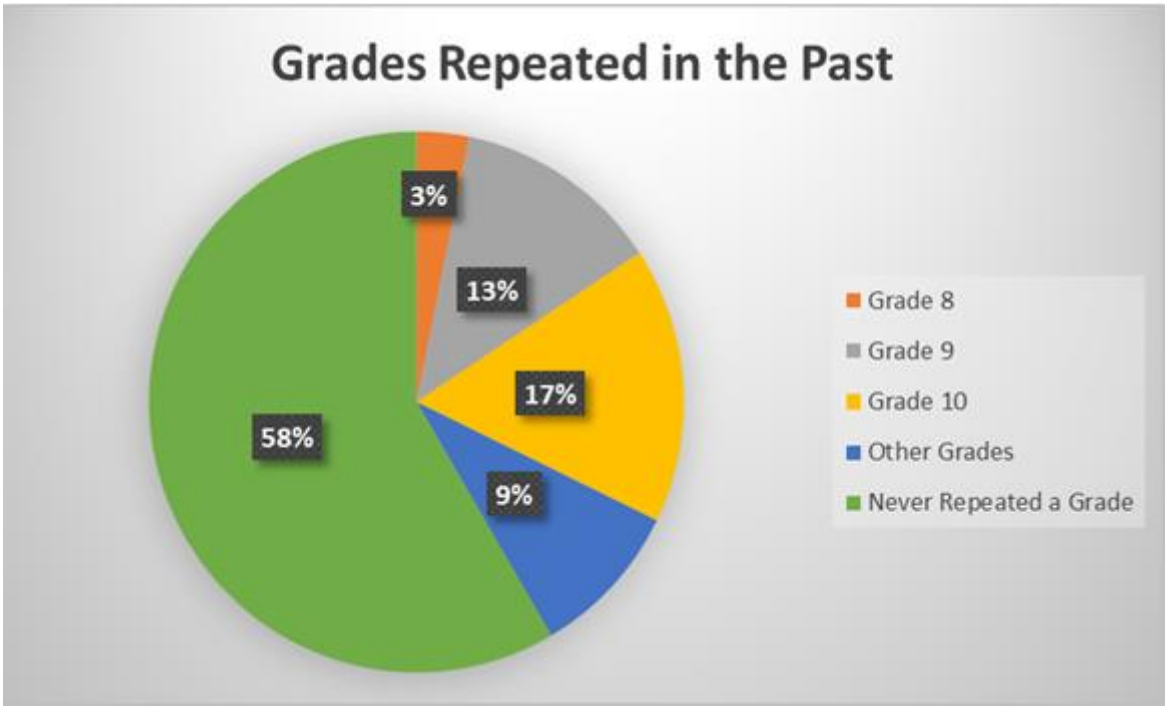

Figure 29: Grades repeated in the past - composition of learners (N=650)

4.3.3.1.3 Average obtained in Grade 10 (N=650)

From the sample, 415 learners (66.7%) obtained an average of between 50%–69% in Grade 10. Only 27% of the sample obtained above 80% (n=27). The ratio between learners who obtained between 30%–49% in comparison to 70%–79% is 68:109 which entails more learners performed better than worse. However, if the learners who obtained between 0%–29% average are compared to the percentage of learners that repeated Grade 10, only three learners out of 104 learners scored below 30%.

Table 5: Frequency analysis of learners' average obtained in Grade 10 (N=650)

Independent variable AVERAGE OBTAINED IN GRADE 10	f	%
0% - 29%	3	0.5
30% - 49%	68	10.9
50% - 69%	415	66.7
70% - 79%	109	17.5
80% +	27	4.3
Total	622	100

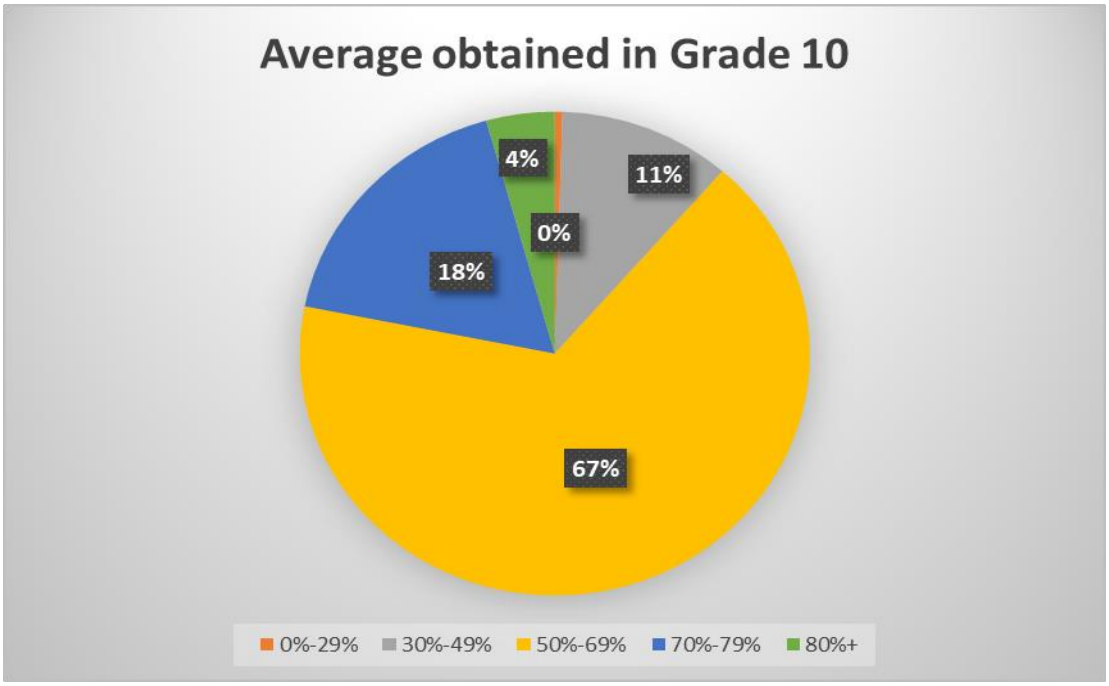

Figure 30: Average obtained in Grade 10 - composition of learners (N=650)

4.3.3.1.4 Home Language

Table 6: Frequency Analysis of Learners' Home language (N=650)

Independent variable **HOME LANGUAGE**	**f**	**%**
Sesotho	284	44.6
IsiXhosa	33	5.2
IsiZulu	47	7.4
English	30	4.7
Afrikaans	243	38.1
Total	637	100

The majority of the learners in the sample were either Sotho learners (n=284; 44.6%), or Afrikaans learners (n=243; 38.1%). These languages represent their respective home language which entails that 57.2% of learners (Sotho, IsiXhosa and IsiZulu) is schooling in a language other than their home language (see also Figure 31).

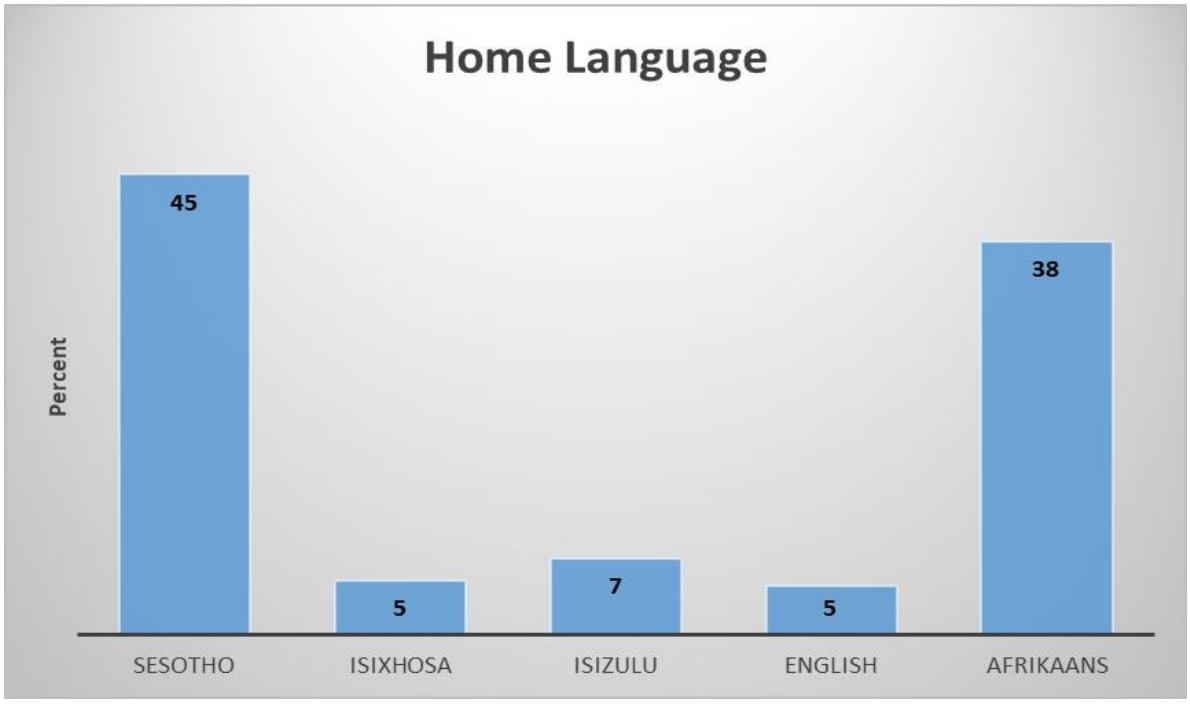

Figure 31: Home Language composition of learners (N=650)

4.3.3.1.5 Language of Learning and Teaching (LOLT)

Table 7: Frequency Analysis of Learners' LOLT (N=650)

Independent variable LOLT	f	%
English	410	63.7
Afrikaans	234	36.3
Total	644	100

Table 7 illustrates that 63.7% (n = 410) of learners in the sample have English as their language of learning and teaching (LOLT), whereas 234 learners (36.3%) pursue Afrikaans as their LOLT. In comparison to the learners that have a home language other than English or Afrikaans (57.2%), it suffices evidence that learners struggle to process information in the classroom due to context and meaning (discussion on this topic continues in Chapter 5). Figure 32 graphically depicts the data.

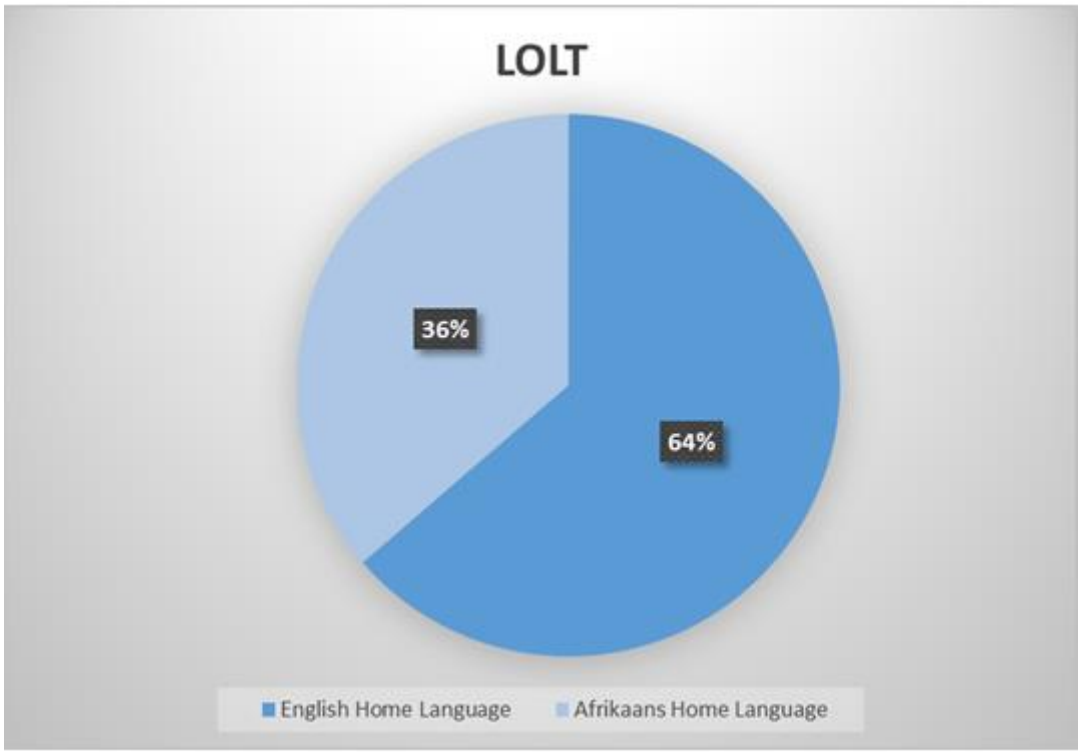

Figure 32: LOLT composition of learners (N=650)

Table 8: Cross tabulation of grades repeated in the past and LOLT data for learners (N=650)

Independent variable GRADES REPEATED IN THE PAST	LOLT	
	Afrikaans	English
Grade 8	9	11
Grade 9	5	74
Grade 10	13	91
Other	17	42
Never Repeated a Grade	186	180
Total	230	398

Table 8 depicted that the Grades repeated in the past are mostly evident amongst learners who have English as their LOLT. The learners that have Afrikaans as their LOLT reported 44 cases of failure in the past, and learners that have English as their LOLT reported 218 failures.

4.3.3.1.6 Average class size

Table 9: Frequency analysis of learners' average class size (N=650)

Independent variable AVERAGE CLASS SIZE	f	%
Below 20	35	5.5
Between 20 - 30	225	35.5
Between 30 - 40	292	45.8
Above 40	86	13.5
Total	638	100

The Department of Basic Education reports that class sizes in South African schools should not exceed 30 learners (DBE, 2012). Notwithstanding, 45.8% of the learners in the sample testify that their class size is made up of 30–40 learners. Furthermore, 13.5% of learners stated that their class size is above 40 learners in the class. This means that 59.3% of learners have to participate in the teaching-learning process in classes above 30 and 40 learners. This statistic is very informative when discussing the HLM hypotheses on the four dependent variables (conscious

awareness, cognitive and metacognitive engagement, and information-processing ability in the classroom) – see also Figure 33.

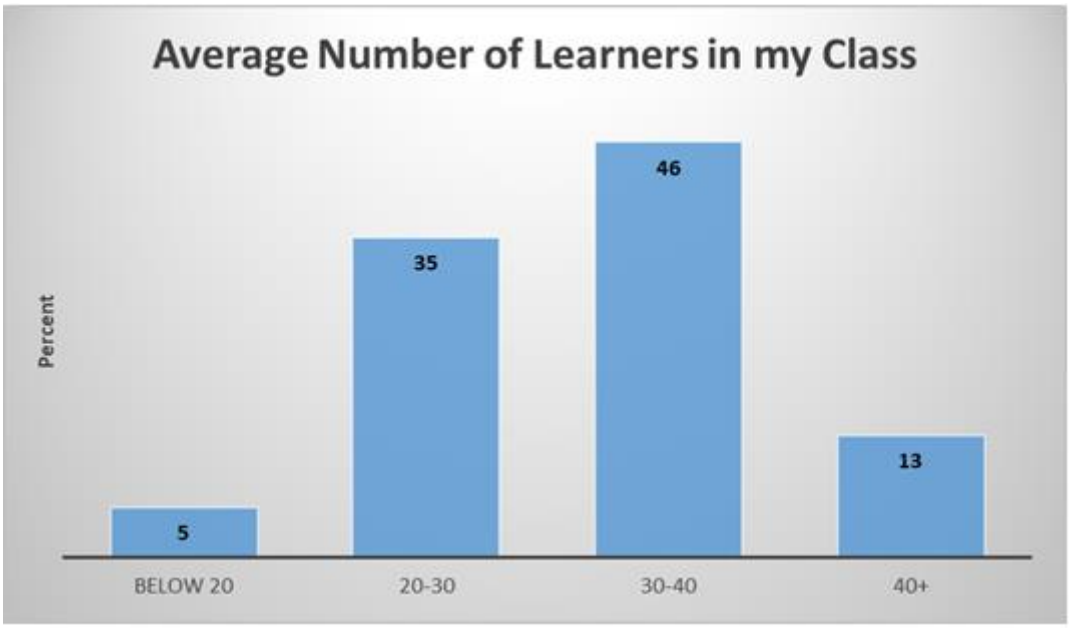

Figure 33: Average number of learners in my class composition of learners (N=650)

Table 10: Cross tabulation of grades repeated in the past and average class size data for learners (N=650)

GRADES REPEATED IN THE PAST	Average Class Size				
	Below 20	**20–30**	**30–40**	**40+**	**Total**
Grade 8	7	8	3	2	20
Grade 9	1	14	30	34	79
Grade 10	0	30	59	25	114
Other	5	21	27	6	59
Never repeated a grade	22	152	173	19	368
Total	35	225	292	86	638

The highest number of learners repeating Grade 10 is evident in classes above 30 learners and more (n = 378; 59.2%) in comparison to learners in classes below 30 learners (n = 260; 40.8%).

The next section describes the demographic variables, as the identified independent variables of the hypotheses related to teachers.

4.3.3.2 Demographic variables of teachers

4.3.3.2.1 Age Group

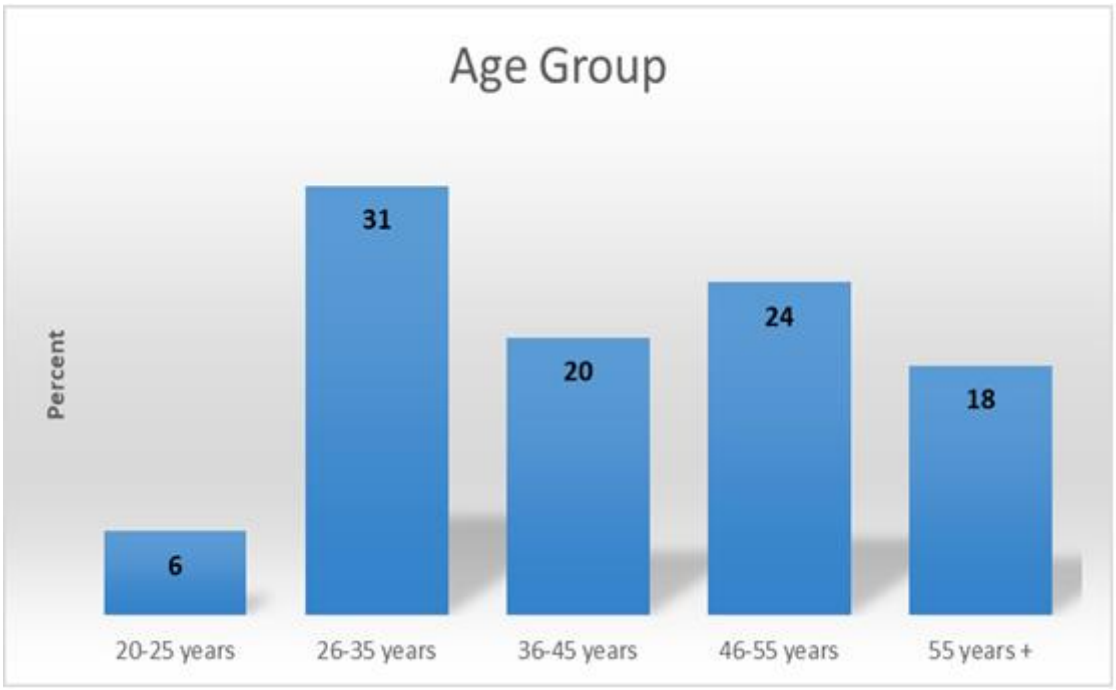

Figure 34: Age composition of teachers (N=101)

From the graph above, it is evident that the majority of teachers are in the age groups 26–35 years (n = 31; 31.3%), and 46–55 years (n = 24; 24.2%). Table 11 also illustrates that young teachers in the age group between 20–25 years are three times (18/6) fewer than older teachers on their way to retirement (n = 18; 18.2%). This could imply that a teacher shortage might become evident as informally inferred from the sample.

Table 11: Frequency Analysis of Teachers' age group (N=101)

Independent variable **AGE GROUP**	**f**	**%**
Between 20 – 25 years	6	6.1
Between 26 – 35 years	31	31.3
Between 36 – 45 years	20	20.2
Between 46 – 55 years	24	24.2
Above 55 years	18	18.2
Total	99	100

4.3.3.2.2 Highest Qualification

Table 12: Frequency analysis of teachers' highest qualification (N=101)

Independent variable **HIGHEST QUALIFICATION**	**f**	**%**
Matric	1	1.0
Diploma	12	12.4
Bachelor's degree	60	61.9
Honours degree	18	18.6
Master's degree	5	5.2
PhD	1	1.0
Total	97	100

Table 11 indicates that teachers with a bachelor's degree are in the majority (n = 60; 61.9%). In addition, 18.6% have furthered their studies as possible life-long researchers in honours degrees. 12.4% of teachers have a teaching diploma. Figure 35 displays the data graphically.

Figure 35: Highest qualification composition of teachers (N=101)

4.3.3.2.3 Teaching experience

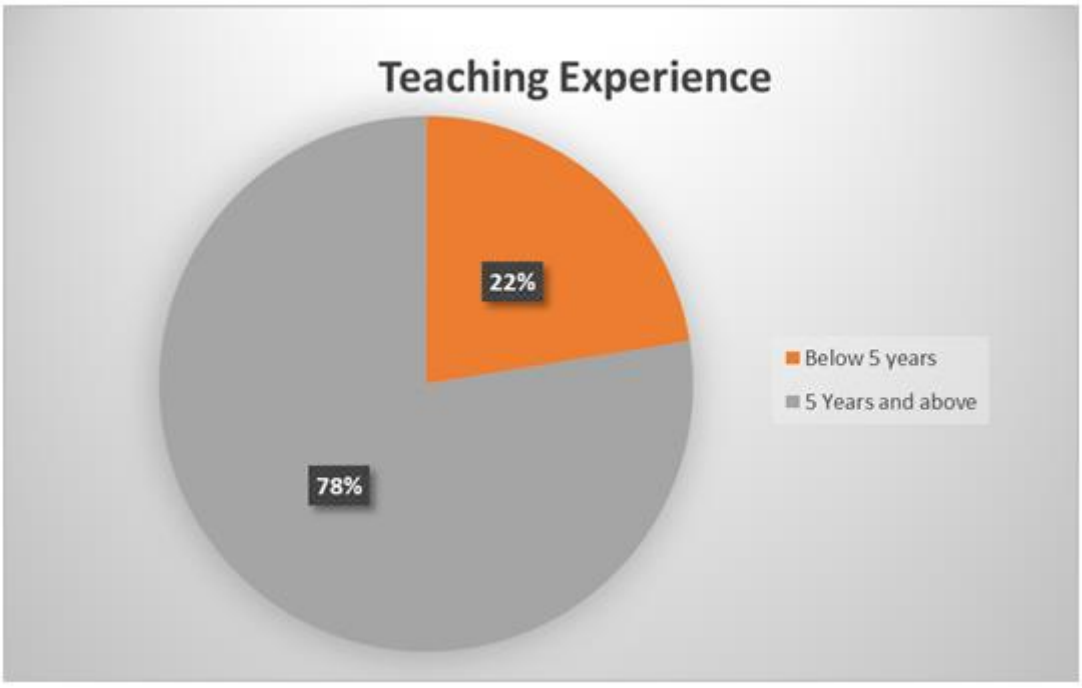

Figure 36: Teaching experience of teachers (N=101)

As evident from the sample (Figure 36), the majority of teachers (n = 76; 77.6%) are considered to be experienced (i.e. five years and more). This statistic will provide enough evidence in

supporting arguments in the discussion chapter of this study. See table 13 for the detailed information.

Table 13: Frequency analysis of teachers' teaching experience (N=101)

Independent variable **TEACHING EXPERIENCE**	**f**	**%**
Below 5 years	22	22.4
5 Years and above	76	77.6
Total	98	100

4.3.3.2.4 Post Level

Table 14: Frequency analysis of teachers' post level (N=101)

Independent variable **POST LEVEL**	**f**	**%**
Deputy Principal (PL 3)	11	11.2
Head of Department (PL 2)	12	12.2
Teacher (PL 1)	75	76.5
Total	98	100

As per Table 13 and Figure 37, the majority of teachers in this sample were post level 1 teachers (n = 75; 76.5%), i.e. teachers who are primarily focused on classroom teaching and learning only, without the burden of school administration operations and managerial responsibilities.

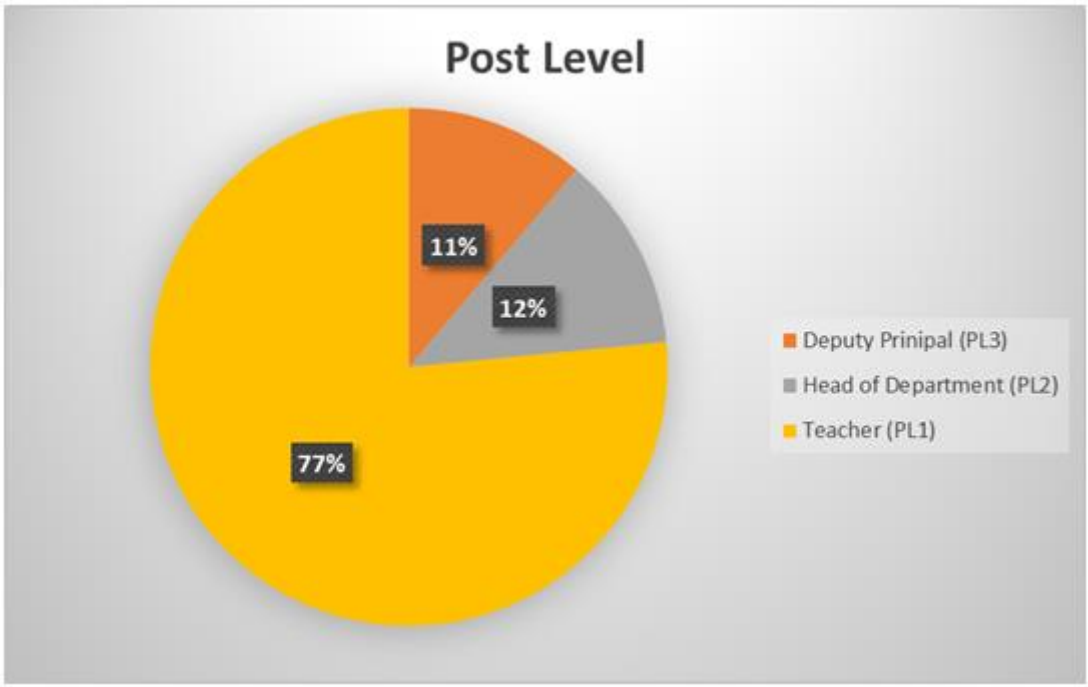

Figure 37: Post level composition of teachers (N=101)

4.3.3.2.5 Average class size

Table 15: Frequency analysis of teachers' average class size (N=101)

Independent variable **AVERAGE CLASS SIZE**	**f**	**%**
Below 20	17	17.3
Between 20–30	34	34.7
Between 30–40	27	27.6
Above 40	20	20.4
Total	98	100

Table 14 depicts teachers' responses in terms of the average class size they teach. Learners' data compares to the responses of teachers regarding the average class size. According to teachers, almost half of the classes they teach (n = 47; 48%) accommodate more than 30 learners (also see Figure 38).

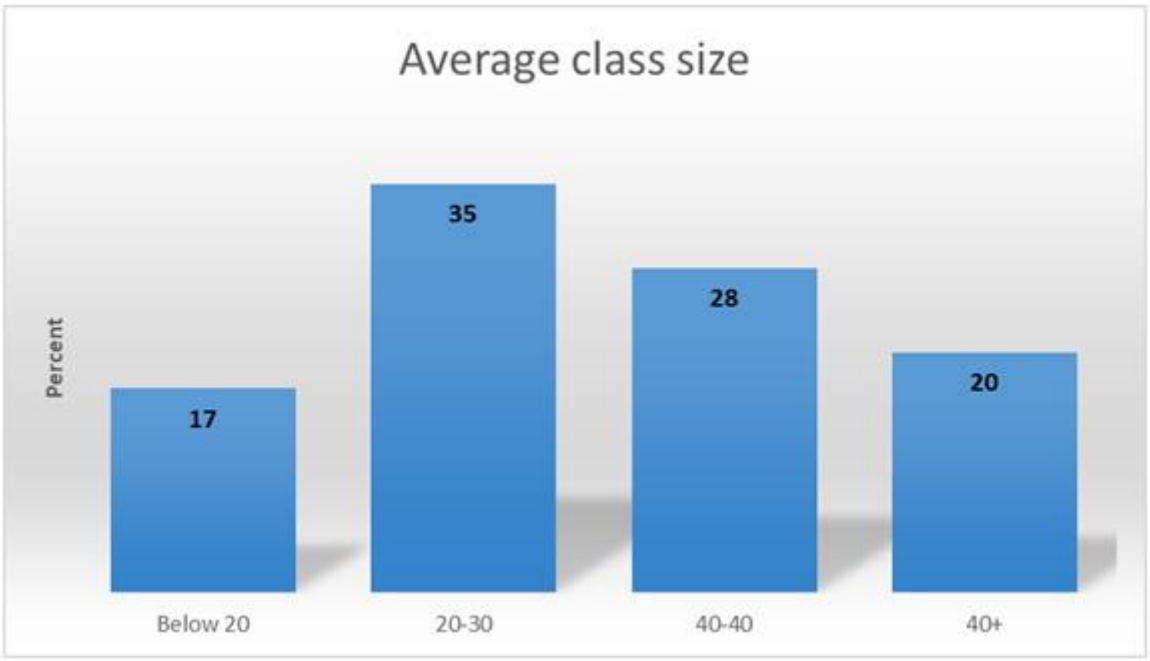

Figure 38: Average class size composition of teachers (N=101)

4.4 VALIDITY AND RELIABILITY MEASURES

Reports of validity and reliability estimates are necessary to determine the adequacy of the psychometric properties of the scales in a questionnaire. The information gathered for this study was done using a Likert-type scale questionnaire. Since it was attempted to quantify constructs which are not directly measurable, multiple-item scales and summated ratings were utilised to quantify the construct(s) of interest. The construct validity of the questionnaire was tested first through Exploratory Factor Analysis (EFA), and confirmed by Confirmatory Factor Analysis (CFA).

4.4.1 Validity measures

Factor analysis is employed when constructs are not directly measurable and simultaneously ensure construct validity of the questionnaire. The constructs measured for this study (IPA, CA, CE, and ME) were extracted by employing factor analysis. There are two types of factor analysis, namely EFA and CFA.

4.4.1.1 Exploratory Factor Analysis (EFA) for learners

As the first step, EFA was conducted on the data pertaining to learners. The sample size was deemed to be adequate (n=650) by referring to the Kaiser-Meier-Olkin (KMO) measure of sampling adequacy.

Table 16: KMO and Bartlett's test for learners

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.966**
Bartlett's Test of Sphericity	
Approx. Chi-Square	26917.058
df	2775
Sig.	0.000

As deduced from Table 16, the correlation between variables is considered significant at $p < 0.05$ (0.001). Furthermore, the KMO measure of sampling adequacy of 0.966 is indicative of a sufficient sample size (KMO > 0.9 --> superb).

Figure 39 displays the scree plot which indicate that four distinct factors loaded above an Eigen value of 1 and was retained as part of the analysis and hypotheses testing. This implies that the four factors extracted by employing the Principal Component and the Direct Oblimin rotation method, explained a total variance of 45.5% in the constructs or dependent variables.

The pattern matrix (Appendix M) indicated the regression weight loading for each question (75 questions in total). The questions that loaded above a regression weight of 0.3 were retained. Out of the total of 75 questions, 9 questions loaded below 0.3 and were discarded. The EFA indicated that 12 questions loaded significantly for the dependent variable CE, 14 questions in total loaded significantly on CA, 25 questions loaded significantly on ME, and 15 questions loaded significantly on IPA. These results were also confirmed by the CFA analysis.

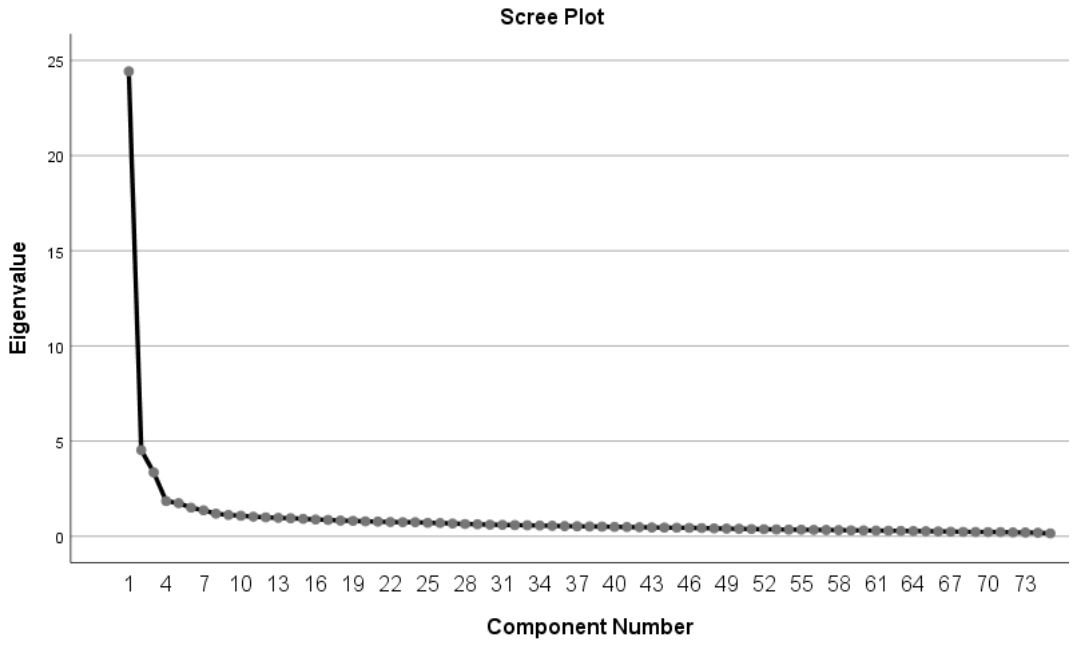

Figure 39: Scree plot of Eigen values for learners

4.4.1.2 Exploratory Factor Analysis (EFA) for teachers

EFA was conducted on the data pertaining to teachers. The sample size was deemed to be adequate (n=101) by referring to the Kaiser-Meier-Olkin (KMO) measure of sampling adequacy.

Table 17: KMO and Bartlett's test for teachers

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.852**
Bartlett's Test of Sphericity	
Approx. Chi-Square	9172.673
df	3081
Sig.	0.000

As deduced from Table 17, the correlation between variables is considered significant at $p < 0.05$ (0.001). Furthermore, the KMO measure of sampling adequacy of 0.852 is indicative of a sufficient sample size (KMO = 0.8 - 0.9 --> very good).

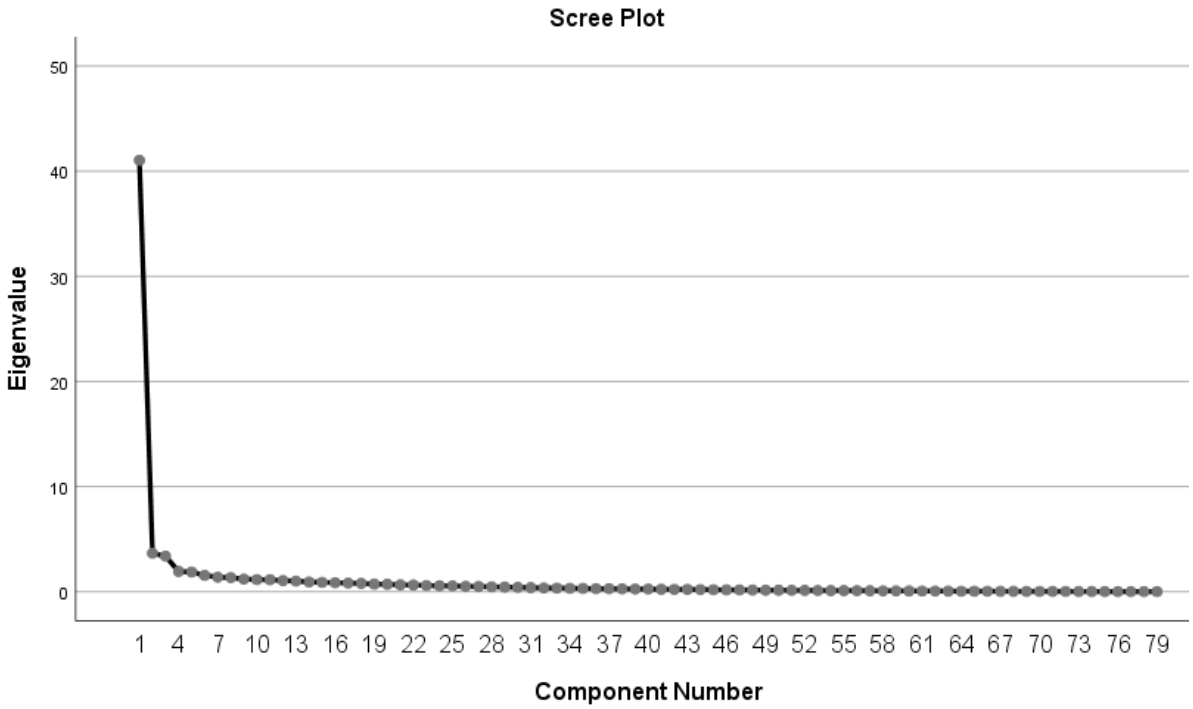

Figure 40: Scree plot of Eigen values for teachers

Figure 40 displays the scree plot which indicate that three distinct factors loaded above an Eigen value of 1 and was retained as part of the analysis and hypotheses testing. This implies that the three factors extracted by employing the Principal Component and the Direct Oblimin rotation method, explained a total variance of 60.9% in the constructs or dependent variables.

The pattern matrix (Appendix N) indicated the regression weight loading for each question (79 questions in total). The questions that loaded above a regression weight of 0.3 were retained. Out of the total of 75 questions, 6 questions loaded below 0.3 and were discarded. The EFA indicated that 51 questions loaded significantly for the dependent variable IPA, 15 questions in total loaded significantly on E, and 7 questions loaded significantly on CA. These actual loadings differed significantly from the theorised model for teachers. The questions that were originally anticipated for ME and CE loaded significantly on IPA. The original questions for the dependent variable CA loaded slightly different in two distinct groups. The researcher grouped these two factors CA and E according to the nature of the questions. These results were also confirmed by the CFA analysis.

4.4.1.3 Confirmatory Factor Analysis (CFA)

Assessment of model validity - Goodness of fit indices

The goodness of fit indices informs the researcher whether the fit of this model is sufficiently good to yield reliable results. The model chi-square is the most commonly used measure of absolute model fit. The chi-square test will produce a significance value p. If the p-value is greater than 0.05, it suggests that the model can be accepted as statistically significant (i.e. it indicates no major deviations between the data and the model). However, it is well known amongst statisticians that model p-values are not always the best way to decide if a model is adequate (in an absolute sense) or the best model (in a relative sense). What is generally agreed upon is that the chi-square automatically increases with increasing sample size and the p-values reflects increasing power for detecting deviations. However, the chi-square test is viewed by some as an overly strict indicator of model fit, given its power to detect even trivial deviations from the proposed model (Hancock & Mueller, 2010). Mueller (1996) suggested that the chi-square test statistic be divided by degrees of freedom. Degrees of freedom provide the amount of mathematical information available to estimate model parameters. In the case of SEM, this is given by the number of unique variances and covariances minus number of parameters $df = ½ (p (p + 1)) – k$, where p = number of variables, and k = number of parameters.

The model for learners' data yielded a Minimum Sample Discrepancy divided by Degrees of Freedom (CMIN/DF) value of 5.072. The model for teachers' data yielded a Minimum Sample Discrepancy divided by Degrees of Freedom (CMIN/DF) value of 1.970. The interpretation of the size of this value depends to a large extent on the viewpoint of the researcher, but in practice some interpret ratios as high as 3, 4 or even 5 as still representing a good model fit (Mueller, 1996). It is however considered good practice to report multiple fit indices, typically from three broad classes (Hancock & Mueller, 2010).

Mueller (1996) described values of above 0.9 as indicative of a good overall fit for a Comparative Fit Index. A relatively acceptable Comparative Fit Index (CFI) of 0.848 was found for the model from data obtained from learners, while a Root Mean Square Error of Approximation (RMSEA) value of 0.079 (indicative of an acceptable fit < .10) with a 90% confidence interval [0.076; 0.083] was obtained. A relatively acceptable Comparative Fit Index (CFI) of 0.704 was found for the model from data obtained from teachers, while a Root Mean Square Error of Approximation (RMSEA) value of 0.099 with a 90% confidence interval of [0.095; 0.102] was

obtained. Blunch (2008) states that models with RMSEA values of 0.10 and larger should not be accepted. The CFA tables can be found in Appendix O (learner data) and Appendix P (teacher data).

4.4.2 Reliability

Cronbach's alpha which measures the internal consistency reliability of the research instrument for this study, was used as the reliability coefficient for the Likert-type scales. A Cronbach alpha coefficient was calculated on each of the constructs to confirm their reliability in the local context. A Cronbach's alpha reliability coefficient usually ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of the items in the scale. Based on the formula _ = *rk / [1 + (k -1) r]*, where *k* is the number of items considered and *r* is the mean of the inter-item correlations, the size of alpha is determined by both the number of items in the scale and the means of the inter-item correlations. George and Mallery (2003) provide the following rule of thumb: _ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable.

The inter-rater reliability of the questionnaire was tested through the ICC. ICC can be stated as the proportion of variance between groups variance to the total variance explained by the IVs (Heck, Thomas, & Tabata, 2014), and measures the reliability of ratings or measurements for clusters, i.e. data that has been collected as groups or sorted into groups. Like most correlation coefficients, the ICC ranges from 0 to 1. ICCs with values around 0.5 or higher are often taken as an indication of substantial clustering of observations within level two units (e.g. schools or classrooms).

As shown in Table 18, the Cronbach alpha for the DVs reported all above 0.8 and 0.9, which indicates a good to excellent level of internal consistency. The ICC and inter-rater reliability for the DVs reported all above 0.5 which indicates good reliability.

Table 18: Cronbach alpha and ICC reliability coefficients for the dependent variables

Dependent variables	Cronbach alpha coefficient	ICC coefficient	Number of items tested
For Learner data:			
Cognitive Engagement (CE)	0.820	0.607	11
Conscious Awareness (CA)	0.897	0.692	14
Metacognitive engagement (ME)	0.940	0.596	25
Information Processing Ability (IPA)	0.939	0.510	15
For Teacher data:			
Engagement (E)	0.936	0.658	14
Conscious Awareness (CA)	0.949	0.665	7
Information Processing Ability (IPA)	0.937	0.657	51

4.5 RESEARCH QUESTIONS AND HYPOTHESES

The main research question that guided the study refers to the simultaneous impact of juxtaposed learning theories in the classroom on learner information processing ability towards learner cognitive growth and development. Section 3.8.1 provides an outline of the subsidiary research questions that have been formulated.

In an attempt to answer these research questions, two distinct hypotheses groups were formulated with reference to HLM type hypotheses and SEM type hypotheses for teachers and learners. These hypotheses differ from the original formulated hypotheses (prior to the analysis phase) due to the EFA and CFA tests done to ensure construct validity as reported in Section 4.4 The original hypotheses for teachers and learners included all four DVs as distinct measures, whereas the revised hypotheses for teachers included only three variables with an adjustment to the compilation of these constructs as determined by the EFA and confirmed by CFA. The DVs of teachers were almost the same as those of learners in so far as the teachers' questionnaire items, though different in structure, were designed to convey an endemic response (directly or indirectly) to that of learners. Such structuring of similar but different questions heightened a matrix of related or diametrically opposed responses.

For the ease of reporting, the HLM research hypotheses formulated will be reported as Section A (learners) and Section B (teachers). These hypotheses are displayed in Tables 19 and 20. The two SEM research hypotheses formulated will be reported as Section C (learners) and Section D (teachers).

There were 24 HLM hypotheses stated relating to learners, and 15 HLM hypotheses stated pertaining to teachers; 39 HLM hypotheses in total of which 18 were found to be statistically significant. Based on the reported learner performance variables, as presented in the literature (Chapter 2), the hypotheses were formulated with the DVs and IVs variables as discussed in section 4.3.

SEM Hypothesis C1: Learners

There is no significant statistical relationship between ***IPA, CA, CE,*** and ***ME***.

SEM Hypothesis D1: Teachers

There is no significant statistical relationship between ***IPA, CA,*** and ***E***.

Table 19: HLM hypotheses for learners (24 in total)

MAIN HYPOTHESES	SUB-HYPOTHESES
HLM HYPOTHESES LEARNERS	
Hypothesis A1: Age **There is no significant statistical difference between *age* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis A1.1*** There is no significant statistical difference between ***age*** and IPA ***Hypothesis A1.2*** There is no significant statistical difference between ***age*** and CA ***Hypothesis A1.3*** There is no significant statistical difference between ***age*** and CE ***Hypothesis A1.4*** There is no significant statistical difference between ***age*** and ME
Hypothesis A2: Home Language **There is no significant statistical difference between *home language* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis A2.1*** There is no significant statistical difference between ***home language*** and IPA ***Hypothesis A2.2*** There is no significant statistical difference between ***home language*** and CA ***Hypothesis A2.3*** There is no significant statistical difference between ***home language*** and CE ***Hypothesis A2.4*** There is no significant statistical difference between ***home language*** and ME
Hypothesis A3: Language of Learning and Teaching (LOLT)	***Hypothesis A3.1*** There is no significant statistical difference between ***LOLT*** and IPA

There is no significant statistical difference between *LOLT* and *learner performance* (IPA, CA, CE and ME).	***Hypothesis A3.2*** There is no significant statistical difference between ***LOLT*** and CA ***Hypothesis A3.3*** There is no significant statistical difference between ***LOLT*** and CE ***Hypothesis A3.4*** There is no significant statistical difference between ***LOLT*** and ME
Hypothesis A4: Grades repeated **There is no significant statistical difference between *grades repeated* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis A4.1*** There is no significant statistical difference between ***grades repeated*** and IPA ***Hypothesis A4.2*** There is no significant statistical difference between ***grades repeated*** and CA ***Hypothesis A4.3*** There is no significant statistical difference between ***grades repeated*** and CE ***Hypothesis A4.4*** There is no significant statistical difference between ***grades repeated*** and ME
Hypothesis A5: Average obtained **There is no significant statistical difference between *average obtained* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis A5.1*** There is no significant statistical difference between ***average obtained*** and IPA ***Hypothesis A5.2*** There is no significant statistical difference between ***average obtained*** and CA ***Hypothesis A5.3*** There is no significant statistical difference between ***average obtained*** and CE ***Hypothesis A5.4***

	There is no significant statistical difference between ***average obtained*** and ME
Hypothesis A6: Average Class size **There is no significant statistical difference between learners' *average class size* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis A6.1*** There is no significant statistical difference between ***average class size*** and IPA ***Hypothesis A6.2*** There is no significant statistical difference between ***average class size*** and CA ***Hypothesis A6.3*** There is no significant statistical difference between ***average class size*** and CE ***Hypothesis A6.4*** There is no significant statistical difference between ***average class size*** and ME

Table 20: HLM hypotheses for teachers (15 in total)

MAIN HYPOTHESES	SUB-HYPOTHESES
HLM HYPOTHESES TEACHERS	
Hypothesis B1: Age **There is no significant statistical difference between *age* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis B1.1*** There is no significant statistical difference between ***age*** and IPA ***Hypothesis B1.2*** There is no significant statistical difference between ***age*** and CA ***Hypothesis B1.3*** There is no significant statistical difference between ***age*** and E
Hypothesis B2: Highest qualification **There is no significant statistical difference between *highest qualification* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis B2.1*** There is no significant statistical difference between ***highest qualification*** and IPA ***Hypothesis B2.2*** There is no significant statistical difference between ***highest qualification*** and CA ***Hypothesis B2.3*** There is no significant statistical difference between ***highest qualification*** and E
Hypothesis B3: Experience **There is no significant statistical difference between *experience* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis B3.1*** There is no significant statistical difference between ***experience*** and IPA ***Hypothesis B3.2*** There is no significant statistical difference between ***experience*** and CA ***Hypothesis B3.3*** There is no significant statistical difference between ***experience*** and E

Hypothesis B4: Post level **There is no significant statistical difference between *post level* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis B4.1*** There is no significant statistical difference between ***post level*** and IPA ***Hypothesis B4.2*** There is no significant statistical difference between ***post level*** and CA ***Hypothesis B4.3*** There is no significant statistical difference between ***post level*** and E
Hypothesis B5: Average class size **There is no significant statistical difference between *average class size* and *learner performance* (IPA, CA, CE and ME).**	***Hypothesis B5.1*** There is no significant statistical difference between ***average class size*** and IPA ***Hypothesis B5.2*** There is no significant statistical difference between ***average class size*** and CA ***Hypothesis B5.3*** There is no significant statistical difference between ***average class size*** and E

The results and a discussion of the results in order to answer the above-mentioned questions and to report on the tested hypotheses, are subsequently discussed in the forthcoming sections. The results are based on the data that were collected using a quantitative questionnaire. The next section discusses the statistical analysis and inferential statistics employed during this study.

4.6 STATISTICAL ANALYSIS

4.6.1 Introduction

This section explains the manner in which the statistical analysis was done. The EFA and CFA tests for construct validity were employed, followed by a Cronbach alpha test to ensure reliability of the measuring instrument. Statistical assumption tests of normality and homoscedasticity were done to ensure that all the underlying assumptions were met prior to data analysis. The section is concluded with the inferential statistics in testing the HLM and SEM hypotheses.

4.6.2 Assumptions for statistical analysis

Garson (2013) asserts that all statistical procedures have underlying assumptions. An expected component of quantitative studies is to establish that the data of the study meet these assumptions of the procedure. Similarly, O'Neil (2009) outlines the importance of meeting the conditions of a particular statistical procedure before data analysis is done. Parametric tests are significant tests which assume: (1) a certain distribution of the data (usually a normal distribution), (2) the interval level of measurement, and (3) the homogeneity of variances when two or more samples are compared. Most common significance tests are parametric (Garson, 2013). However, it has long been established that moderate violations of parametric assumptions have little or no effect on substantive conclusions in most instances (Cohen in Garson, 2013). In this study, the said tests were all conducted before analysing the data to ensure that these conditions were met.

4.6.2.1 Normality

According to O'Neil (2009), it is assumed that the data gathered for statistical analysis is from a normally distributed population. As inferential statistics is done to verify that some or all of the results are applicable to the entire population, it is paramount that the population's distribution should also be normal. One instance which guarantees normality is when the distribution of the individual observations from the sample is normal. However, even if the distribution of the individual observations is not normal, the distribution of the *sample means* will be normal if the

sample size is around 30 or larger. This is due to the 'central limit theorem' which posits that even when a population is non-normally distributed, the distribution of the *sample means* will be normal when the sample size is 30 or more. Since the sample size of this study was larger than 30 (N=650 for learners; N=101 for teachers), the principle of normality of distribution was adapted. The analysis for normality is done through histograms indicating the normal distribution curve, to check for normality of the data distribution (O'Neil, 2009) on each dependent variable.

Figure 41 to figure 47 indicate the normality for the dependent variables for learners (IPA, CA, CE and ME) and for teachers (IPA, CA and E).

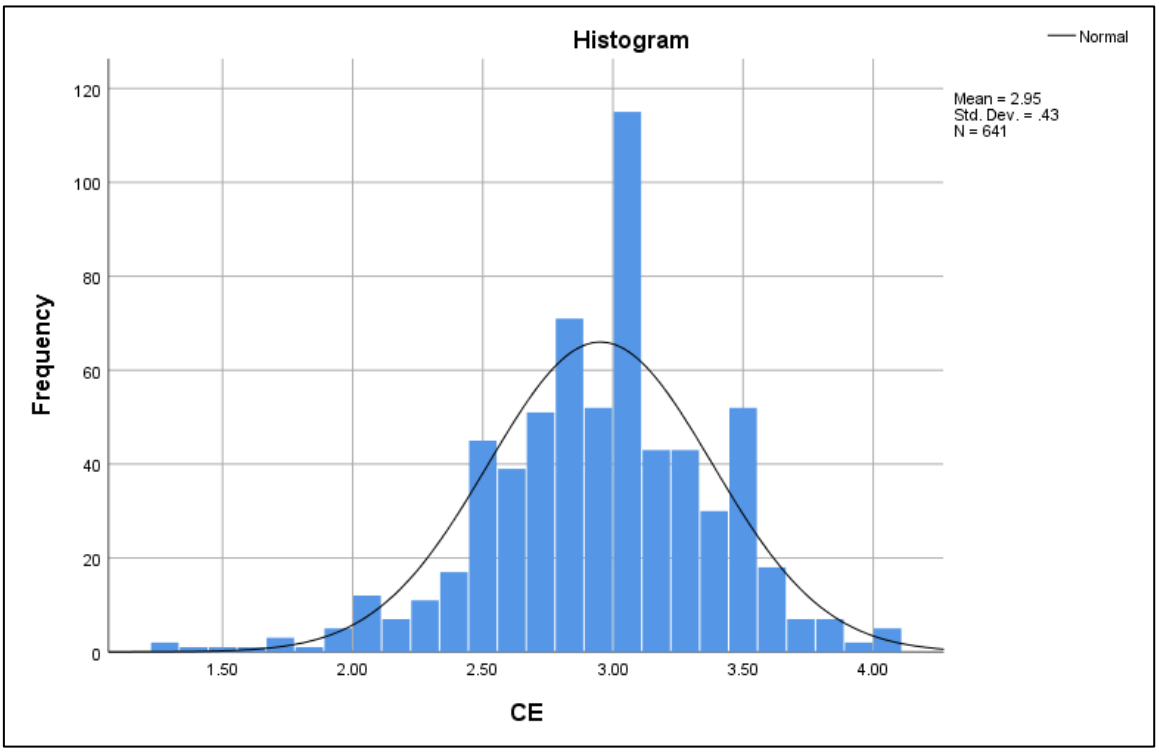

Figure 41: Test of normality for CE Learners

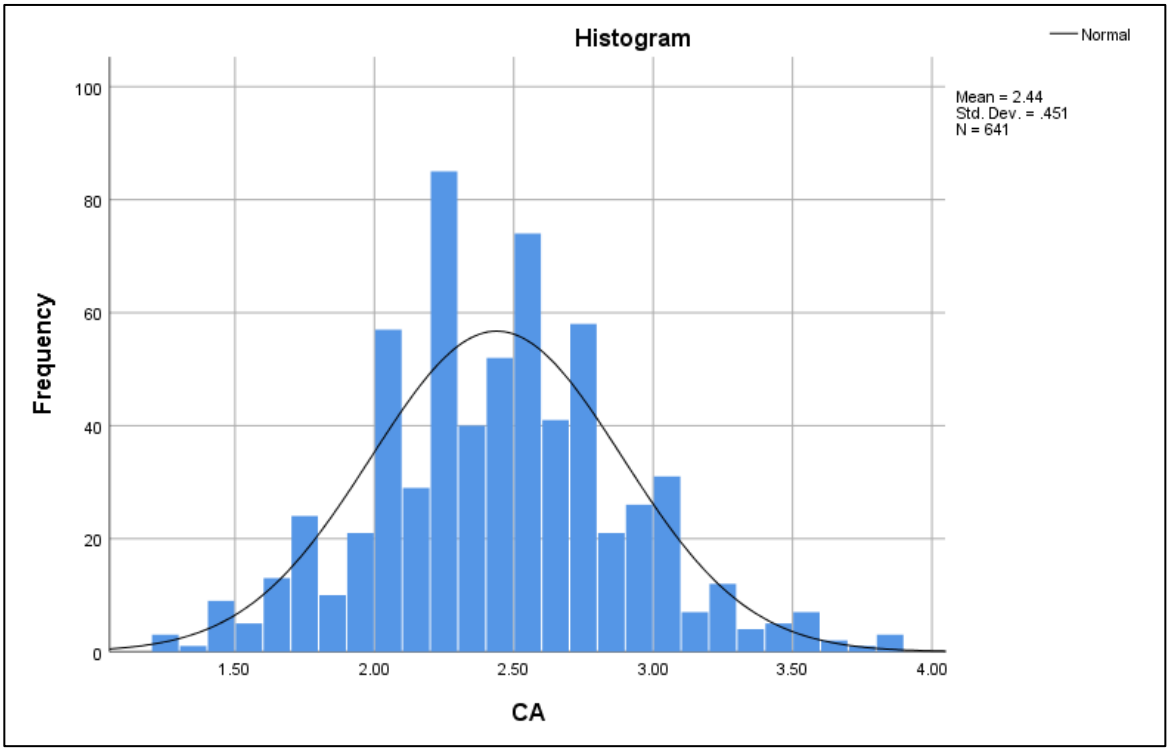

Figure 42: Test of normality for CA Learners

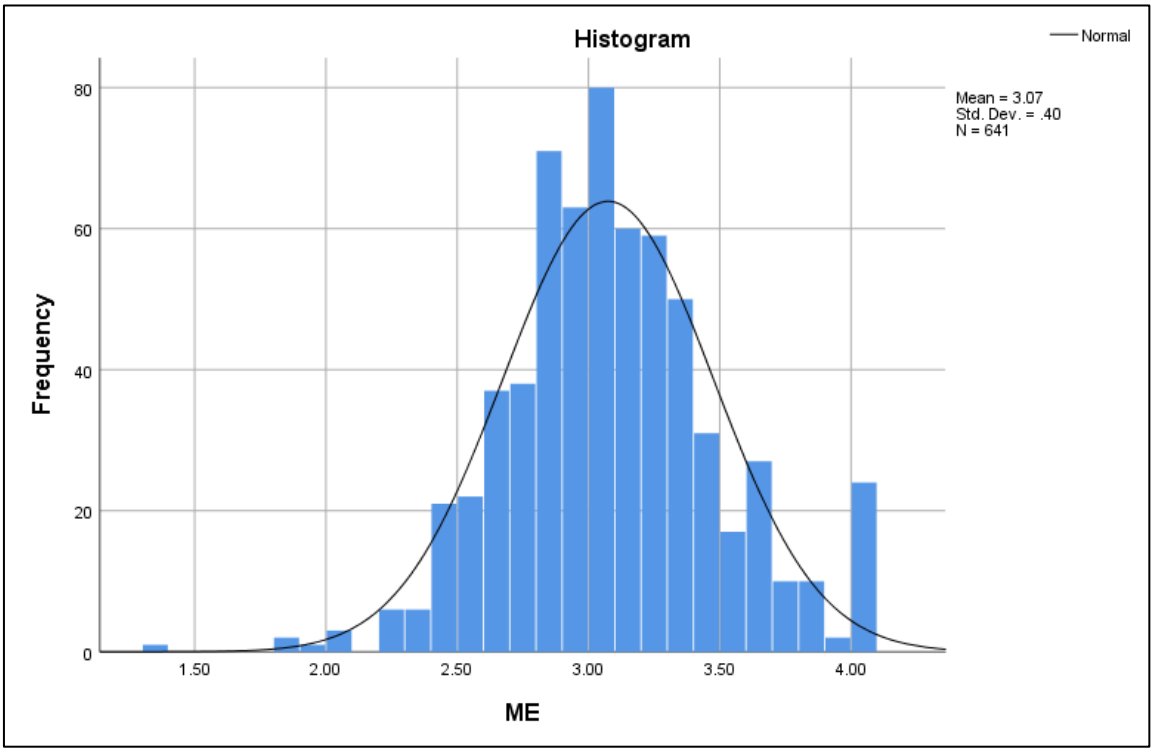

Figure 43: Test of normality for ME Learners

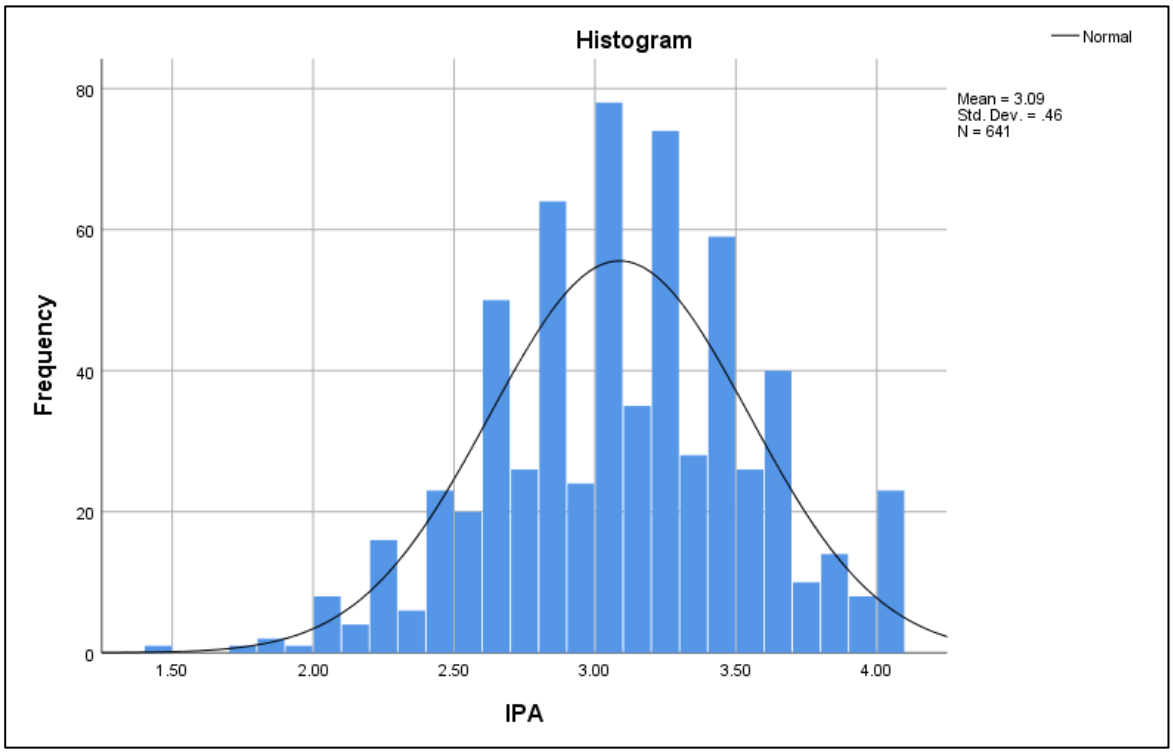

Figure 44: Test of normality for IPA Learners

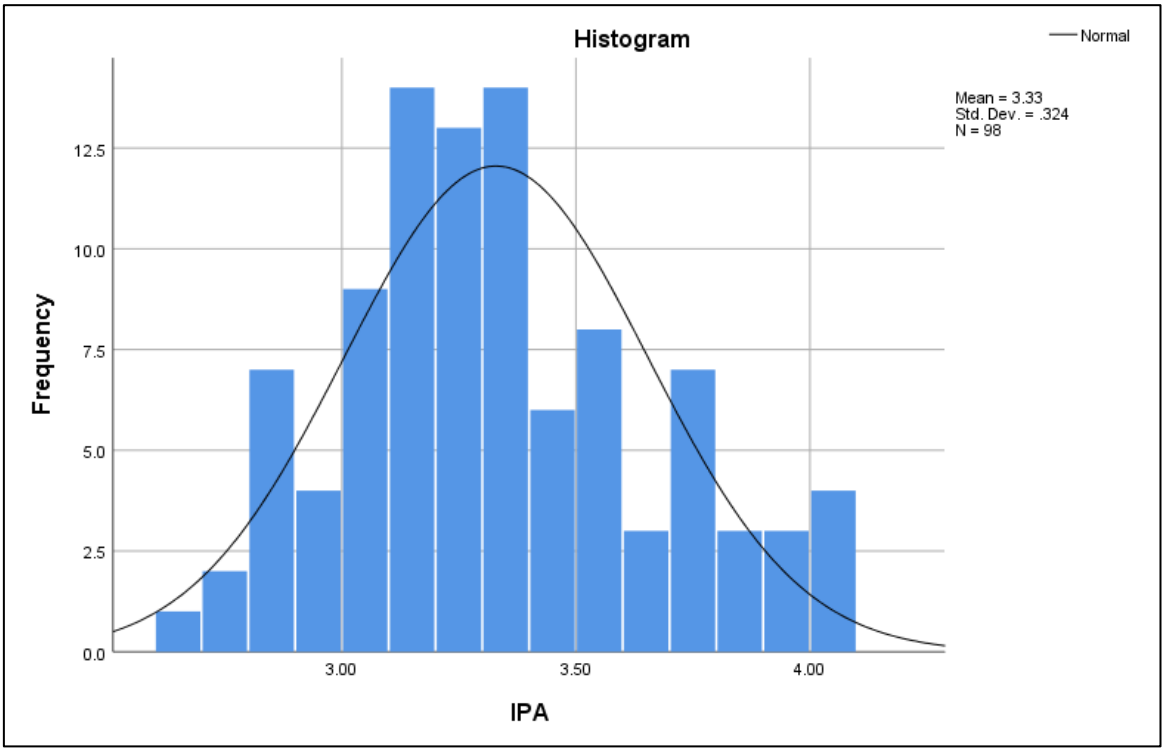

Figure 45: Test of normality for IPA Teachers

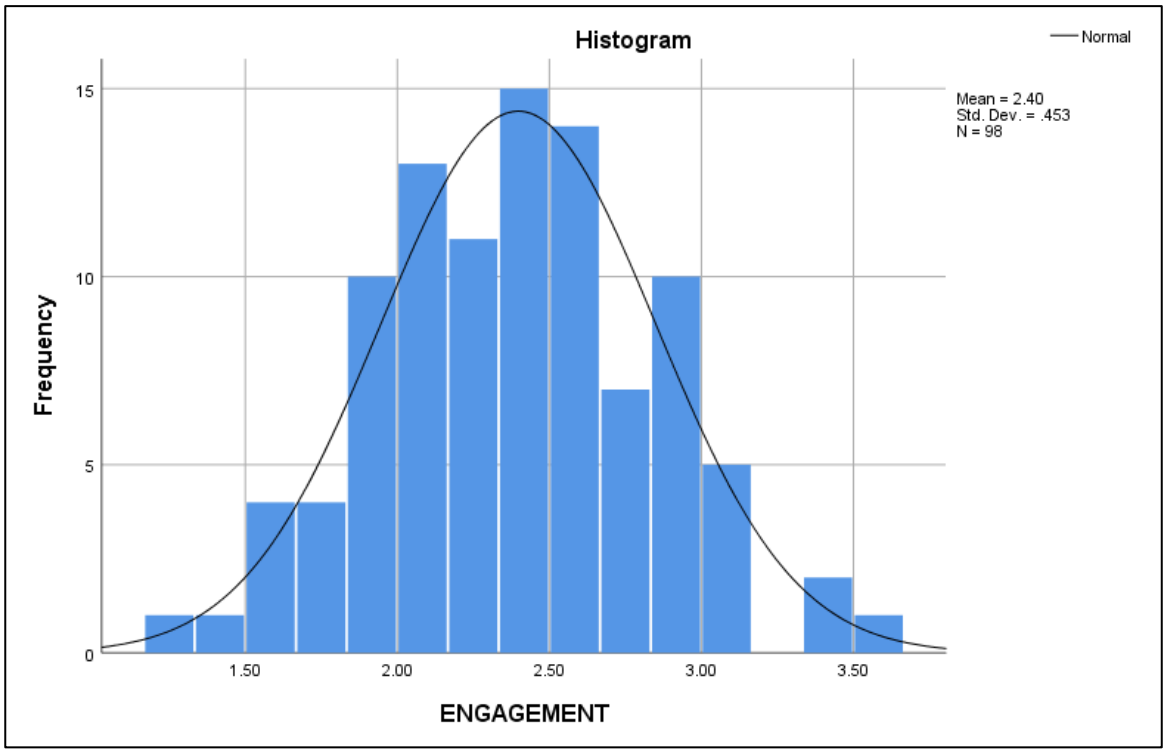

Figure 46: Test of normality for ENGAGEMENT Teachers

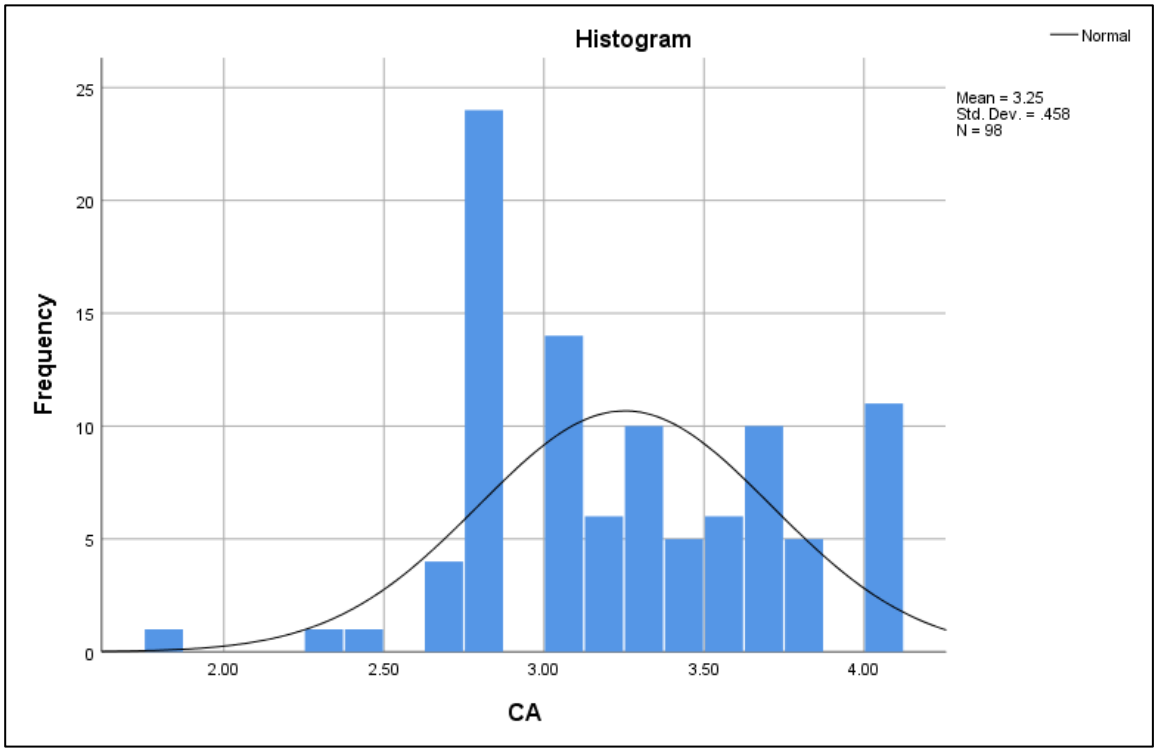

Figure 47: Test of normality for CA Teachers

4.6.2.2 Homoscedasticity

In statistics, the Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption. It tests the null hypothesis that the population variances are equal (called homogeneity of variance or homoscedasticity). If the resulting p-value of Levene's test is less than some significance level (typically 0.05), the obtained differences in sample variances are unlikely to have occurred based on random sampling from a population with equal variances. Thus, the null hypothesis of equal variances is rejected, and it is concluded that there is a difference between the variances in the population.

Homogeneity of variances (homoscedasticity) thus assumes that the dependent variables exhibit equal levels of variance across the range of predictor variables. Conversely, heteroscedasticity refers to a scenario where the variability of a variable is unequal across the range of values of a second variable that predicts it (Taylor, 2013). Table 21 indicates the descriptive statistics and tests conducted for homoscedasticity.

Table 21: Levene's test of homogeneity of variances for the dependent variables

Dependent variables	**Levene Statistic**	***df 1***	***df 2***	**Sig.**
For Learner data:				
Cognitive Engagement (CE)	.639	4	639	.635
Conscious Awareness (CA)	2.239	4	639	.063
Metacognitive engagement (ME	.606	4	639	.659
Information Processing Ability (IPA)	1.829	4	639	.122
For Teacher data:				
Cognitive Engagement (CE)	.824	4	94	.513
Conscious Awareness (CA)	.644	4	94	.633
Information Processing Ability (IPA)	1.433	4	94	.229

A Levene's test was conducted for each dependent variable. All the dependent variables were found to be *not statistically significant* (equal variances are assumed), since the p-value was in

each case > (greater than) 0.05. Based on the above homogeneity of variances for each of the variables, the researcher accepted this statistical assumption met.

4.7 INFERENTIAL STATISTICS

4.7.1 Hierarchical Linear Modelling (HLM)

The researcher employed HLM to test the relative influence of the independent variables on the dependent variables. HLM was employed because of its advanced computational capability to handle the nested nature of the data with learners nested in schools. These ANOVA-type HLMs were performed using CA, CE, ME and IPA as dependent variables (for learners), and CA, E and IPA for teachers, to assess whether the scores predict unique variance following the hierarchical nature of the data. Each analysis took the same form, with school (independent variable) entered as subject (school) and biographical variables as factors. A *post hoc* test was conducted in each instance to detect where the difference is located (i.e. in and between which independent variables (groups), as well as the ES to indicate the magnitude of the statistical difference for practical or educational purposes. The results of these analyses are presented in Table 22 and Table 23.

Table 22: HLM hypotheses for learners

Dependent Variable	Independent Variable		Mean	St Dev	MSE	School variance estimate	*df*	F	Sig value p	*Post hoc* test/ ES	
										Groups	Cohen's d
IPA	Age	15	3.454	0.196	0.520	0.056	634.689	2.681	0.031	17/19	0.378
		16	3.127	0.082							
		17	3.132	0.072							
		18	3.173	0.084							
		19+	3.419	0.105							
	Home Language	Sesotho	3.267	0.071	0.517	0.049	540.867	5.098	0.001	Sesotho/Afrikaans	0.354
		IsiXhosa	3.268	0.139						IsiZulu/Afrikaans	0.590
		IsiZulu	3.444	0.120						English/Afrikaans	0.601
		English	3.458	0.146							
		Afrikaans	3.000	0.075							
	LOLT	English	3.308	0.067	0.514	0.052	234.128	17.177	0.000	English/Afrikaans	0.440
		Afrikaans	2.977	0.078							
	Average class size	Below 20	2.625	0.190	0.516	0.101	321.637	4.028	0.008	Below 20/20-30	0.800
		20–30	3.236	0.091						Below 20/30-40	0.720

		30–40 40+	3.189 3.334	0.088 0.117						Below 20/40+	0.902
CA	Home Language	Sesotho IsiXhosa IsiZulu English Afrikaans	2.527 2.275 2.910 2.727 2.544	0.069 0.139 0.119 0.145 0.073	0.526	0.043	520.038	4.319	0.002	Sesotho/IsiZulu IsiXhosa/isiZulu IsiZulu/Afrikaans	0.508 0.842 0.486
	Grades repeated	Grade 8 Grade 9 Grade 10 Other Never	2.199 2.478 2.712 2.551 2.549	0.177 0.101 0.092 0.109 0.064	0.531	0.046	605.791	2.401	0.049	Grade 8/Grade 10	0.676
	Average class size	Below 20 20–30 30–40 40+	1.946 2.708 2.521 2.629	0.187 0.089 0.086 0.115	0.509	0.095	314.733	6.609	0.001	Below 20/20-30 Below 20/30-40 Below 20/40+	0.980 0.739 0.879
CE	Home Language	Sesotho IsiXhosa IsiZulu English Afrikaans	3.095 3.166 3.068 3.135 2.896	0.050 0.097 0.083 0.101 0.053	0.247	0.025	537.629	3.866	0.004	Sesotho/Afrikaans	0.381

	LOLT	English Afrikaans	3.103 2.881	0.046 0.053	0.246	0.025	218.358	16.088	0.001	English/Afrikaans	0.425
	Grades repeated	Grade 8 Grade 9 Grade 10 Other Never	2.818 2.976 3.202 3.084 2.983	0.123 0.073 0.068 0.078 0.050	0.247	0.033	616.711	4.419	0.002	Grade 8/Grade 10 Grade 9/Grade 10 Grade 10/Never	0.726 0.426 0.413
	Average obtained	0-29% 30%-49% 50%-69% 70%-79% 80%+	2.338 2.872 3.022 3.057 3.060	0.262 0.071 0.050 0.063 0.098	0.195	0.038	610.521	3.598	0.007	0-29% / 70%-79%	1.492
ME	Home Language	Sesotho IsiXhosa IsiZulu English Afrikaans	3.172 3.244 3.397 3.399 3.018	0.060 0.112 0.097 0.116 0.063	0.317	0.040	570.166	5.460	0.001	isiZulu/Afrikaans English/Afrikaans	0.634 0.638
	LOLT	English Afrikaans	3.210 3.030	0.056 0.064	0.321	0.039	279.215	7.839	0.005	English/Afrikaans	0.300
	Grades repeated	Grade 8 Grade 9	2.944 3.083	0.136 0.082	0.296	0.045	619.132	3.299	0.011	Grade 10/Never	0.357

		Grade 10 Other Never	3.308 3.167 3.100	0.076 0.087 0.057							
	Average obtained	0-29% 30%-49% 50%-69% 70%-79% 80%+	2.454 2.958 3.127 3.270 3.152	0.305 0.081 0.056 0.072 0.113	0.265	0.047	611.071	4.802	0.001	30% - 49% / 70% -79%	0.558

The HLM test indicated *statistically significant differences* in all of the dependent variables across the specified levels of the independent variables as indicated in Table 22. The respondents indicated their agreement with the items using a four-point Likert-type scale ranging from 1 (strongly disagree) to 4 (strongly agree). For practical and educational significance, the magnitude of effect is tested through Cohen's *d*, the standardised difference between means or ES, also reported on the identified groups during the *post hoc* test. Cohen suggested that $d = 0.2$ be considered a 'small' ES, 0.5 represents a 'medium' ES and 0.8 a 'large' ES. This means that if two groups' means do not differ by 0.2 standard deviations or more, the difference is trivial, even if it is statistically significant.

Reporting the results of the Hierarchical Linear Modelling (HLM) hypotheses for learners

Hypothesis A1.1

There is no significant statistical difference between ***age*** and IPA.

Age was a significant predictor of IPA as obvious from $F(635) = 2.681$, $p < 0.05$ (0.031), $d = 0.378$. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between ages 17 and 19, with a small to medium ES (*d*) of 0.378. The highest level of agreement was reported for the age group 15 (M=3.454, SD=0.196), followed by the 19+ age group (M=3.419, SD=0.105); and the lowest level agreement was reported for the age group 16 (M=3.127, SD=0.082).

Hypothesis A2.1

There is no significant statistical difference between ***home language*** and IPA.

Home language was a significant predictor of IPA as obvious from $F(541) = 5.098$, $p < 0.05$ (0.001), $d = 0.354$; 0.590; 0.601. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the languages Afrikaans and Sesotho ($d = 0.354$), Afrikaans and IsiZulu ($d = 0.590$), and Afrikaans and English ($d = 0.601$). This implies that learners speaking Afrikaans at home compared to learners speaking Sesotho at home differ significantly whereas the effect/strength of the difference reported 0.354 (small to medium effect). The respective effect/strengths of the difference between Afrikaans and IsiZulu is 0.590 (medium effect), and between Afrikaans and English 0.601 (medium to large effect). The highest level of agreement was reported for the home language group English

(M=3.458, SD=0.146), followed by the IsiZulu group (M=3.444, SD=0.120); and the lowest level of agreement was reported for the Afrikaans group (M=3.000, SD=0.075).

Hypothesis A3.1

There is no significant statistical difference between ***LOLT*** and IPA.

LOLT was a significant predictor of IPA as obvious from F (234) = 17.177, p < 0.05 (0.001), *d* = 0.440. ***Therefore, the hypothesis can be rejected.*** The strength of the difference between learners with English as LOLT and Afrikaans as LOLT measured 0.440 which indicate a medium ES (*d*). The highest level of agreement was reported for the English LOLT group (M=3.308, SD=0.067), and the lowest level of agreement was reported for the Afrikaans LOLT group (M=2.977, SD=0.078).

Hypothesis A6.1

There is no significant statistical difference between ***average class size*** and IPA.

Average class size was a significant predictor of IPA as obvious from F (322) = 4.028, p < 0.05 (0.008), *d* = 0.800; 0.720; 0.902. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the below 20 and 20-30 class size (*d* = 0.800), below 20 and 30–40 (*d* = 0.720), and below 20 and 40+ (*d* = 0.902). This implies that learners in classes below 20 learners and learners in classes of between 20–30 differ significantly whereas the effect/strength of the difference reported 0.800 (large effect). The respective effect/strengths of the difference between classes below 20 and classes between 30–40 is 0.720 (large effect), and between classes below 20 and classes of 40+ is 0.902 (very large effect). The highest level of agreement was reported for the 40 + group (M=3.334, SD=0.117), followed by the 20–30 group (M=3.236, SD=0.091); and the lowest level of agreement was reported for the below 20 group (M=2.625, SD=0.190).

Hypothesis A2.2

There is no significant statistical difference between ***home language*** and CA.

Home language was a significant predictor of CA as obvious from F (520) = 4.319, p < 0.05 (0.002), *d* = 0.508; 0.842; 0.486. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the languages Sesotho and IsiZulu (*d* = 0.508), IsiXhosa and IsiZulu (*d* = 0.842), and IsiZulu and Afrikaans (*d* = 0.486). This implies that learners speaking Sesotho at home compared to learners speaking IsiZulu at

home differ significantly whereas the effect/strength of the difference reported 0.508 (medium effect). The respective effect/strengths of the difference between IsiXhosa and IsiZulu is 0.842 (large effect), and between IsiZulu and Afrikaans 0.486 (medium effect). The highest level of agreement was reported for the home language group IsiZulu (M=2.910, SD=0.119), followed by the English group (M=2.727, SD=0.145); and the lowest level of agreement was reported for the IsiXhosa group (M=2.275, SD=0.139).

Hypothesis A4.2

There is no significant statistical difference between ***grades repeated*** and CA.

Grades repeated was a significant predictor of CA as obvious from $F(606) = 2.401$, $p < 0.05$ (0.049), $d = 0.676$. ***Therefore, the hypothesis can be rejected***. As identified during the *post hoc* test and testing the ES, the difference is evident between Grade 8 and Grade 10, with a medium to large ES (*d*) of 0.676. The highest level of agreement was reported for the Grade 10 group (M=2.712, SD=0.092), followed by the other group (M=2.551, SD=0.109); and the lowest level of agreement was reported for the Grade 8 group (M=2.199, SD=0.177).

Hypothesis A6.2

There is no significant statistical difference between ***average class size*** and CA.

Average class size was a significant predictor of CA as obvious from $F(315) = 6.609$, $p < 0.05$ (0.001), $d = 0.980; 0.739; 0.879$. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the below 20 and 20-30 class size ($d = 0.980$), below 20 and 30–40 ($d = 0.739$), and below 20 and 40+ ($d = 0.879$). This implies that learners in classes below 20 learners and learners in classes of between 20 - 30 differ significantly whereas the effect/strength of the difference reported 0.980 (very large effect). The respective effect/strengths of the difference between classes below 20 and classes between 30–40 is 0.739 (large effect), and between classes below 20 and classes of 40+ is 0.879 (large effect). The highest level of agreement was reported for the 20–30 group (M=2.708, SD=0.117), followed by the 30–40 group (M=2.521, SD=0.086); and lowest level of agreement was reported for the below 20 group (M=1.946, SD=0.187).

Hypothesis A2.3

There is no significant statistical difference between ***home language*** and CE.

Home language was a significant predictor of CE as obvious from F (538) = 3.866, p < 0.05 (0.004), *d* = 0.381. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the languages Sesotho and Afrikaans (*d* = 0.381). This implies that learners speaking Sesotho at home compared to learners speaking Afrikaans at home differ significantly whereas the effect/strength of the difference reported 0.381 (small to medium effect). The highest level of agreement was reported for the home language group IsiXhosa (M=3.166, SD=0.097), followed by the English group (M=3.135, SD=0.101); and the lowest level of agreement was reported for the Afrikaans group (M=2.896, SD=0.053).

Hypothesis A3.3

There is no significant statistical difference between ***LOLT*** and CE.

LOLT was a significant predictor of CE as obvious from F (218) = 16.088, p < 0.05 (0.001), *d* = 0.425. ***Therefore, the hypothesis can be rejected.*** *T*he strength of the difference between learners with English as LOLT and Afrikaans as LOLT is 42.5% which indicates a medium ES (*d*) of 0.425. The highest level of agreement was reported for the English LOLT group (M=3.103, SD=0.046), and the lowest level of agreement was reported for the Afrikaans LOLT group (M=2.881, SD=0.053).

Hypothesis A4.3

There is no significant statistical difference between ***grades repeated*** and CE.

Grades repeated was a significant predictor of CE as obvious from F (617) = 4.419, p < 0.05 (0.002), *d* = 0.726; 0.426; 0.413. ***Therefore, the hypothesis can be rejected***. As identified during the *post hoc* test and testing the ES, the difference is evident between the learners who repeated Grade 8 and the learners who repeated Grade 10 (*d* = 0.726), between Grade 9 and Grade 10 (*d* = 0.426), and between Grade 10 and never repeated a grade (*d* = 0.413). This implies that learners who repeated Grade 8 and learners who repeated Grade 10 differ significantly whereas the effect/strength of the difference reported 0.726 (large effect). The respective effect/strengths of the difference between learners that repeated Grade 9 and learners who repeated Grade 10 is 0.426 (medium effect), and between learners who repeated Grade 10 and learners who never repeated a grade is 0.413 (medium effect). The highest level of agreement was reported for the Grade 10 group (M=3.202, SD=0.068), followed by the other group (M=3.084, SD=0.078); and the lowest level of agreement was reported for the Grade 9 group (M=2.976, SD=0.073).

Hypothesis A5.3

There is no significant statistical difference between ***average obtained*** and CE.

Average obtained was a significant predictor of CE as obvious from F (611) = 3.598, p < 0.05 (0.007), *d* = 1.492. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test, the difference is evident between learners who obtained between 0%–29% average in Grade 10, and learners who obtained between 70%–79% average in Grade 10 have a very large ES (*d*) of 1.492. The highest level of agreement was reported for the average obtained 80%+ group (M=3.060, SD=0.098), followed by the 70%–79% group (M=3.057, SD=0.063); and most disagreement was reported for the 0%–29% group (M=2.338, SD=0.262).

Hypothesis A2.4

There is no significant statistical difference between ***home language*** and ME.

Home language was a significant predictor of ME as obvious from F (570) = 5.460, p < 0.05 (0.001), *d* = 0.634; 0.638. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between the languages IsiZulu and Afrikaans (*d* = 0.634), and between home language English and Afrikaans (*d* = 0.638). This implies that learners speaking IsiZulu at home compared to learners speaking Afrikaans at home differ significantly whereas the effect/strength of the difference reported 0.634 (medium to large effect). Similarly, learners who speak English at home compared to learners who speak Afrikaans at home differ significantly as well whereas the effect/strength is measured at 0.638. The highest level of agreement was reported for the home language group English (M=3.399, SD=0.116), followed by the IsiZulu group (M=3.397, SD=0.097); and the lowest level of agreement was reported for the Afrikaans group (M=3.018, SD=0.063).

Hypothesis A3.4

There is no significant statistical difference between ***LOLT*** and ME.

LOLT was a significant predictor of ME as obvious from F (279) = 7.839, p < 0.05 (0.005), *d* = 0.300. ***Therefore, the hypothesis can be rejected.*** *T*he strength of the difference between learners with English as LOLT and Afrikaans as LOLT is 0.300 which indicates a medium ES (*d*). The highest level of agreement was reported for the English LOLT group (M=3.210, SD=0.056), and the lowest agreement was reported for the Afrikaans LOLT group (M=3.030, SD=0.064).

Hypothesis A4.4

There is no significant statistical difference between ***grades repeated*** and ME.

Grades repeated was a significant predictor of ME as obvious from F (619) = 3.299, p < 0.05 (0.011), *d* = 0.357. ***Therefore, the hypothesis can be rejected***. As identified during the *post hoc* test and testing the ES, the difference is evident between the learners that repeated grade 10 and the learners that never repeated a grade (*d* = 0.357) with a small to medium ES of 0.357. The highest level of agreement was reported for the Grade 10 group (M=3.308, SD=0.076), followed by the other group (M=3.167, SD=0.087); and the lowest level of agreement was reported for the Grade 8 group (M=2.944, SD=0.136).

Hypothesis A5.4

There is no significant statistical difference between ***average obtained*** and ME.

Average obtained was a significant predictor of ME as obvious from F (611) = 4.802, p < 0.05 (0.001), *d* = 0.558. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test, the difference is evident between learners who obtained between 30% - 49% average in Grade 10, and learners who obtained between 70%–79% average in Grade 10 have a medium ES (*d*) of 0.558. The highest level of agreement was reported for the average obtained between 70% - 79% group (M=3.270, SD=0.098), followed by the 80% + group (M=3.152, SD=0.113); and most disagreement was reported for the 0%–29% group (M=2.454, SD=0.305).

The following HLM hypotheses for learners (see Table 22 above) were all statistically insignificant (p > 0.05) and therefore accepted. They are ***hypotheses*** A1.2, A1.3, A1.4, A3.2, A4.1, A5.1, A5.2, A5.4, and A6.3.

Reporting the results of the Hierarchical Linear Modelling (HLM) hypotheses for teachers:

Table 23: HLM hypotheses for teachers

Dependent Variable	Independent Variable		Mean	St Dev	MSE	School variance estimate	*df*	F	Sig value p	*Post hoc* test/ ES	
										Variables	Cohen's d
IPA	Age	20–25 26–35 36–45 46–55 55+	3.204 3.283 3.322 3.754 3.397	0.273 0.156 0.172 0.167 0.181	0.283	0.253	77.765	2.703	0.036	26-35 / 46-55	0.644
	Post level	PL 3 PL 2 PL 1	3.120 3.463 3.314	0.096 0.095 0.061	0.069	0.048	84.943	4.613	0.013	PL 3/ PL 2	1.010
E	Highest qualification	Matric Diploma Bachelor Honours Masters PhD	2.647 2.595 2.390 3.085 2.418 2.387	0.718 0.241 0.161 0.211 0.347 0.709	0.429	0.322	73.262	2.754	0.025	Bachelors / Honours	0.802

Hypothesis B1.1

There is no significant statistical difference between ***age*** and IPA.

Age was a significant predictor of IPA as obvious from F (78) = 2.703, p < 0.05 (0.036), *d* = 0.644. ***Therefore, the hypothesis can be rejected.*** As identified during the *post hoc* test and testing the ES, the difference is evident between age groups 26–35 and 46–55, with a medium ES (*d*) of 0.644. The highest level of agreement was reported for the age group 46–55 (M=3.754, SD=0.167), followed by the 55+ age group (M=3.397, SD=0.181); and most disagreement was reported for the 20–25 age group (M=3.204, SD=0.273).

Hypothesis B4.1

There is no significant statistical difference between ***post level*** and IPA.

Post level was a significant predictor of IPA as obvious from F (85) = 4.613, p < 0.05 (0.013), *d* = 1.010. ***Therefore, the hypothesis can be rejected***. As identified during the *post hoc* test, the difference is evident between post level 3 and post level 2, with a very large ES (*d*) of 1.010. The highest level of agreement was reported for the post level group (M=3.463, SD=0.095), followed by the post level 2 (HODs) group (M=3.463, SD=0.095); and most disagreement was reported by the post level 1 teachers' group (M=3.314, SD=0.061).

Hypothesis B2.3

There is no significant statistical difference between ***highest qualification*** and E.

Highest qualification was a significant predictor of E as obvious from F (73) = 2.754, p < 0.05 (0.025), *d* = 0.802. ***Therefore, the hypothesis can be rejected***. As identified during the *post hoc* test, the difference is evident between teachers with a bachelor's degree and teachers with an honours degree, with a large ES (*d*) of 0.802. The highest level of agreement was reported for the honours group (M=3.085, SD=0.211), followed by the matric group (M=2.647, SD=0.718); and most disagreement was reported for the PhD group (M=2.387, SD=0.709).

The following HLM hypotheses for teachers (see table 23 above) were all statistically insignificant (p > 0.05) and therefore accepted. They are ***hypotheses*** B1.2, B1.3, B2.1, B2.2, B3.1, B3.2, B3.3, B4.2, B4.3, B5.1, B5.2, and B5.3.

4.7.2 Structural Equation Modelling (SEM)

A SEM analysis was done on the data from learners and teachers to test the SEM hypothesis. Figure 48 and Table 24 display the results.

SEM Hypothesis C1: Learners

There is no significant statistical relationship between ***IPA, CA, CE,*** and ***ME***.

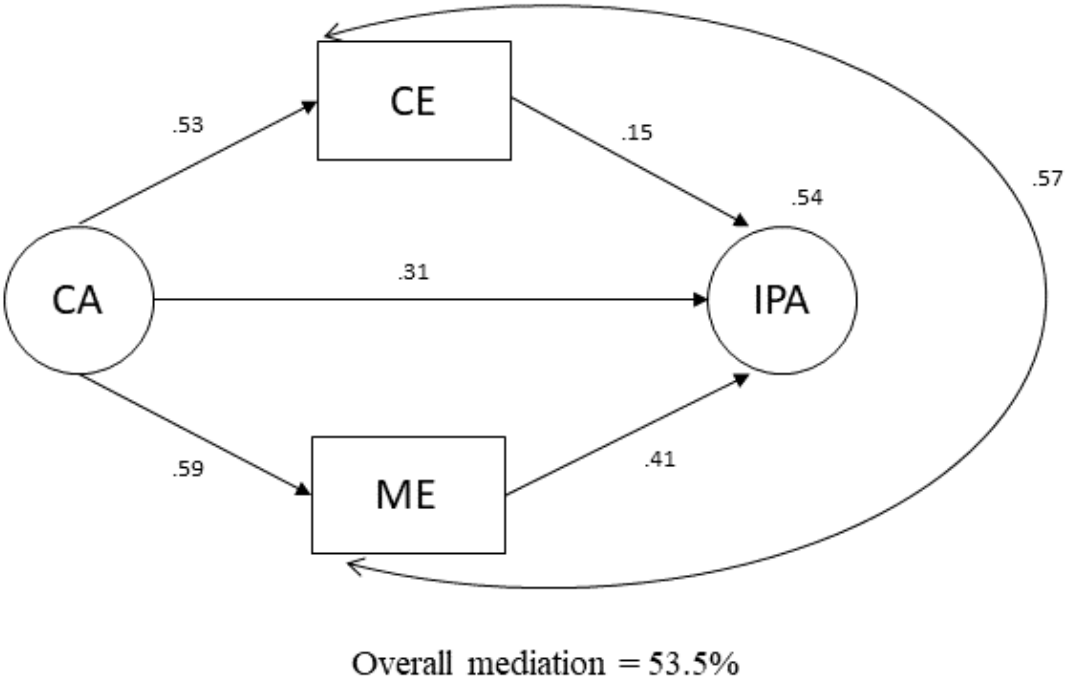

Figure 48: SEM analysis on data from learners

From Figure 48 and Table 24, all the regression weight estimates (i.e. path coefficients) are indicative of the amount (strength) of variance accounted for by each exogenous variable (i.e. IVs) on the endogenous variable (i.e. DV), meaning how strongly each exogenous variable influences the endogenous variable. The strength of these regression coefficients is reported as weak (.30), moderate (.50) and strong (.70) relative to the obtained ß weights. The statistical significance of these relationships between variables are also reported. As is evident from Table 24, these relationships between the four variables was found to all be statistically significant at $p < 0.05$ (0.001), where CA, CE, and ME were significant predictors of IPA:

CE <--- CA Standarised indirect coefficient =.533, $p<0.05$(0.001) was statistically significant.
ME<--- CA Standarised indirect coefficient = .586, $p<0.05$(0.001) was statistically significant.

IPA<--- CA Standarised direct coefficient = .310, p<0.05(0.001) was statistically significant.
IPA<--- ME Standarised indirect coefficient = .410, p<0.05(0.001) was statistically significant.
IPA<--- CE Standarised indirect coefficient = .150, p<0.05(0.001) was statistically significant.

Figure 48 claims that CA is a significant predictor ($p < 0.001$) of IPA (direct effect with a weak positive correlation of .31). CA is also positively correlated with ME (moderate to strong correlation of .59) and CE (moderate correlation of .53). There is a significant and strong combined mediation (indirect) effect evident for ME and CE on the direct effect of CA on IPA measured at 53.5%. This implies that ME and CE (as mediator variables) also significantly affect IPA.

Baron and Kenny (1986) explain that a mediation model seeks to explain the relationship between an independent variable and a dependent variable via the inclusion of a third variable, known as a mediator variable. Rather than a direct causal relationship between the independent variable and the dependent variable, a mediation model proposes that the independent variable influences the mediator variable, which in turn influences the dependent variable. Thus, the mediator variable serves to clarify the nature of the relationship between the independent and dependent variable. The mediation effect of ME (.59 and .41) however, is stronger than the mediation effect of CE (.53 and .15) on IPA as depicted in Figure 48.

Table 24: SEM analysis of data from learners (N=650)

Variables	Regression weight estimates	S.E.	Sig value p	Standardised Regression weight estimates
CE <--- CA	.572	.064	0.001	.533
ME <--- CA	.723	.077	0.001	.586
IPA <--- CA	.400	.062	0.001	.310
IPA <--- ME	.429	.047	0.001	.410
IPA <--- CE	.181	.049	0.001	.150
CE <---> ME	.572	Correlation		
Overall mediation = .535				

Therefore, the SEM hypothesis for learners are rejected as all these relationships are statistically significant.

In addition to learner SEM analysis, the researcher also conducted a SEM analysis on the data of teachers. The following research hypothesis were formulated.

SEM Hypothesis D1: Teachers

There is no significant statistical relationship between ***IPA, CA,*** and ***E***.

In analysing the regression coefficients (ß weight), it is clear from Table 25 and Figure 49, that there is a positive correlation between all the variables. The relationship between these three variables were also found to be all statistically significant at $p < 0.05$ (0.001).

E<--->CA Standarised indirect coefficient = .572,$p<0.05$(0.001) was statistically significant.
ME<--->CA Standarised indirect coefficient = .723,$p<0.05$(0.001) was statistically significant.
IPA<--->CA Standarised direct coefficient = .400, $p<0.05$(0.001) was statistically significant.

A regression weight of .75 is measured between E and IPA, which implies that the strength of the inter-dependence between E and IPA is significantly strong. Similarly, the correlation between CA and IPA reported .69 (strong effect). Both E and CA had a strong positive correlation on IPA. Furthermore, E and CA were found to be casually correlated at .51 (moderate).

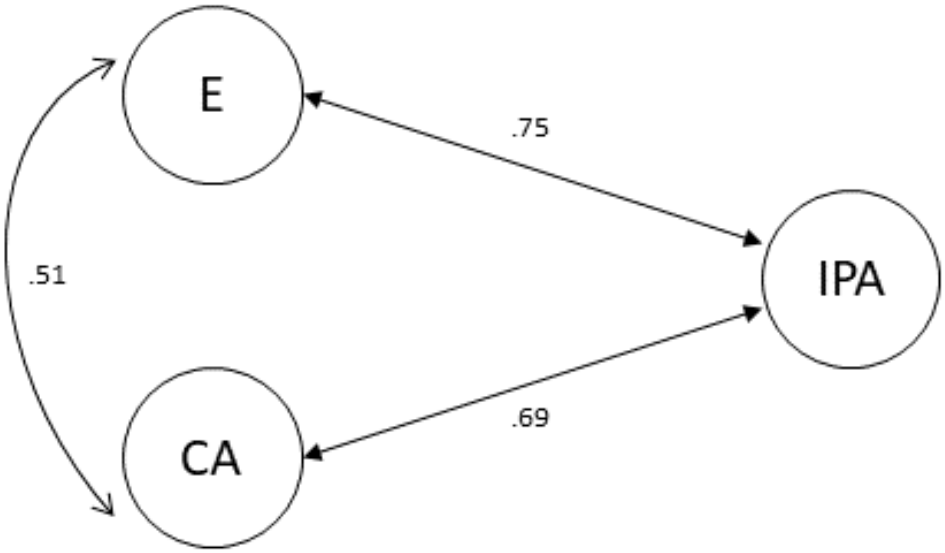

Figure 49: SEM analysis on data from teachers

Table 25: SEM analysis of data from teachers (N=101)

Variables	Regression weight estimates	S.E.	Sig value p
IPA <---> E	.751	.100	0.001
CA <---> CE	.508	.114	0.001
CA <---> IPA	.691	.102	0.001

Therefore, the SEM hypothesis for teachers are rejected as all these relationships are statistically significant.

4.5 CONCLUSION

This chapter presented the results of the study. The purpose of the study was explained. The demographic variables were identified and presented. These demographic variables were selected on the premise that they represent the independent variables in the hypotheses testing. The demographic variables were analysed as they would inform the interpretation of hypotheses. Furthermore, the validity and reliability tests, as well as tests for statistical assumptions were conducted. Inferential statistics were employed to test the HLM hypotheses and the SEM hypotheses. The next chapter contains the discussion following the study and recommendation pertaining to the results of the study are discussed.

CHAPTER 5

DISCUSSIONS AND RECOMMENDATIONS

Proactive Clarification

The researcher, as a seasoned FET phase teacher and lecturer in tertiary education; has always been irked and astounded by a concern that raises the question, "Why in the learning situation, is it a common occurrence that some learners achieve good results while others perform poorly?" Conversely put, "Why do some learners perform poorer than the others in assessments even though they received the same content from the same teacher, and under the same environmental interactive conditions?"

Experienced and novice teachers, both practising and in administration, were approached for a probable explanation. In short, the question left some of them quaking in their boots or walking on eggshells; others gave cogent defence, their moods not sanguine, and their thoughts about schooling still mired in the reverberations of the political past; and still some others, bluntly apportioned the blame to a sincere ignorance and conscientious inanity by both the teachers and learners.

There was glaring incongruence in the responses. The researcher still found it difficult to allocate the blame between learners or teachers in that "some learners perform poorer than the others even if all else is offered equally." However, it did not miss the researcher's grasp that the responses flagged a constant and continuous loop of back and forth blames and counter blames about why there is a difference in learner performance.

5.1 INTRODUCTION

The discussion in the above paragraphs which explains the researcher's quandary about the differences in learner performance in the classroom captures the essence and gist of the study. Hence, the researcher surmises that her problem about "why some learners' performance is unsatisfactory, could be found in conducting this research study about *The simultaneous impact of juxtaposed learning theories on learner information processing ability for cognitive growth and development.*

The aim of this chapter, therefore, is to demonstrate whether the investigation has provided answers to the problems that were stated at the outset. The most significant results and findings of the research are discussed. The chapter also proposes well-founded requisite approaches and recommendations based on the findings of this study. This will be followed by a proposed model serving as an approximate panacea to capture, retain, and maintain learner participation and involvement in processing information**.** Research proposals that evolve from this study are made. Finally, the conclusions and anticipated recommendations for the enhancement of academic achievement are given consideration.

5.2 DISCUSSIONS

Over the years of teaching and the concomitant experience that has evolved into ideas, and compounded into an ideology about teaching and learning; the researcher tenaciously holds the view that education is not a neutral phenomenon. It is an ideology, with ideology conceived as a terrain on which people move, and acquire consciousness of their position. It is proper to indicate that, precisely because education is ideological and an important mechanism for shaping societal values; teachers should not be left out but be at the front and centre of educational diffusion in schools as the vital part of teaching and learning.

Through teaching, education is one of the most crucial vehicles for shaping broader societal values. It is always a carrier of particular messages, both implicitly and explicitly. As often cited, teachers mostly impart the societal messages through texts, modules, readers, and learning guides. Their vitality is explicated by the manner in which they teach and the content of the subject that they teach. The findings of this study are more convincing evidence for the latter contention. Discussions of the statistical analyses of the study, discussion of the results of the study, justification of the impact of juxtaposed theories of learning, ***explanations about the proposed model of enabling information processing ability by the learners***, and the researcher's validation and/or critique are subsequently presented.

5.2.1 Discussion of the statistical analyses

The researcher employed inferential statistical analysis in testing the hypotheses pertaining to the research questions. Data analysis to yield results of significance or insignificance between the IVs in relation to the DVs was through Hierarchical Linear Modelling (HLM) and Structural Equation Modelling (SEM).

The HLM hypotheses testing illustrated and explained the different influences the independent variables (also the demographic variables explained in this study) exerted on the dependent variables, and the statistical significance of these differences. Each of the factors that might be associated with the cognitive growth and development of learners could be conceptualised as different levels of nesting – learners (at level 1) in schools, in which each level potentially affects learner performances. *Post hoc* tests were conducted to determine between which of the IVs, the statistically significant difference is evident. For educational and practical purposes, the magnitude of the effect size (ES) on these statistical differences were also explained.

SEM is a general statistical modelling and confirmatory technique used to delineate structural relationships among theoretical constructs (DVs) in that it tests: i) models that are conceptually derived, and ii) if the theory fits the data. As part of the model specification, the exogenous (IVs) variables represented CA, CE and ME whilst the endogenous (DV) variable was IPA. The SEM analysis tested the theoretical (hypothesised/structural) model (i.e. the SEM hypothesis) about the casual relationship between the DVs (IPA, CA, CE and ME) as determined by the empirical data and measurement model.

By the employment of descriptive and inferential statistics, the researcher combined the Frequency, SEM, and HLM analysis to allow for the advantage of being able to model both the hierarchical structure of the data and the complex relationships between variables. This perceptibly led to more accurate and reliable models and results.

5.2.2 Discussion of the results of the study

Discussions pertaining to the results will encompass both statistical analysis and the implication of the learning theories that apply to each DV. The section first discusses the results for the SEM analysis done on the data obtained from learners and teachers. The results also demonstrate how they relate to answer the subsidiary research questions.

5.2.2.1 Structural Equation Modelling (SEM) analysis discussion

a) Learner data

As David (2019) stated in the literature review of the study, Bandura's social learning theory maintains that thought is influenced by internal processes involving ***attention***, memory, and motivation, which might not be as readily observable as behaviour and its consequences. As

echoed in section 2.3.6, Latief and Dar (2014) explains that learning depends, in part, on the effective use of basic cognitive processes such as memory and ***attention***, the activation of relevant background knowledge, and the deployment of cognitive strategies to achieve particular learning goals.

Learning begins with attention and classroom attention could be cultured through active learning. However, principles of active learning remain a challenge for teachers in classrooms and this study attempted to outline these challenges by conducting HLM analysis in which the influence of learner demographic variables (IVs) is explained to provide thoughtful insights for the creation of TLIE in South African schools. Against this backdrop, the results of learners and teachers in this study concur with assertions by David (2019), and Latief and Dar (2014).

The subsidiary research question set for learners is based on the SEM hypothesis for learners, which states that, "There is no significant statistical relationship between ***IPA, CA, CE,*** and ***ME."*** The complementary research question for learners is expressed as, "Is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information processing ability of learners in the classroom?

As evidenced in Figure 50, the information processing ability (IPA) of learners is directly and positively influenced by their conscious awareness (CA) in the classroom and was found to be statistically significant as calculated by the SEM analysis. The SEM analysis also illustrated that the relationship of CA and IPA is strongly mediated by CE and ME as predictor variables, where CA also strongly influences CE and ME, and CE and ME influences IPA.

As deduced from the SEM analysis, there is a significant statistical relationship between these four DVs according to the learners. This implies that learners are of the opinion that their information processing ability is directly influenced and dependent on their conscious awareness in the classroom.

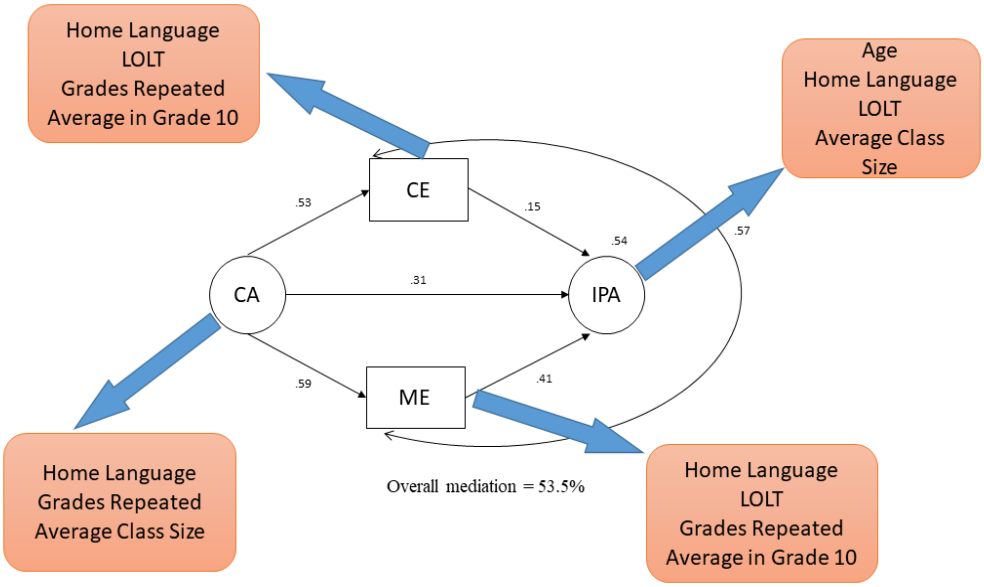

Figure 50: HLM and SEM analysis results for learners

Learners are furthermore of the opinion that the relationship between their conscious awareness and information processing ability is mediated by their cognitive and metacognitive engagement in the classroom. Solis (2008) agrees that teachers need to teach for ***engagement*** and from education literature it becomes evident that learner engagement is a prerequisite of learning, and for learning to be truly meaningful, learners have to be ***cognitively and, metacognitively engaged***.

b) Teacher data

Eggen and Kauchak (2014) highlighted the importance of the teacher's role in ***promoting learners' cognitive active*** roles in the classroom. Van Amburgh et al. (2007) postulates that the concept of ***learner engagement and active learning*** is becoming more than just educational rhetoric. Teachers should promote engagement by expressing high expectations of learners, and create personal human relationships between teachers and learners. Teachers also need to link to prior knowledge and experience and review frequently by offering continual assessment and feedback. Teachers should seek evidence of participation by ensuring all learners are always doing something. Teachers should furthermore articulate rules for participation and use a variety of interaction modes and structure tasks in rigorous, active, and accountable ways. The assertions by Eggen and Kauchak (2014), and Van Amburgh et al. (2007) are endorsed by the findings of teachers' performance in this study.

The subsidiary research question set for teachers is based on the SEM hypothesis for teachers, which states that, "There is no significant statistical relationship between ***IPA, CA,*** and ***E***." The complementary research question for teachers is expressed as, "Is there any relationship between conscious awareness, cognitive engagement, metacognitive engagement, and information processing ability; and what role does conscious awareness, cognitive engagement, and metacognitive engagement play in the information-processing ability of learners in the classroom?

As deduced from the SEM analysis (Figure 51), there is a significant statistical relationship between the three DVs according to the teachers. They are of the opinion that the information-processing ability of learners is directly influenced by learner engagement and conscious awareness of the learners in the learning process. They further recognise the correlation between learner engagement and their conscious awareness.

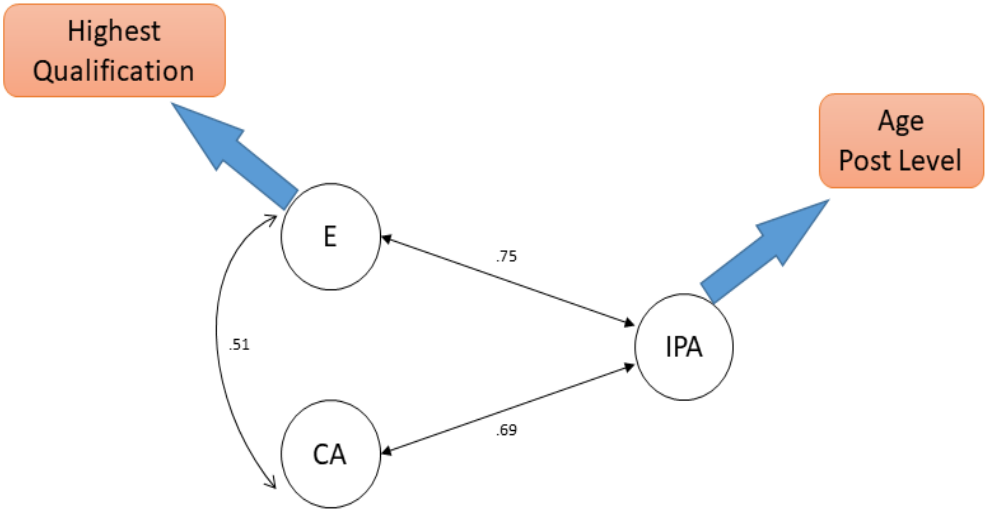

Figure 51: HLM and SEM analysis results for teachers

5.2.2.2 Hierarchical Linear Modelling (HLM) analysis discussion

a) Learner data

The HLM analysis further explained the influence of the IVs on the DVs as reasoned by the SEM analysis. The research question answered through the employment of the HLM analysis is: What are the opinions of the ***learners*** regarding the simultaneous impact of juxtaposed learning

theories on learner information-processing ability towards learner cognitive growth and development as influenced by learner performances in the classroom?

This research question is answered by the following discussions on the HLM analysis. The HLM analysis tested 24 hypotheses and pointed out that statistically significant differences exist between the IVs and DVs identified for 15 hypotheses. There were 9 hypotheses that indicated insignificant statistical results. The following section explains the significance found in learner data.

i. Conscious Awareness (CA)

Conscious Awareness (**CA**) as a DV, was significantly influenced by the following IVs: Home Language, Grades Repeated, and Average Class Size.

The significance test revealed that Home Language was a significant predictor of CA. This means that learners are of the opinion that their home language influences their conscious awareness in the classroom.

The hypothesis testing indicated that Grades Repeated in the past, as an independent variable, had a significant influence on the learners' ability to be consciously aware in the class, which implies that learners feel that their conscious awareness in the classroom is greatly affected by the fact that they had repeated grades in the past. The *post hoc* test revealed that a large difference was evident between learners who repeated Grade 8 and Grade 10 in the past.

According to learners, CA is greatly influenced by their average class size. This means that learners attribute their ability to be consciously aware in class to how many learners are present in the class. The *post hoc* test revealed that learners in classes of less 20 learners in the class differ significantly from learners in classes with 30 and 40 or more learners.

This is indicative of why learners attribute their conscious awareness to class size. In a class where many learners are present, it is difficult for teachers to gain the attention of the learners effectively in attempt to be consciously aware of the learning process.

ii. Cognitive Engagement (CE)

Cognitive Engagement (CE) as a DV, was significantly influenced by the following IVs: Home Language, LOLT, Grades Repeated, and Average Obtained in Grade 10.

Language plays an important role in the cognition of a learner according to Vygotsky, as highlighted in the literature review in Chapter 2 of the study. It is not surprising to the researcher that learners are of the opinion that their cognitive engagement is affected by their home language and their LOLT. These in turn affects their information-processing ability. The *post hoc* and Cohen's *d* tests indicated that there was a relatively large difference evident between learners speaking Sesotho and Afrikaans learners.

The hypothesis testing indicated that LOLT, as an independent variable, had a significant influence on CE; which implies that learners feel that their cognitive engagement in the classroom is greatly affected by their LOLT. The post hoc test revealed that a relatively large difference was evident between learners who have English as their LOLT in comparison to learners who have Afrikaans as their LOLT.

The hypothesis testing indicated that Grades Repeated in the past, as an independent variable, had a significant influence on CE, which implies that learners feel that their cognitive engagement in the classroom is greatly affected by the fact that they had repeated grades in the past. The *post hoc* test revealed that a large difference was evident between learners who repeated Grade 10 in the past in comparison to all other grades repeated in the past.

The descriptive statistics imply that almost 40% of the learners in the sample have repeated a grade at some or the other stage in their high school career; barring failure in Grade 11 and/or Grade 12. This failure rate of 40% is indicative of the inclusivity of the 34% of the learners above 17 years, plus an additional 6% learners of those learners categorised as the 66% appropriate age for Grade 11.

Teachers should be immensely aware of the fact that learners regard their past failures as significant indicators to be cognitively engaged in the learning process. Donald, Lazarus & Moolla (2014) explain in this regard that Seligman's theory on positive psychology holds that feelings of helplessness are learned through repeated experiences of not being able to control traumatic or distressing events in one's life, and not just the experiences themselves. This holds true for learners who feel discouraged by the fact of past failures. Positive psychology interventions are now making their way into classrooms all over the world (Ciarrochi, Atkins, Hayes, Sahdra, & Parker, 2016). Essentially, using a positive psychological approach in education serves to foster a sense of competence, confidence, and optimism, all of which generate a sense of control or agency, in the learners taught (Taylor, Kemeny, Reed, Bower,

Tara, & Gruenewald, 2000). In turn, these elements create a sense of well-being and general happiness (Seligman, 2007).

According to learners, CE is greatly influenced by their average obtained in Grade 10. This means that learners attribute their cognitive engagement in class to their academic performance (average obtained) in Grade 10. The post hoc test revealed that learners obtaining between 0%–29% differ significantly with learners obtaining 70%–79%.

This section confirms the fact that grades repeated in the past are correlated with the averages these learners obtain. Teachers should equally promote learners' self-efficacy by the application of Bandura's learning theory that advocates for social cognition. Brandon (2016) explains how teachers could apply principles of social cognitive learning theory in an educational setting. Teachers should regard that learning as a cognitive process (perception, memory, language, problem solving, and abstract thinking) that takes place in a social context where learners are active participants in the learning process, not passive participants. Cognition (the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses), environment, and behaviour influence each other. Another teacher application of this theory is to encourage learners to develop their individual self-efficacy through confidence building and constructive feedback, a concept that is rooted in social learning theory.

iii. Metacognitive Engagement (ME)

Metacognitive Engagement (ME) as a DV, was significantly influenced by the following IVs: Home Language, LOLT, Grades Repeated, and Average Obtained in Grade 10.

The significance test revealed that Home Language was a significant predictor of ME. This means that learners are of the opinion that their home language influences their metacognitive engagement in the classroom. The *post hoc* and Cohen's *d* tests indicated that there was a large difference evident between learners speaking IsiZulu, English, and Afrikaans.

The hypothesis testing indicated that LOLT, as an independent variable, had a significant influence on ME, which implies that learners feel that their metacognitive engagement in the classroom is greatly affected by their LOLT. The *post hoc* test revealed that a medium difference was evident between learners who have English as their LOLT in comparison to learners who have Afrikaans as their LOLT.

The hypothesis testing indicated that Grades Repeated in the past, as an independent variable, had a significant influence on ME; which implies that learners feel that their metacognitive engagement in the classroom is greatly affected by the fact that they had to repeat grades in the past. The *post hoc* test revealed that a medium difference was evident between learners who repeated Grade 10 in the past in comparison to no grades repeated in the past.

According to learners, ME is greatly influenced by their average obtained in Grade 10. This means that learners attribute their metacognitive engagement in class to their academic performance (average obtained) in Grade 10. The *post hoc* test revealed that learners obtaining between 30%–49% differ largely with learners obtaining 70%–79%.

iv. Information-Processing Ability (IPA)

Information Processing Ability (IPA) as a DV was significantly influenced by the following IVs: Age, Home Language, LOLT, and Average Class Size.

Learners were of the opinion that Age was a significant predictor of IPA. This entails that learners felt that their information processing ability is strongly influenced by their age. The *post hoc* test revealed a medium strength difference between the learners aged 17 and 19. In discussing Age, 34% of learners were older than 17, which imply that these learners had repeated a grade at some stage in their high school career.

The significance test revealed that Home Language was a significant predictor of IPA. This means that learners are of the opinion that their home language influences their information processing cognitive engagement in the classroom. The *post hoc* and Cohen's *d* tests indicated that there was a relatively large difference evident between Sesotho-speaking learners and Afrikaans-speaking learners.

The hypothesis testing indicated that LOLT, as an independent variable, had a significant influence on IPA, which implies that learners feel that their information-processing ability in the classroom is greatly affected by their LOLT. The *post hoc* test revealed that a relatively large difference was evident between learners who have English as their LOLT in comparison to learners who have Afrikaans as their LOLT.

According to learners, IPA is greatly influenced by their average class size. This means that learners attribute their information processing ability in class to how many learners are present

in the class. The *post hoc* test revealed that learners in classes of less than 20 learners in the class differ significantly from learners in classes with over 30 and 40 learners.

5.3 JUXTAPOSED OF THE VARIOUS THEORIES OF LEARNING AND THEIR EDUCATIONAL IMPLICATIONS

As explained in Chapter 2, the researcher sought to explore the juxtaposed simultaneous impact of the learning theories in the classroom, and simultaneously, determine how the teachers' craft and the classroom environment induces learners' attention and thoughtfulness to maximum learning. Figure 52 depicts the complexity of the requisite dynamics at play for attention when teaching is done with express purpose and intent to develop cognitive ability and functioning of the learners through awareness, knowledge, and adherence to matters of information processing.

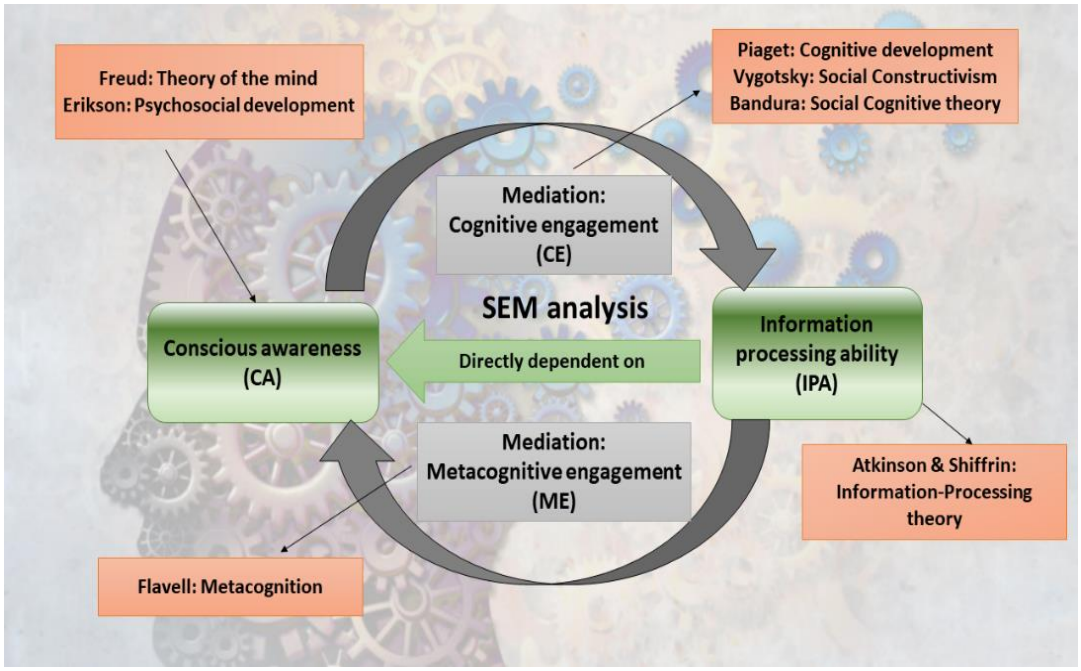

Figure 52: Juxtaposed Learning theories and learner performance

5.3.1 Juxtaposition regarding Conscious Awareness (CA)

Cognitive processes are enhanced by positive psychological variables such as awareness, engagement, and self-efficacy, which in turn impacts on a learner's cognition as explained by Freud, Erikson, and Bandura. Freud asserts that a learner is continuously bombarded by the

conflicting forces of the id and superego embedded in the subconscious mind. Such forces have the power of distraction to focus and pay attention in the classroom. It is befitting that Awan (2017) asserts that there is a dire need on the part of teachers to be aware of the more powerful nature of the unconscious drives of the learner than the surface power of his or her conscious self. A truly liberal teaching methodology and liberal treatment can save the vitality of the teaching and learning space.

Albert Bandura's (1986) socio-cognitive theory advises that the learner should initially be consciously aware of the learning process by paying attention until the learner has reached the stage where the skill (as explained by the teacher) has been learned. Conversely put, teachers should enable the capturing and maintaining of learners' interest and subsequent attention to anticipate conscious awareness in the learning process in the classroom.

The psychosocial learning theory of Erikson enlightens our understanding of the factors that influence a learner's ability to function effectively in the classroom. Erikson's psychosocial theory of personality development, also explains the importance of cultural and social context (social constructivism) that serves as an important lesson for teachers. The humanistic psychologist Abraham Maslow's notion on related mental states such as intrinsic motivation, also link with Freud's neurological correlates of the optimal state of consciousness. Cognitive psychologists are, therefore, implicitly and or explicitly tacitly in concert about the importance of conscious awareness in the classroom.

5.3.2 Juxtaposition regarding Cognitive Engagement (CE)

Acquired knowledge structures refer to learning outcomes. A thorough understanding of how learners mentally form the connections or construct knowledge structures is important for the improvement of teaching and learning performance. Chen, Masur and Mcnamee (2011) aver that unlike traditional teaching approaches, a teaching-learning interactive environment that recognises importance of learners mentally forming connection of knowledge structures, utilise techniques that focus on the well-being of learners where learning is viewed as a cooperative approach in enriching the educational experience for the learner. Research adds that, positive learner engagement in the classroom has reported research findings in the critical enhancement of learner achievement.

Slavin (2009) proposes that Vygotsky's theory on the other hand, includes the desirability of setting up cooperative learning arrangements among groups of learners with different levels of ability. A Vygotskian approach to instruction also emphasises scaffolding, with learners taking more and more responsibility for their own learning. According to Vygotsky, for the curriculum to be developmentally appropriate, the teacher must plan activities that encompass not only what learners are capable of doing on their own, but what they can learn with the help of others (Slavin, 2009).

Erikson accentuates the importance of Vygotsky's proposition of cooperative learning by stating that contemporary educational application of Vygotsky's theories is 'reciprocal teaching', used to improve learners' ability to learn from text. In this method, teachers and learners collaborate in learning and practicing four key skills: summarising, questioning, clarifying, and predicting. The teacher's role in the process is reduced over time. The ZPD has several implications for teaching in the classroom.

Thought and language become increasingly interdependent in the first few years of life, and it is the panacea to enhance learner's thinking abilities. The most important cognitive teaching tool is language. It is imperative for teachers to be able to use understandable language to explain concepts and constructs to learners. If used meaningfully, it enables teachers to offer social guidance and to assist learners to develop the kind of thinking they need to become effective participants in the classroom. Effecting the ZPD process, as according to Vygotsky, and aligning subject presentation consistent with the learner's cognitive developmental age becomes challenging and pleasantly feasible.

Vygotsky believes that the role of education is to provide learners with experiences, that are in their ZPD, an equivalent of Piaget's recommendation to teachers' knowledge of the stages of cognitive development in order to prepare and present at the cognitive developmental level of learners. Understanding the levels of the ZPD and the learners' stage of cognitive developmental, is essential knowledge for teachers. In classroom settings, teachers may first assess learners to determine their current skill level or cognitive stage. Once ascertained, teachers can then proceed to offer instruction that stretches the limits of each learner's capabilities.

Teachers can use the information about Vygotsky's ZPD in organising classroom activities. Teachers should set up cooperative learning activities in such a way that learners at different levels can help each other. Teacher instructions can be planned to provide practice within the

ZPD where scaffolding provides hints and prompts at different levels. In scaffolding, the teacher (adult) does not simplify the task, but the role of the learner is simplified through the graduated intervention of the teacher.

5.3.3 Juxtaposition regarding Metacognitive Engagement (ME)

Research reveals the importance of a combination of factors in the learning process, which suggests that learners must be able to draw simultaneously on a range of resources. Breed (2013) espouses that some of these resources are concerned with knowledge about how to process information (cognitive resources) and awareness of different available learning strategies (metacognitive resources).

As mentioned in section 2.3.6, Schneider (2008) explains that teachers need to understand the information-processing model in order to teach for metacognitive awareness amongst learners effectively. Flavell contends that children develop an increasingly complex theory of mind and mental processes, and that this development is enabled by their increasing capacity for abstract thought (Krause et al., 2009).

Price-Mitchell (2015) proposes several strategies that teachers could employ in their classrooms to improve metacognition. Teachers should teach learners how their brains are wired for growth. The beliefs that learners adopt about learning and their own brains will affect their performance. Research shows that when learners develop a growth mind-set vs. a fixed mind-set, they are more likely to engage in reflective thinking about how they learn and grow. Teaching learners about the science of metacognition can be an empowering tool, helping learners to understand how they can literally grow their own brains.

Teachers should also give learners practice recognising what they do not understand. The act of being confused and identifying one's lack of understanding is an important part of developing self-awareness. Teachers should take time at the end of a challenging class to ask, "What was most confusing about the material we explored today?" This not only jumpstarts metacognitive processing, but also creates a classroom culture that acknowledges confusion as an integral part of learning.

A very important aspect for teachers to regard is the issue of feedback and reflection. Teachers should facilitate reflexive thinking by providing opportunities for learners to reflect on classwork

and as such provide constructive feedback to learners. Higher-order thinking skills are fostered as learners learn to recognise their own cognitive growth.

Reflexivity is the metacognitive process of becoming aware of our biases and prejudices that get in the way of healthy development. Teachers can create a classroom culture for deeper learning and reflexivity by encouraging dialogue that challenges human and societal biases. When learners engage in conversations or write essays on biases and moral dilemmas related to politics, wealth, racism, poverty, justice, liberty, etc., they learn to "think about their own thinking." They begin to challenge their own biases and become more flexible and adaptive.

5.3.4 Juxtaposition regarding Information Processing Ability (IPA)

Research reveals the importance of a combination of factors in the learning process, which suggests that learners must be able to draw simultaneously on a range of resources. Breed (2013) states that some of these resources are concerned with knowledge about how to process information (cognitive resources) and awareness of different available learning strategies (metacognitive resources).

As mentioned in section 2.3.6, Schneider (2008) explains that teachers need to understand the information-processing model in order to teach for metacognitive awareness amongst learners effectively. Flavell contends that children develop an increasingly complex theory of mind and mental processes, and that this development is enabled by their increasing capacity for abstract thought (Krause et al., 2009).

5.3.5 Conclusion

The principal aim and objectives of this study were to deliver an answer to the following questions.

- To what extent does the simultaneous impact of juxtaposed learning theories in the classroom influence learner information-processing ability towards learner cognitive growth and development?
- Ascertain the extent to which the simultaneous impact of juxtaposed learning theories (behaviourism, cognition, and constructivism) in the classroom to influence learner information processing ability towards learner cognitive growth and development.

The researcher, therefore, strongly believes that teachers should take special interest in the study of the brain (i.e. from an educational-neuroscientific stance), because they should understand how the brain contributes to educational phenomena, such as learning, critical thinking, problem solving, information processing and memory. Teachers are indeed not neuroscientists, but they are members of the only profession in which their vocation is to change and transform the human brain daily.

The researcher has evidence from this study that knowledge and understanding of the various theories of learning, and the impact of juxtaposition of such theories when embraced, advocated, and practised by the teacher, can have on the cognitive developmental levels of the learners. More so, possession and utilisation of the latter knowledge by the teacher gives learners the added advantage of knowing how they know and learn, i.e. their metacognitive engagement in an interactive teaching-learning environment.

Based on the discussions of the Structural Equation Modelling (SEM) findings, the Hierarchical Linear Modelling (HLM) findings, and the underlying implications from the juxtaposed theories; it would be unwise to deny that certain inefficiencies have existed with certain teaching corps, and between and within individual learners regarding information processing.

It has become apparent to the researcher that, though not a matter of calamity and the resultant uneasiness to the researcher, analysis of the significant and non-significant hypotheses, *post hoc* tests, and pertinent item analysis of hypotheses of insignificance, the following points of view have emerged.

i. Teachers are apparently either not prepared, lacklustre, or lackadaisical to teach learners with the ulterior motive of being good and successful teachers as would be evidenced by way of moulding learners' depth and breadth of being sophisticated and complex thinkers.

ii. It is also questionable whether some teachers still harbour the autarkical pride which motivates many a teacher after entering the classroom, closing the door behind him or her, face the class and say to himself, "Here's information for you, convert it into knowledge. And, this is how you should receive it, and …", of course, unbeknownst to you, "…I have some techniques too" to help you with the conversion in order to grow and develop cognitively?

The researcher argues that the appropriate role of teachers is not to train learners in routine skills, but to inspire, and to excite learners to new heights of creativity and imagination. The latter cannot be achieved through the sole humdrum of lesson presentation standing at the front of the classroom.

On the basis of the above-mentioned stance, the researcher surmises that: the most critical strategy, performances, and the manoeuvres of a good and successful teacher regarding the ability to change and modify learners' behaviours to learn, is embedded in the power of the teacher to regulate and order learners how to think, act, and behave (i.e. how to process information).

Conversely, the teacher's ability to enable learners to receive, perceive, and manipulate the incoming information by either assimilation or accommodation in the cognitive schemata for deeper and broader knowledge that is meaningful and understandable is through the teacher's knowledgeability of the simultaneous impact of juxtaposed theories of learning so as to stimulate and cultivate learners' information processing ability.

5.4 THE PROPOSED MODEL TO ENGENDER INFORMATION PROCESSING ABILITY IN THE CLASSROOM (MEIPAC)

In the researcher's review of the findings of data analysis through the SEM and HLM models, there emerged a realisation that indicates the characteristics, strength, and weaknesses of the underlying subtleties that impede or handicap the information-processing abilities of learners. The spotlight of the realisation also shone on the teachers' shortcomings to exude and instigate information processing ability in the learners.

The realisations stated above compounded and crystallised into a need to design a model for express purposes and intent to contribute to the corpus of knowledge regarding "Learner Information Processing," as influenced by the dependent variables determined by the researcher.

The need for creating a model was also incited by probable ideologies, traditions, and assumptions deduced and analysed from the responses given in some questionnaire items. The arguments emanated from the researcher's analyses of such responses and prompted the creation of the suggested model for teaching and learning, and for the dynamics of learners' processing

that teachers need to have uppermost in their minds as they prepare their lessons for presentation in class.

5.4.1 The Model

This proposed model explains and emphasises the active cognitive factors to be taken into account when facilitating learning by a teacher in the classroom. These cognitive factors were inferred and determined as DVs (CA, CE, ME, and IPA) of this study. These cognitive factors (Figure 53), illustrate the flow of information processing. The educational implication of these cognitive factors is to receive and manipulate information from the environment and convert it into meaningful and understandable knowledge stored in the cognitive schemata of the learner.

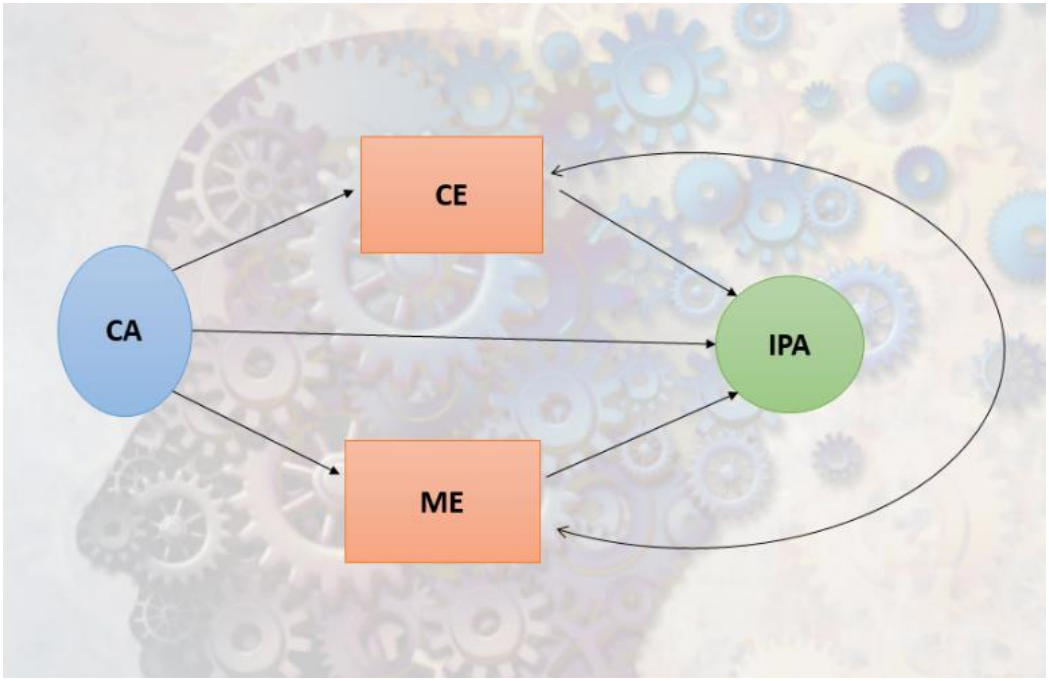

Figure 53: The Proposed Model (MEIPAC)

Within the paradigm of the suggested model by the researcher (MEIPAC), it can be deduced that teaching is not an exercise of happenstance of a moment in time. It embodies the whole presentation before, during, and after the lesson. There are ubiquitous aspects relating to the learner, content, and the classroom environment that teachers need to consider for every lesson. Some of the aspects overlap and over relate.

The researcher argues that the appropriate role of teachers is not to train learners in routine skills, but to inspire, and to excite learners to new heights of creativity and imagination. The latter

cannot be achieved through the sole humdrum of lesson presentation standing at the front of the classroom. The main function of the factors cognitive engagement, cognitive awareness, and metacognitive engagement as shown in the model, therefore, are to guide the teacher to help the learner create a cognitive perspective; to deepen and broaden the learner's stored information, to develop critical and higher-order thinking that immensely contribute to cognitive growth and development.

On the basis of the above-mentioned stance, the researcher surmises that: the most critical strategy, performances, and the manoeuvres of a good and successful teacher regarding the ability to change and modify learners' behaviours to learn, is embedded in the power of the teacher to regulate and order learners how to think, act, and behave (i.e. how to process information). Consequentially, the model serves as a continuous reminder to teachers during presentations that the state of the learner's conscious awareness and engagement are paramount as precursors to making sense of the incoming information from the environment.

Conversely, the teacher's ability to enable learners to receive, perceive, and manipulate the incoming information by either assimilation or accommodation in the cognitive schemata for deeper and broader knowledge that is meaningful and understandable is through the teacher's knowledgeability of the simultaneous impact of juxtaposed theories of learning so as to stimulate and cultivate learners' information processing ability.

5.4.2 The Significance of the Proposed Model

The exhortation germane to the above paragraphs are subsumed in the outcry by cohorts of past and even present practising teachers that certain inefficiencies exist with certain teaching corps, and between and within individual learners regarding information processing. Uppermost in their concerns for the latter is that many a learner lacks capability to capture, retain, and maintain participation and involvement in processing information throughput lesson presentation by the teacher

It has become apparent to the researcher that, though it is not yet a matter of calamity and the resultant uneasiness to the researcher, the exhortations expressed in the paragraph above predicate a need by Teacher Training Institutions to prioritise drawing "teacher trainees' attention to hone" their capability to enable learners to process information during practice teaching sessions. Practising their capability to enable learners could be undertaken by, *inter-alia*, through following ways:

- Clear formulation and expression in the lesson aim or objectives how learner information processing will be facilitated.

- Desist the in vogue practise of sporadically asking learners whether they understand or not – learners say they do always. Rather, teacher trainees to be encouraged to ask questions when in doubt whether learners understand.

- Conceivably, presenting their lessons in steps, followed by questions to determine understanding of the particular step; and then presenting further steps, and followed by related questions to the step; will raise the level of the learners' cognitive awareness, cognitive engagement, and individual learner's check on his or her metacognitive comprehension.

5.4.3 Educational Implications of the Model

The model illustrates the dynamics at play that create the complexity of information processing for express purposes and intent to enrich learning for cognition. The researcher hopes that the implications of this model will create a greater awareness of the essential dynamics of learning by the teacher. Although not visible within the model, it must be stressed that the model (for learners on receipt of information; and the dynamics for teachers to have uppermost during their preparations to teach) is based on sound understanding of the requisites that serve as templates to understanding and knowing.

In the event that teachers are either lacklustre, or lackadaisical to teach learners with the ulterior motive to becoming good and successful teachers as would be evidenced by the way of their moulding learners' depth and breadth to being sophisticated and complex thinkers; the proposed model serves to motivate teachers to become good facilitators of information. It is conceivable that such a conscious effort to be good facilitators would enliven the learners' conscious awareness and engagement during lesson presentation.

Eggen and Kauchak (2014), and Cherry (2019f); provide, *inter-alia*, the following teaching strategies to awaken and maintain cognitive awareness and engagement by the leaners:

- Focussed attention
- Avoid cramming of information
- Structure and organise information

- Utilise mnemonic devices
- Elaborate and rehearse information
- Visualise concepts
- Relate new information to things already known
- Read out loud
- Pay extra attention to difficult concepts
- Vary voice tone, movement, gestures, and use silence between explanations of difficult concepts and constructs to allow learners to process concepts and constructs.

5.4.4 Recommendations

The following recommendations are extracted from the findings of this study. The recommendations are grouped under two subsections: Recommendations on Teaching and Learning, and, Research Recommendations. The researcher wishes to emphasise that these recommendations were not offered in priority order. Rather, as it is unrealistic to anticipate the relative importance each recommendation over the other, they should be adopted and implemented not in incremental approach, but wholesome by the teachers.

5.4.4.1 Recommendations on Teaching and Learning

In the process of teaching, it is imperative for teachers to encourage learners to ask questions, to analyse, to criticise, to compare and contrast, to wonder, and to become aware of alternatives. Certainly, learners' perceptions about themselves, their attitude towards academic work, and motivations influence their academic performance.

Teachers should, therefore, also help learners analyse their own behaviour of processing information, evaluate their beliefs regarding their lifelong requirement to be consumers and manufacturers of knowledge bases that would mould their meaningful understanding of the elements or aspects of what constitute life, living, and being assets through their mind/thinking.

The recommendations on Teaching and Learning above may be misconstrued as a *caveat* for the onset of Armageddon or the sound of cannons blasting on the eve of the Third World war in learning. Rather, the recommendations are appeals for more research to help us as teachers clean the wax from one's ears so that one can better hear the noises of the calls to improve learners' information-processing ability. The calls to repair the antennae of learners so that their sensory perception may feel and detect the processes of cognitive growth and development. Finally, the

calls to service the seismic equipment so that the threatening, and sometimes deadly, earthquakes of unforeseen fossilised

The following points of view require extensive research related to teachers and teaching. They are essential to moulding a personal character of a "good and successful" teacher. These points are:

i. Teachers should intentionally create a conducive and interactive teaching-learning environment in which learners can discover that their serious effort toward learning makes it possible for them to attain a sense of academic competence, which unconsciously, modify the quality of their cognitive growth and development immeasurably. It is in this context that the research surmises that learners will immensely perceive the significance of the curriculum content incalculably.

ii. Teachers should calculatingly socialise the attitudes of learners from previous and present *zeitgeist* (popular opinions) of strikes, the embodiment of their democratic rights to learning, and the embedded interest and concern for their worldview to be undergirded by scientific knowledge base that is "pregnant" with acceptable norms and values.

iii. Teachers should be subjected to periodic evaluation and accountability by departmental heads and or senior teachers for the depth and breadth of their learners' information processing ability; deducing from low achievement scores in assessments. Remediation by way of allowing a mentor assigned or chosen by the teacher can then be justified to train or advice on how to rouse and maintain information-processing ability by the learners.

iv. Though contentious and seemingly insensitive, the researcher humbly proposes that all teacher trainees whose second language or third language is English; should consider it feasible and academically sensible to take a module in Practical English, barring political connotations of such an exercise in some quarters. Experienced teachers tacitly agree that a Practical English module would be a panacea to hearten teacher trainees to excel when teaching for stimulating learners' information-processing abilities. Furthermore, taking such a module would catapult the trainees' courage to profess an appropriate knowledge base that strategically has learners becoming educated consumers of information.

v. As outlined earlier, the researcher re-emphasises the wish that teachers become life-long learners and researchers by actively engaging in educational research, and research relating to brain-based teaching and learning. The researcher further hopes that teachers will advance their educational qualifications, to become knowledgeable about Learning Theories in effectively engaging learners in a meaningful learning experience.

5.4.4.2 Research Recommendations

There is a renewed interest at all levels of education for decisions to be data driven and based on hard evidence. This has resulted in a greater need for all teachers to understand, conduct, and use research findings (McMillan & Schumacher, 2010). A more objective approach to educational research is called for, but we need to be clear about the role of human judgment, which is indeed critical to research. The researcher opines that the anticipated effect of such a focus would uplift many a teacher of professional autarkical pride and efficacy probably.

i. More research still needs to be done on how best; with minimum costs, new teachers and parents with inadequate level of ability to teach, can be empowered to play a contributory role in sensitising, cultivating, and supporting learners to manipulate the information offered to them mentally by teachers for cognitive growth and development

ii. The following HLM hypotheses were all statistically insignificant at ($p > 0.05$), but practically significant and therefore accepted above 75%. As such, the researcher call for attention to conduct further research studies on them:

Learner Hypotheses:

- ✓ There is no significant statistical difference between Average obtained and IPA
- ✓ There is no significant statistical difference between ***average obtained*** and ME

Teacher Hypotheses

- ✓ There is no significant statistical difference between ***highest qualification*** and CA
- ✓ There is no significant statistical difference between ***post level*** and E

5.5 CONCLUSION

It is proper to conclude that attention was drawn to the triadic link of parallels, the similarities, and the differences of information processing provided by the various cognitive theories of learning, the variables germane to information processing by the learners, and the variables that undergird good and successful teachers in facilitating effective and efficient processing of information by learners. The dynamics of learning studied and explained in this study, cannot be based on mere assumptions, but must be informed by a reliable study. Hence this chapter discussed the effective application of juxtaposed learning theories by teachers in the classroom towards the enhancement of learners' information-processing abilities through learner performances because of learner conscious awareness, cognitive engagement, and metacognitive engagement.

It is hoped by the researcher that the understanding and application of the findings of the study will testify of assertive efforts to enhance learners' cognitive growth and development towards the improvement of the quality of education. Notwithstanding, and without irrational exuberance, the research findings of this study demonstrated that *The Simultaneous Impact of Juxtaposed Theories of Learning on the Cognitive Growth and Development* should loom large in the thoughts of all and sundry.

As concluding remarks, it is the researcher's sincere wish and hope that the implications of the findings, the recommendations based thereon, will be considered by curriculum makers at institutions of Teacher Training and Development. It is on the strength of the findings and recommendations that the researcher cites and concurs with Willis (2012) that:

> There are no more critical life supports than passionate, informed teachers who can resuscitate [learners'] joyful learning. When [teachers] learn about how the brain appears to process, recognize, remember and transfer information at the level of neural circuits,

synapses and neurotransmitters, and when they share that knowledge with [learners], they share empowerment with their [learners]. Informed teachers help [learners] understand their ability to change their brains and experience success and renewed confidence. [Learners] thrive in classrooms where teachers have the added tools from their neuroscience understanding. The result is nothing less than reigniting the joys of learning, even when they have been extinguished for years.

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APPENDICES GUIDE

As guide to obtaining detailed information about all the appendices, follow the instructions below:

1. Navigate to the intended Appendix (e.g. Appendix J: List of schools).
2. Place the cursor anywhere on the document and double left-click on the document.
3. The detailed information of the document on the list of schools will be shown in a separate window.
4. To close the document, left-click on the red X in the right hand corner of the document.
5. You are back to the original front page of the Appendix J (List of schools).

APPENDICES

Appendix A: RESEARCH ETHICS APPROVAL FROM CUT

Central University of Technology, Free State

RESEARCH ETHICS APPROVAL

Date: 15 September 2017

1.1.1 This is to confirm that ethical clearance has been provided by the Faculty Research and Innovation Committee in view of the CUT Research Ethics and Integrity Framework, 2016 with reference number **[D FRIC 16/4/9].**

Applicant's Name	M Fourie 206068166
Supervisor Name for Student Project (where applicable)	Dr DK Selaledi (main) Prof GJV Schlebusch (co)
Level of Qualification for Student Project (where applicable)	D.Ed
Tittle of research project	**LEARNERS' COGNITIVE DEVELOPMENT JUXTAPOSED WITH THE DYNAMICS OF THE CONSCIOUSNESS AND METACOGNITION: A RECONCILIATION OF THEORY AND PRACTICE**

The following special conditions were set:

x	Ethical measures as outlined in the proposal and which have been endorsed by the Faculty Research and Innovation Committee have to be adhered to.

We wish you success with your research project.

Regards

Prof JW Badenhorst
(Ethics committee representative: Research with humans)

Appendix B: APPLICATION LETTER FOR APPROVAL TO CONDUCT RESEARCH FROM CUT

Central University of Technology, Free State

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHAREBE YA THEKNOLOJI, FOREISTATA

TO WHOM IT MAY CONCERN

I, Prof GJ Schlebusch (promoter), hereby declares that Ms Mariette Fourie (student number: 206068166) is registered for the Doctor of Education degree at the Central University of Technology, Free State. The title of her dissertation is *Learners' Cognitive Development Juxtaposed with the Dynamics of the Consciousness and Metacognition: A Reconciliation of Theory and Practice.* The proposal and title of Ms Fourie's study have been approved by the Faculty Research and Innovation Committee of the Central University of Technology, Free State (D FRIC 16/4/9).

It will be greatly appreciated if Ms Fourie could be granted permission by the Free State Department of Education to conduct the empirical part of her study in twenty high schools in the Fezile Dabi Educational District.

Thank you for your kind consideration of the above said request.

Yours in Education

Prof GJ Schlebusch

15 September 2017

Central University of Technology, Free State

Prof GJ Schlebusch (PhD)
Associate Professor
Department of Post Graduate Studies: Education
Faculty of Humanities
Welkom Campus

Tel: +27 57 910 3572 | Fax: 0862755340 | E-mail: gschlebu@cut.ac.za
P.O. Box 1881, Mothusi Road, WELKOM, 9459
South Africa

Appendix C: APPLICATION TO REGISTER AND CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

Ref: Research Application

APPLICATION TO REGISTER AND CONDUCT RESEARCH IN THE FREE STATE DEPRARTMENT OF EDUCATION

- Please complete all the sections of this form that are applicable to you. If any section is not applicable please indicate this by writing N/A.
- If there are too few lines in any of the sections please attach the additional information as an addendum.
- Attach all the required documentation so that your application can be processed.
- Send the completed application to:

DIRECTOR: STRATEGIC PLANNING, POLICY AND RESEARCH

Room 319, 3rd Floor
Old CNA Building
Bloem Plaza
Charlotte Maxeke Street
BLOEMFONTEIN, 9300

OR

Free State Department of Education
Private Bag X20565
BLOEMFONTEIN, 9300

Email: berthakitching@gmail.com and B.Kitching@fseducation.gov.za

PLEASE DO NOT EMAIL ANYTHING IN PICTURE FORMAT

Tel: 051 404 9283 /9211 / 082 454 1519

Appendix D: NOTIFICATION LETTER TO CONDUCT RESEARCH IN YOUR DISTRICT BY M FOURIE

education

Enquiries: KK Motshumi
Ref: Notification of research: M Fourie
Tel. 051 404 9221 / 079 503 4943
Email: K. Motshumi@fseducation.gov.za

The District Director
Fezile Dabi District

Dear Mr Chuta

NOTIFICATION TO CONDUCT RESEARCH PROJECT IN YOUR DISTRICT BY M FOURIE

1. The above mentioned candidate was granted permission to conduct research in your district and your Chief Directorate as follows:

   Topic: Learners' cognitive development juxtaposed with the dynamics of the consciousness and metacognition: a reconciliation of theory and practice

   Schools involved: 20 Schools in Fezile Dabi District: Afrikaans Hoer Skool (Sasolburg), Afrikaanse Hoer Skool (Kroonstad), Bolphihlelo, Brentpark, Falisizwe Heilbron, HTS Sasolburg, Kgolagano, Kroonstad Combined School, Le Notsi, Parys Senior Secondary School, Phenetang, Qalabotjha, Salomon Senekal Combined School, Sandersville, Sarel Cilliers, Sasolburg Senior Secondary School, Sediba Thuto, Villiers Combined School and Wilgerivier.

   Target Population: 600 Grade11 learners doing Afrikaans Home Language and English Home Language, 100 Grade 10 – 12 teachers, all subjects, 20 HODs and 20 Deputy Principals.

   Period: From date of signature to 30 September 2017 and again from January to March 2018. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours.

2. **Research benefits:** The findings of this study would be helpful in better preparing teachers to involve learners in a conscious learning process; maintaining a supportive setting for them in which they can grow professionally; and contribute to higher learner achievement in the Free State province. The study will attempt to find the relationship between effective teacher performances versus the teaching process from a cognitive perspective for the assertive improvement of quality education.

3. Logistical procedures were met, in particular ethical considerations for conducting research in the Free State Department of Education.

4. The Strategic Planning, Policy and Research Directorate will make the necessary arrangements for the researcher to present the findings and recommendations to the relevant officials in your district.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE 27/09/2017

RESEARCH APPLICATION FOURIE M NOTIFICATION EDITED 22 SEPT 2017, FEZILE DABI DISTRICT
Strategic Planning, Research & Policy Directorate
Private Bag X20565, Bloemfontein, 9300 - Old CNA Building, Room 310, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9280 / 9221 Fax: (086) 6578 679

Appendix E: LETTER OF APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

education
Department of Education
FREE STATE PROVINCE

Enquiries: KK Makhuni
Self: Research Permissions: M Fourie
Tel: 051 404 9203 / 9221 / 079 503 4593
Email: K.Nkuhuni@fsedu cation.gov.za

M Fourie
12 Eertstelaan
PARYS, 9585

084 553 2865

Dear Ms Fourie

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education

   Topic: Learners' cognitive development juxtaposed with the dynamics of the consciousness and metacognition: a reconciliation of theory and practice

   Schools involved: 20 Schools in Fezile Dabi District: Afrikaans Hoer Skool (Sasolburg), Afrikaanse Hoer Skool (Kroonstad), Boiphihlelo Brentpark, Falisizwe, Heilbron, HTS Sasolburg, Kgolagano, Kroonstad Combined School, Le Notsi, Parys Senior Secondary School, Phehellang, Qalabotjha, Salomon Senekal Combined School, Sanderswile, Sarel Cilliers Sasolburg Senior Secondary School, Sediba Thuto, Villiers Combined School and Wilgerivier.

   Target Population: 800 Grade11 learners doing Afrikaans Home Language and English Home Language, 100 Grade 10 – 12 teachers, all subjects, 20 HODs and 20 Deputy Principals.

2. **Period of research**: From the date of signature of this letter until 30 September 2017 and again from January to March 2018. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year.

3. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.

4. The approval is subject to the following conditions:

   4.1 The collection of data should not interfere with the normal tuition time or teaching process.

   4.2 A bound copy of the research document or a CD, should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.

   4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

   4.4 The attached ethics documents must be adhered to in the discourse of your study in our department.

5 Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 27/09/2017

RESEARCH APPLICATION M FOURIE NOTIFICATION EDITED 22 SEPT 2017, FEZILE DABI DISTRICT
Strategic Planning, Policy & Research Directorate
Private Bag X20565, Bloemfontein, 9300 Room 319, Old CNA Building, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9203 / 9221 Fax: (086) 2078 678

Appendix F: LETTER OF PERMISSION TO PRINCIPLES

Central University of Technology, Free State

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
CENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOKELANENG YA THEKENOLOGI, PROVENSETATA

Central University of Technology Free State
WELKOM CAMPUS
PO Box 1881
Thabong
WELKOM
9459

Tel: (057) 910 3632

Date: _____

RE: LETTER OF PERMISSION TO CONDUCT RESEARCH AT _____ SECONDARY SCHOOL IN THE FEZILE DABI EDUCATION DISTRICT.

Dear Principal,

My name is Mariëtte Fourie, and I am currently conducting research (in fulfilment of the requirements for the *DOCTOR OF EDUCATION* degree). I am a lecturer in the Post-Graduate School of Education, Faculty of Humanities and a D.Ed. student at the Central University of Technology, Free State. The study *"Learners' Cognitive Development Juxtaposed with the Dynamics of the Consciousness and Metacognition: A Reconciliation of Theory and Practice"* is intended to conclude into an academic dissertation.

I am conducting my research in the first quarter of 2018, resulting a school visit whereby one class of Grade 11 learners are requested to complete a questionnaire as well as five selected FET teachers, one HOD and 1 Deputy Principal. Interviews will also be held with exclusive FET teachers during February 2018. I would be grateful not to cause any inconvenience to either the Grade 11 learner nor the FET teacher, HOD and Deputy Principal at your school. I further undertake to conduct this research study to the availability and convenience of the school and its functionalities.

1

Appendix G: LEARNER LETTER OF CONSENT TO PARTICIPATE IN RESEARCH

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHAREBANG YA THEKNOLOJI, FOREISTATA

Central University of Technology Free State
WELKOM CAMPUS
PO Box 1881
Thabong
WELKOM
9459

Tel: (057) 910 3500

Date: _____

RE: LEARNER LETTER OF CONSENT TO PARTICIPATE IN RESEARCH AT A HIGH SCHOOL IN THE FEZILE DABI EDUACTION DISTRICT.

TO WHOM IT MAY CONCERN

This letter serves to confirm that I, (Full names and Surname), a Grade 11 learner at (write the full name of your school), has voluntarily agreed to participate in the study "*Learners' Cognitive Development Juxtaposed with the Dynamics of the Consciousness and Metacognition: A Reconciliation of Theory and Practice*". I made the choice to voluntarily participate after being informed about all the possible implications of my involvement in the study, both to me as a learner and to the school as a whole. I have also been informed of my right to withdraw from the study any time I feel I can no longer carry on with it for whatever reasons.

Yours Faithfully

_____ _____

Grade 11 Learner Witness

Appendix H: PARENT LETTER OF CONSENT TO PARTICIPATE IN RESEARCH

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHLASELA YA THEKNOLOJI, FREISTATA

Central University of Technology Free State
WELKOM CAMPUS
PO Box 1881
Thabong
WELKOM
9459

Tel: (057) 910 3500

Date: _____

RE: PARENT LETTER OF CONSENT FOR GRADE 11 LEARNER TO PARTICIPATE IN RESEARCH AT A HIGH SCHOOL IN THE FEZILE DABI EDUACTION DISTRICT.

TO WHOM IT MAY CONCERN

This letter serves to confirm that I, (Full names and Surname), parent of (write the full name of your child), which is a Grade 11 learner at (write the full name of the school), has voluntarily agreed that my child may participate in the study "*Learners' Cognitive Development Juxtaposed with the Dynamics of the Consciousness and Metacognition: A Reconciliation of Theory and Practice*". My child made the choice to voluntarily participate after being informed about all the possible implications of his/her involvement in the study, both to me as a parent and to the school. I have also been informed of my child's right to withdraw from the study any time he/she feels he/she can no longer carry on with it for whatever reasons.

Yours Faithfully

_____ _____

Parent Witness

Appendix I: TEACHER LETTER OF CONSENT TO PARTICIPATE IN RESEARCH

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHARENG YA THEKENOLOJI, FORESTATA

Central University of Technology Free State
WELKOM CAMPUS
PO Box 1881
Thabong
WELKOM
9459

Tel: (057) 910 3500

Date: ________________

RE: TEACHER LETTER OF CONSENT TO PARTICIPATE IN RESEARCH AT A HIGH SCHOOL IN THE FEZILE DABI EDUACTION DISTRICT.

TO WHOM IT MAY CONCERN

This letter serves to confirm that I, (Full names and Surname), a FET Teacher at (write the full name of your school). has voluntarily agreed to participate in the study "*Learners' Cognitive Development Juxtaposed with the Dynamics of the Consciousness and Metacognition: A Reconciliation of Theory and Practice*". I made the choice to voluntarily participate after being informed about all the possible implications of my involvement in the study, both to me as a learner and to the school as a whole. I have also been informed of my right to withdraw from the study any time I feel I can no longer carry on with it for whatever reasons.

Yours Faithfully

______________________ ______________________

FET Teacher Witness

Appendix J: LIST OF SCHOOLS IN THE FEZILE DABI EDUCATION DISTRICT THAT PARTICIPATED IN THE STUDY

M Fourie 206068166 DEd: List of Schools in Fezile Dabi

	School Name	LOLT	EMIS	Category	Physical Address	Physical Town	Tel No	Learners	Teachers
1	LE NOTSI S/S	English	443611141	Ordinary Sec.	1471 REFENGKGOTSO	DENEYSVILLE	163 711 632	281 - 320	50 - 56
2	FALESIZWE S/S	English	441610084	Ordinary Sec.	1221 MABOYA STREET	FRANKFORT	588 131 909	81 - 120	15 - 21
3	WILGERIVIER C/S	Afrikaans	441610266	Combined	Markstraat	FRANKFORT	588 131 010	121 - 160	22 - 28
4	HEILBRON C/S	Afrikaans	441811277	Combined	WRIGHTSTRAAT	HEILBRON	588 523 007	161 - 200	29 - 35
5	SANDERSVILLE C/S	English/Afrikaans	441811261	Combined	1 MAIN STREET	HEILBRON	588 531 495	201 - 240	36 - 42
6	SEDIBA-THUTO S/S	English	441811147	Ordinary Sec.	2285 Kuape Street	HEILBRON	588 521 924	241 - 280	43 - 49
7	SAREL CILLIERS C/S	English/Afrikaans	442411249	Combined	Dirkie Uysstraat 3	KOPPIES	567 771 869	321 - 360	57 - 63
8	AFRIKAANSE H/SKOOL KROONSTAD	Afrikaans	442506316	Ordinary Sec.	Du Toitstraat	KROONSTAD	562 123 159	481 - 520	85 - 91
9	BRENTPARK S/S	Afrikaans	442506332	Ordinary Sec.	Brierley Street	KROONSTAD	562 181 547	521 - 560	92 -98
10	KROONSTAD CS/S (Blouskool)	English/Afrikaans	442506318	Comp. Sec.	NOORDWEG	KROONSTAD	562 124 551	561 - 600	99 -106
11	PHEHELLANG S/S	English	443011028	Ordinary Sec.	1054 Koloane Street	PARYS	568 198 069	721 -760	128 - 134
12	PARYS SKOOL S/S	English/Afrikaans	443011241	Ordinary Sec.	Schilbachstraat	PARYS	568 113 472	p1 - p40	p1 - p40
13	AFRIKAANSE H/SKOOL SASOLBURG	Afrikaans	443611240	Ordinary Sec.	LEMMERSTRAAT 1	SASOLBURG	169 761 060	361 - 400	64 - 70
14	HTS SASOLBURG	English/Afrikaans	443611245	Tech. Sec.	13 Harry Smith Street	SASOLBURG	169 760 760	401 - 440	71 - 77
15	SASOLBURG S/S	English/Afrikaans	443611242	Ordinary Sec.	Taurus Street	SASOLBURG	169 760 534	441 - 480	78 - 84
16	KGOLAGANO S/S	English	444306254	Ordinary Sec.	4166 RAMMULOTSI	VILJOENSKROON	733 296 571	601 - 640	107 - 113
17	SALOMON SENEKAL C/S	Afrikaans	444306320	Combined	VILJOENSTRAAT 34	VILJOENSKROON	563 432 821	641 -680	114 - 120
18	QALABOTJHA S/S	English	441610173	Ordinary Sec.	794 Wetsie Street	VILLIERS	588 210 169	1 - 40	1 - 7
19	VILLIERS C/S	Afrikaans	441610265	Combined	Lombaardstraat	VILLIERS	588 210 024	41 - 80	8 - 14
20	BOIPHIHELO S/S	English	444611126	Ordinary Sec.	970 Khumalo Street	VREDEFORT	847 610 730	681 - 720	121 -127

Appendix K: QUESTIONNAIRE FOR LEARNERS

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHARENG YA THEKNOLOJI, FOREISETATA

No. ______

SCHOOL OF POST GRADUATE STUDIES: EDUCATION

FACULTY OF HUMANITIES

DOCTOR OF EDUCATION

RESEARCH STUDY

Strictly Confidential

QUESTIONNAIRE FOR LEARNERS

Learners' Cognitive Development juxtaposed with
the dynamics of the Consciousness and Metacognition:
A Reconciliation of Theory and Practice

(Grade 11 Learners)

M. Fourie
B.Ed. (FET) BWESE;
B.Ed. Honours: Educational Management;
Magister Educationis

1

Central University of Technology, Free State

Appendix L: QUESTIONNAIRE FOR TEACHERS

Central University of Technology, Free State

CENTRAL UNIVERSITY OF TECHNOLOGY, FREE STATE
SENTRALE UNIVERSITEIT VIR TEGNOLOGIE, VRYSTAAT
YUNIVESITHI E BOHARENG YA THEKENOLOJI, FOREISTATA

No. ______

SCHOOL OF POST GRADUATE STUDIES: EDUCATION

FACULTY OF HUMANITIES

DOCTOR OF EDUCATION

RESEARCH STUDY

Strictly Confidential

QUESTIONNAIRE FOR TEACHERS

Learners' Cognitive Development juxtaposed with
the dynamics of the Consciousness and Metacognition:
A Reconciliation of Theory and Practice

(FET Teachers)

M. Fourie
B.Ed. (FET) BWESE;
B.Ed. Honours: Educational Management;
Magister Educationis

1

Appendix M: EFA FOR LEARNERS

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  /METHOD=CORRELATION

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Factor Analysis

Appendix N: EFA FOR TEACHERS

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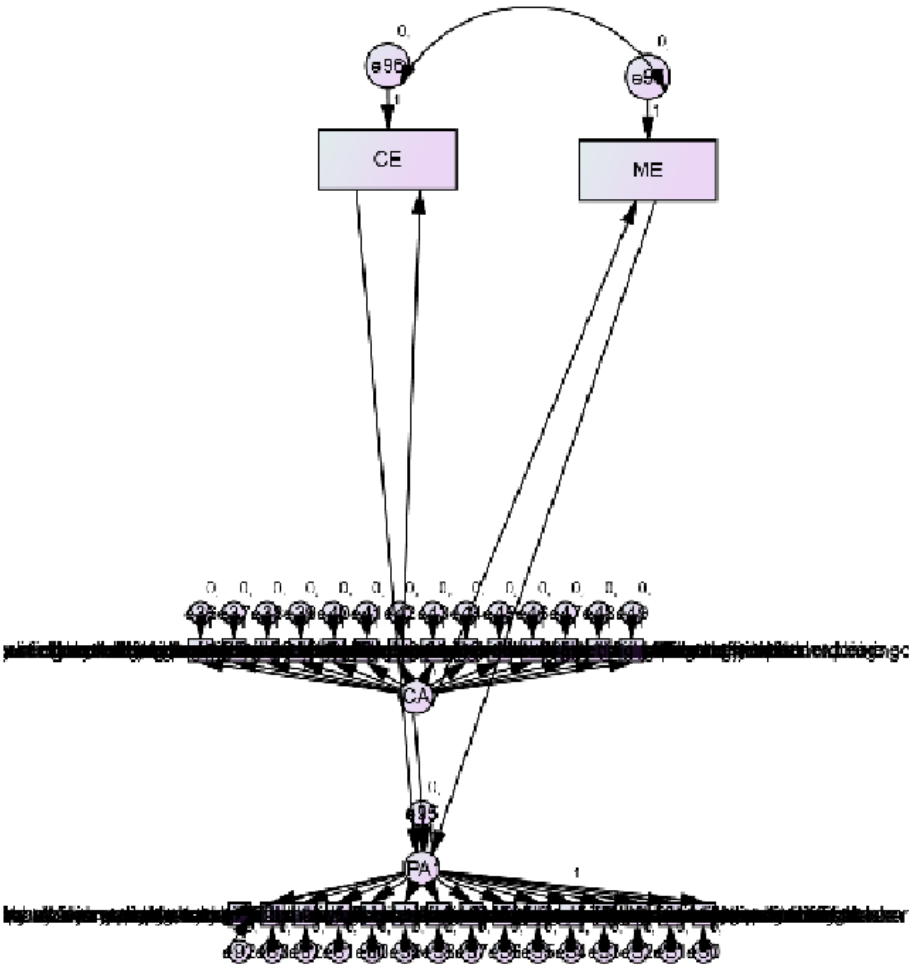
Factor Analysis

Appendix O: CFA FOR LEARNERS



Estimates (Group number 1 - Default model)

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Appendix P: CFA FOR TEACHERS

Estimates (Group number 1 - Default model)

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

Appendix O: LANGUAGE EDITING REPORT

NWU® | CTrans
Centre for Translation and Professional Language Services

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Tel: 016 910 3485
E-mail: wendy.barrow@nwu.ac.za
menitza.botha@nwu.ac.za

25 April 2019

To whom it may concern

This letter serves to confirm that the thesis with the title ***Simultaneous impact of juxtaposed learning theories on learner information processing ability for cognitive growth and development*** has been language edited by the *Centre for Translation and Professional Language Services* (CTrans). CTrans is a registered corporate member of the South African Translators' Institute (SATI) that makes use of qualified and experienced language practitioners to provide professional translation and language editing services.

CTrans hereby acknowledges that the document has undergone a proper and professional language edit (including the checking of spelling, grammar, register and punctuation). The onus rests on the client to work through the proposed changes after the edit and accept or reject these changes.

Yours sincerely

Wendy Barrow

CTrans Coordinator