CHAPTER 2

REVIEW OF RELATED LITERATURE

“A literature review is an evaluative report of information found in the literature related to your selected area of study. The review should describe, summarise, evaluate and clarify this literature. It should give a theoretical base for the research and help you (the author) determine the nature of your research. Works which are irrelevant should be discarded and those which are peripheral should be looked at critically.”

CQUniversity, 2016

2.1 INTRODUCTION

A literature review is a search and evaluation of the available literature in the given subject or chosen topic area. It documents the state of the art with respect to the subject or topic that the researcher is writing about.

A literature review has four main objectives:

- It surveys the literature in your chosen area of study
- It synthesises the information in that literature into a summary
- It critically analyses the information gathered by identifying gaps in current knowledge; by showing limitations of theories and points of view; and by formulating areas for further research and reviewing areas of controversy
- It presents the literature in an organised way

A literature review reveals that the researcher has an in-depth grasp of the subject; and that the researcher understands where the research fits into and adds to an existing body of agreed knowledge. A literature review, demonstrates a familiarity with a body of knowledge and establishes the credibility of the research, summarises prior research and says how the research is linked to it; integrates and summarises what is known about a subject, demonstrates that the researcher has learnt from others and that the research is a starting point for new ideas.

In the research methodology “literature” refers to the knowledge of a particular area of investigation of any discipline which includes theoretical, practical and its research studies. “Review” means to organize the knowledge of the specific area of research to involve an edifice of knowledge to show that present study would be an addition to this field. Research
in any field implies a step ahead in the exploration of the unknown -unknown which is darkness. One such preparation is gathering of knowledge of what has already been done in the given field.

A step towards unknown can only be taken after the review of literature and researches done in that area. Any research without such a review is like a building without any foundation. Review of related literature helps the researcher to assist themselves with the current knowledge in the field or area in which the research is going to be conducted. The review of the literature is the gate-pass for the research work to be done by a researcher. It guides the researcher in the research to be undertaken and also helps to avoid the duplication of research. It shows the way to the researcher.

The physicians must remain acquainted with the latest knowledge, innovations and discoveries in the field of medicine to treat the patients. Accordingly, the successful lawyer must also remain well informed with the cases so as to quote those cases for further reference of the case at hand. In the same way in the field of education also, a researcher needs to acquaint himself with the latest knowledge, information about what has been done in the particular area from which he intends to take up a research problem. In order to solve a particular problem, a careful review of the research journals, books, educational surveys, dissertations, theses and other sources of information related to the problem must be undertaken after the problem has been selected by the researcher. Related literature provides us a clear picture of the problem under research. The review of literature has two phases; first of all, it includes identifying all relevant material published in the problem area and in the secondary phase is for the benefit of the researcher and the readers. For the researcher, it establishes the document in the field and for the readers it provides a summary of thinking.

The review of the related literature is considered essential for many reasons. It helps to identify the unanswered questions in the concerned fields on the one hand and in locating the specific issues, requiring immediate and pointed attention by the researcher in avoiding unnecessary duplication of efforts and focusing on the relevant aspects of the issue under reference. He must devote sufficient time in reviewing of research already undertaken on related problems. “The research for reference materials is a time consuming but fruitful phase of investigation” (Best 1961). A familiarity with the literature on any problem area helps the students to discover what is already known, what others have attempted to find, and what methods have been found to be promising or disappointing and what problems remain to be unsolved. In order to be creative and original, one must read extensively and critically as a
stimulus to thinking. Review of related literature also serves the subsequent purposes for the research:

- To define the limits of field. It enables the researcher to define and delimit his problem.
- To state the objectives clearly and precisely. The knowledge of the related literature provides the researcher up-to-date information on works done by others.
- To eliminate the risk of duplication of what has already been done. It also helps in providing ideas, theories, explanation or hypotheses valuable in formulating the problems.
- To avoid worthless problems, by making the researcher select those areas in which positive findings are likely to result and his efforts would be likely to add to the knowledge in a meaningful way.
- To equip the researcher with an understanding of research methodology, which mentions the way of study is to be administered.
- To avail the researcher to know about the tools and instruments which prove to be useful and promising.

Review of related-litterature plays the pivotal role at the crucial juncture of planning of the study. It is an intellectual pursuit “essential to the development of the problem and to the deviation of an effective approach to its solution.” It works as guide post not only with regard to the quantum of work done in the field but also to perceive the gaps and lacuna in the concerned field of research. Therefore, the investigator thought it pertinent to review the related researches and literatures to study the specific problem.

The main objective of the present study was to make, “A Study on the Relationship between Cognitive Ability and Academic Achievement of Eighth Standard Pupils in Coimbatore”.

For this purpose, the investigator has tried to review all the available studies carried out in India and foreign countries as much as possible pertaining to different aspects of Cognitive Ability test. This chapter is presented under two heads:
1. Theoretical Perspective
2. Review of Related Studies
2.2 THEORETICAL PERSPECTIVE

2.2.1 COGNITIVE ABILITY

One way in which talented individuals can be identified is through the evaluation of their general cognitive ability. General cognitive ability is the ability that consistently differentiates individuals on mental abilities regardless of test or task (Jensen, 1998). Cognitive ability tests are also known more broadly as aptitude and ability tests or general intelligence assessments.

These cognitive ability tests can help to show schools and educational institutions to know how quickly one can pick up task, how well an individual be able to make appropriate decisions in a timely manner, whether the individual be able to cope well with situations that are new to more complicated and whether one can exercise sound reasoning and provide suitable solutions to problems. Ultimately, these cognitive ability tests can give a strong indication of likely overall academic performance, as well as identifying areas that require development and coaching. Sometimes cognitive ability tests can be used in schools, to give teachers an idea of where to focus teaching.

Cognitive ability is assumed to be composed of a number of hierarchically ordered abilities with a very general cognitive ability factor at the top of the hierarchy (McGrew, 2009). Numeracy, literacy, and problem solving are probably strongly related to this general factor, but they do not capture all aspects of human intellect. Thus, numeracy, literacy, and problem solving might still be correlated with uncaptured ability in the error term and, through this, they might become endogenous variables. In addition, since education is highly correlated with ability, it might also be an endogenous variable.

There is greater evidence for hereditary influences on cognitive ability than for the pinpointing of many specific influential genes. The level of influence has been found to vary with age and potentially other environmental factors (Deary, 2012).

Cognition involves the capacity to make sense of the self and the world, through action and language. Meaningful learning is a generative process of representing and manipulating concrete things and mental representations, rather than storage and retrieval of information. Thinking, language (verbal or sign) and doing things are thus intimately intertwined. This is a process that begins in infancy, and develops through independent and mediated activities. Initially, children are cognitively oriented to the here and now, able to reason and act logically on concrete experiences.
As their linguistic capabilities and their ability to work in the company of others develop, it opens up possibilities of more complex reasoning in tasks that involve abstraction, planning and dealing with ends that are not in view. There is an overall increase in the capability of working with the hypothetical, and reasoning in the world of the possible.

Cognition is the word that psychometrics experts and psychologists use for describing thought processes. Cognitive ability encompasses thought processes that lead to speed up information processing. This means looking at how quickly one can move from perception and acquisition of knowledge, to retaining it, organising it around the existing knowledge and then being able to take those concepts and apply them again in a different situation. This is related to problem-solving, analytic and reasoning skills. There are a wide range of cognitive ability tests, some of which include:

- **Verbal reasoning** solves problem from concepts presented in language
- **Numerical reasoning** solves problem from concepts presented in numbers
- **Abstract reasoning** solves problem solving from visual concepts and images
- **Mechanical reasoning** makes sound judgements using basic principles of science and mechanics
- **Logic and logical reasoning** makes sound judgements and problem solving using logical thinking
- **Spatial ability** manipulates ability to manipulate 2D shapes and visualise 3D concepts
- **Verbal ability** comforts and skill with language e.g. spelling, grammar, synonyms, analogies, written instructions
- **Quantitative ability**, comfort and skill with numbers e.g. decimals, fractions, percentages, number sequences, basic arithmetic, charts and graphs
- **General Intelligence Assessment (GIA)** applies speed of processing new information and applying it to what is known already.
The basic features of cognitive ability constructs are the ability measures that assess the content and performance, it has a unipolar dimension, it is value directional, and the abilities are domain and content specific.

There are a large number of different types of cognitive ability tests. Cognitive ability relates to how quickly and accurately one can process information. Information can be presented verbally, numerically or in spatial and abstract forms. The Thomas General Intelligence Assessment (GIA) measures cognitive aptitudes and abilities across five areas detailed below:

![Diagram showing measures of cognitive abilities and aptitudes]

Figure: 2.1 Measures of Cognitive Abilities and Aptitudes
2.2.2 LEVELS OF COGNITIVE ABILITY

Table 2.1 LEVELS OF COGNITIVE ABILITY

<table>
<thead>
<tr>
<th>Level</th>
<th>Capacity</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>The ability to recall learned materials. It can range from the recall of simple facts to complete theories. It represents the lowest level of learning outcome, requiring only that the student recall previously learned information.</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td>The ability to grasp the meaning of material learned. The student may show understanding of the material by translating it from one form to another by conveying meaning, or by making summary statements about it.</td>
</tr>
<tr>
<td>2</td>
<td>Application</td>
<td>The ability to use learned materials in new and concrete situations. The student is required to apply rules, concepts, principles, laws, or theories.</td>
</tr>
<tr>
<td></td>
<td>Analysis</td>
<td>The ability to break material down into its component parts so that its organizational structure may be understood. The student demonstrated attainment of objectives through the ability to identify parts, show relationships, and recognize organizational principles.</td>
</tr>
<tr>
<td>3</td>
<td>Synthesis</td>
<td>The ability to put parts together to form a new whole. The student demonstrated an ability to devise a new plan of operation, or to produce a set of abstract relations.</td>
</tr>
<tr>
<td></td>
<td>Evaluation</td>
<td>The ability to judge the value of materials. The student might be required to judge the value of a statement, a piece of prose, a poem, an advertisement or a research report.</td>
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Characteristics of Ability Tests

- Usually timed (approximately 15 - 40 minutes)
- Consist of short questions where there is only one right answer but a lot of wrong ones.
- Are typically multiple choice, or short answer format where you are asked to provide a number or a single word response
• Are generally designed to discriminate between highly talented candidates therefore few candidates finish them.
• The questions usually become progressively more difficult.
• Each question is commonly worth the same value therefore speed of cognitive processing and number of correct answers are important
• Most ability tests do not penalise you for incorrect answers, you will need to check this with the test supervisor before you begin.
• They are usually paper and pencil tests although some are available in electronic format.

2.2.3 MODELS OF GENERAL COGNITIVE ABILITY

Multiple models describe the nature of general cognitive ability, but for the purpose of the present study, the researcher focus on the most widely recognised and accepted models in the field.

- Spearman’s general intelligence factor or ‘g’.
- Cattell’s models of crystalized and fluid intelligence
- John Carroll’s three stratum model of cognitive ability

1. Spearman’s Two-Factor Theory.

Charles Spearman developed factor analysis in order to study correlations between tests. Initially, he developed a model of intelligence in which variations in all intelligence test scores are explained by only two kinds of variables: first, factors that are specific to each test (denoted s); and second, a ‘g’ factor that accounts for the positive correlations across tests. This is known as Spearman's two-factor theory. The ‘g’ factor (also known as general intelligence, general mental ability or general intelligence factor) is a construct developed in psychometric investigations of cognitive abilities and human intelligence. It is a variable that summarizes positive correlations among different cognitive tasks, reflecting the fact that an individual's performance on one type of cognitive task tends to be comparable to that person's performance on other kinds of cognitive tasks.

Spearman (1904) first popularized the observation that individuals who do well on one type of mental task also tend to do well on many others. For example, people who are
good at recognizing patterns in sequences of abstract drawings are also good at quickly arranging pictures in order to tell a story, telling what three dimensional shapes drawn in two dimensions will look like when rotated, tend to have large vocabularies and good reading comprehension, and are quick at arithmetic. This pattern of moderate to strong positive correlations across the whole spectrum of mental abilities led Spearman to hypothesize the existence of a general mental ability similar to the common notion of intelligence.

The ‘g’ factor typically accounts for 40 to 50 percent of the between-individual performance differences on a given cognitive test, and composite scores ("IQ scores") based on many tests are frequently regarded as estimates of individuals' standing on the ‘g’ factor. According to him intellectual abilities are comprised of two factors, namely; the general ability known as ‘g’ factor and Specific Abilities known as ‘s’-factors (Figure 2.1). The performance by the individual is determined by the ‘g’ -factor and the S-factors. The total intelligence of the individual is the sum total of the ‘g’-factor and the’s’-factors. The performance of a particular task depends on the ‘g’ factor or general ability and the particular's’ factor or specific ability. ‘g’ factor represents Native Intelligence thus when we respond to any situation or perform an intellectual task, our general mental ability or ‘g’ factor is mainly responsible for it and our specific ability in that particular task is responsible for the rest.

<table>
<thead>
<tr>
<th>Characteristics of ‘g’ Factor:</th>
<th>Characteristics of ‘s’ Factor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It is universal inborn ability.</td>
<td>• It is learned and acquired in the environment.</td>
</tr>
<tr>
<td>• It is general mental energy.</td>
<td>• It varies from activity to activity in the same individual.</td>
</tr>
<tr>
<td>• It is constant.</td>
<td>• Individuals differ in the amount of 's' ability.</td>
</tr>
<tr>
<td>• The amount of 'g' differs from individual to individual.</td>
<td>• Mass of ‘s’ is unlimited.</td>
</tr>
<tr>
<td>• It is used in every activity of life.</td>
<td>• 's' factor can be improved.</td>
</tr>
<tr>
<td>• Greater the 'g' in an individual, greater is his success in life.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2.2: Characteristics of ‘g’ and ‘s’ factor
There are a large number of specific abilities such as ability to draw inferences, ability to complete sentences, ability to code message etc. Different individuals differed both in their ‘g’ as well as ‘s’ factors. For e.g. an individual’s performance in literature is partly due to his general intelligence and partly due some specific aptitude for his language, i.e. g+s1. In mathematics his performance may be the result of g+s2. In drawing, it may be due to g+s3 and in social sciences; it may be due to g+s4 and so on. Thus the factor ‘g’ is present in all specific activities which is depicted in figure 2.3 and 2.4

![Figure 2.3: General Mental Ability and Specific Ability](image-url)
Figure 2.4: Spearman’s Two-Factor Theory or Eclectic Theory

A person’s ability with any particular type of task would be equal to the sum of that person’s general ability plus considerations unique to that particular task. Thus general ability could be measured by constructing subtests of a number of similar items (individual tasks of the same type such as arithmetic problems) of differing complexity. Each subtest would present items of a different type and individual scores across subtests could be aggregated. Task specific factors would average out leaving the final score as mainly a measure of general ability or “g.” Using an approach like this Binet (1905) developed the first IQ test as a way of identifying student’s academic potential.

The test that was adapted for use in English by Terman and in 1916 became the Stanford-Binet IQ tests – still one of the most commonly administered tests of cognitive ability. Spearman’s hypothesis of a single general mental ability and many specific abilities was challenged by Thurstone (1935), who popularized the notion that people had a number of independent primary mental abilities rather than a single general mental ability. Both Spearman and Thurstone made contributions to the development of factor analysis as a way to identify the presence of unobserved variables (abilities) that affect a number of observable variables (sub-test or item scores). Today, the Spearman-Thurstone debate has been resolved with a compromise. The most common view among psychometricians who study cognitive
ability is that there are a number of different abilities. Some people are better at solving problems verbally while others are good at solving problems that involve visualization. Some people who are good at both of these things may be only average at tasks that rely heavily on memory. However, there is a tendency for people who perform well in any of these broad areas also to perform well in all others as well (Carroll 1993). Most modern tests of cognitive ability provide both a full scale score that is most reflective of general intelligence, and a number of special ability specific sub-scores as well.

2. Cattell’s Models of Crystalized and Fluid Intelligence

Raymond Cattell first proposed the concepts of fluid and crystallized intelligence and further developed the theory with John Horn. The Cattell-Horn theory of fluid and crystallized intelligence suggests that intelligence is composed of different abilities that interact and work together to produce overall individual intelligence.

Fluid Intelligence

Cattell defined fluid intelligence as "...the ability to perceive relationships independent of previous specific practice or instruction concerning those relationships." Fluid intelligence involves being able to think and reason abstractly and solve problems. This ability is considered independent of learning, experience, and education. Examples of the use of fluid intelligence include solving puzzles and coming up with problem-solving strategies. Fluid intelligence tends to decline during late adulthood. Fluid intelligence refers to quantitative reasoning, processing ability, adaptability to new environments and novel problem solving.

Crystallized Intelligence

Crystallized intelligence involves knowledge that comes from prior learning and past experiences. Situations that require crystallized intelligence include reading comprehension and vocabulary exams. This type of intelligence is based upon facts and rooted in experiences. As we grow and accumulate new knowledge and understanding, crystallized intelligence becomes stronger, this type of intelligence tends to increase with age. Crystallised intelligence ($Gc$) refers to the accumulation of knowledge (general, procedural and declarative). $Gc$ tasks
include problem solving with familiar materials and culture-fair tests of general knowledge and vocabulary (Horn & Cattell, 1966). $G_f$ and $G_c$ are both factors of $g$ (general intelligence).

**Fluid vs. Crystallized Intelligence**

According to Knox (1977), "...they constitute the global capacity to learn reason and solve problems that most people refer to as intelligence”.

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**Table: Fluid vs. Crystallized Intelligence**

<table>
<thead>
<tr>
<th>Fluid Intelligence</th>
<th>Crystallized Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherited ability to reason and think</td>
<td>Accumulated knowledge and information acquired over a lifetime</td>
</tr>
<tr>
<td>Neurophysiological base: dependent on the state of the brain and nervous system</td>
<td>Application of skills and knowledge to problem solving</td>
</tr>
<tr>
<td>Minimal dependence on school learning or acculturation</td>
<td>Education dependent</td>
</tr>
<tr>
<td>Inductive reasoning; problem solving</td>
<td>Verbal and general knowledge</td>
</tr>
<tr>
<td>Nature</td>
<td>Nurture</td>
</tr>
</tbody>
</table>

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**Figure: 2.5 Fluid and crystallized intelligence**
Fluid and crystallized intelligence are complementary in that some learning tasks can be mastered mainly by exercising either fluid or crystallized intelligence. Both types of intelligence are equally important in everyday life. For example, when taking a psychology exam, you might need to rely on fluid intelligence to come up with a strategy to solve a statistics problem, while you must also employ crystallized intelligence to recall the exact formulas you need to use.

Fluid intelligence along with its counterpart, crystallized intelligence, are both factors of what Cattell referred to as general intelligence. While fluid intelligence involves our current ability to reason and deal with complex information around us, crystallized intelligence involves learning, knowledge and skills that are acquired over a lifetime.

It is important to note that despite the name, crystallized intelligence is not a form of fluid intelligence that has become 'crystallized.' Instead, the two factors of general intelligence are considered separate and distinct.

3. Three Stratum Theory of Cognitive Abilities

John B. Carroll proposed a three stratum factor analytic theories of cognitive abilities. This theory claims that there are many differences in cognitive ability and the relationship with these individual differences can be categorised into three different levels. “All of the abilities covered by the theory are assumed to be ‘cognitive’ in the sense that cognitive processes are critical to the successful understanding and performance of the tasks requiring these abilities, most particularly in the processing of mental information. In many cases, they go far beyond the kind of intelligence measured in typical batteries of intelligence test”, (Carroll, 1993)

"The three-stratum theory of cognitive abilities is an expansion and extension of previous theories. It specifies what kinds of individual differences in cognitive abilities exist and how those kinds of individual differences are related to one another. It proposes that there are a fairly large number of distinct individual differences in cognitive ability, and that the relationships among them can be derived by classifying them into three different Strata: Stratum I, 'narrow' abilities; Stratum II, 'broad abilities; and Stratum III, consisting of a single 'general' ability (Carroll, 1997)"
Path diagrams are wonderfully economical and precise methods of communicating the structure of a model. For example, Carroll’s (1993) Three Stratum Theory of Cognitive Abilities is usually shown like the figure 2.6

![Figure: 2.6 Three - Stratum Theory of Cognitive Abilities](image)

However, this model implies things that might not be strictly true. For example, it is possible that not all of the broad abilities (including g) are distinct entities. It is possible that some of them, to some degree, are what is called hierarchical abstractions. The basic idea is that there might not be some general ability that applies to many different tasks. It is possible that certain distinct abilities tend to be used together in the same kinds of tasks, often forming a functional unity. For example, inductive and deductive (sequential) reasoning are rarely used separately. Rather, they are used in tandem to reach logical conclusions (in a syllogism, for example). Thus, it is reasonable to talk about a superordinate category of fluid reasoning even though it consists of distinct processes. So, in a much abbreviated form, Gf and Gc can conceptualized like so. (Schneider, 2014)
Narrow Abilities (Stratum I)

In this level there are 65 narrow abilities. Example of this abilities in this level are sequential reasoning, reading comprehension, memory span, visualisation, speech-sound discrimination, originality/creativity, numerical facility and simple reaction time.

Broad Abilities (Stratum II)

There are eight broad factors. These are the eight fluid intelligence, crystallized intelligence, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, broad processing speed as presented in figure 2.7

**Figure 2.7- Three - Stratum Theory of Cognitive Abilities**

**Fluid intelligence**-

A type of intelligence that are concerned with basic processes of reasoning and other mental activities that depend only minimally on learning and acculturation.
Crystalized intelligence -

A type of intelligence that are concerned with mental processes that reflects not only the operation of Fluid intelligence, but also the effects of experience, learning, acculturation.

General memory and learning -

The ability involved in the tasks that call learning and memory of new content or responses.

Broad visual perceptions -

An ability involved in tasks or performances that require the perception or discrimination of visual forms as such; involved only minimally, if at all, in the perception of printed language forms.

Broad auditory perception –

An ability involved in tasks or performances that require the perception or discrimination of auditory patterns of sound and speech, particularly when such patterns present difficulties because of fine discrimination, auditory distortion or complex musical structure.

Broad retrieval ability –

Ability involved in tasks or performances that require ready retrieval of concepts or items from long term memory.

Broad cognitive speediness -

Ability involved in tasks or performances that require rapid cognitive processing of information.

Processing speed –

Ability involved in tasks or performances that require reaction time and/or decision speed.

General

At this level it only contains the general factor (ex.g)
Difference from other theories

Carroll’s theory includes a general ability factor. Includes quantitative reasoning as narrow abilities subsumed by Gc. Carroll’s theory includes reading and writing as narrow abilities subsumed by Gc. Includes short term memory with other memory abilities, such as associative memory, meaningful memory and free recall memory.

COGNITIVE VIEW OF INTELLIGENCE

Each person has an individual profile of characteristics, abilities and challenges that result from predisposition, learning and development. These manifests as individual differences in intelligence, creativity, cognitive style, motivation and the capacity to process information, communicate, and relate to others.

Although theories of intelligence have been discussed by philosophers since Plato, intelligence testing is an invention of educational psychology, and is coincident with the development of that discipline. Continuing debates about the nature of intelligence revolve on whether intelligence can be characterized by a single factor known as general intelligence, multiple factors (e.g., Gardner's theory of multiple intelligences) or whether it can be measured at all. In practice, standardized instruments such as the Stanford-Binet IQ test and the WISC are widely used in economically developed countries to identify children in need of individualized educational treatment.

The tests that have been in development the longest, and with the largest research base supporting their reliability and accuracy in predicting school outcomes, are those that measure general intelligence (g) and specific cognitive factors (s) and those that measure achievement in a specific domain of study. Examples include

- The Wechsler series of intelligence and achievement scales (i.e., Wechsler, 2000, 2009),
- The Stanford-Binet Intelligence Scales (Roid, 2006),
- The Woodcock-Johnson series (i.e. Woodcock, McGrew, & Mather, 2001a, 2001b),
- The Cognitive Abilities Test (CogAT) (Lohman & Hagen, 2001), and
- The Iowa Tests of Basic Skills (ITBS) (Hoover, Dunbar, & Frisbie, 2005).
2.2.4 THE COGNITIVE ABILITIES TEST

A test designed to measure an individual’s cognitive function in a specific area, such as verbal reasoning, spatial awareness or mathematics. Cognitive ability develops from birth through adulthood. It is closely related to individual’s success in school. It measures both specific and general abilities. It predicts level of achievement.

Ability testing focuses on questions like what an individual can do at their very best. They measure capacity or potential of an individual rather than achievement. The Cognitive Abilities Test is a group-administered assessment intended to estimate students' learned reasoning and problem solving abilities through a battery of verbal, quantitative, and nonverbal test items. The test purports to assess students' acquired reasoning abilities while also predicting achievement scores. The author of the test is David F. Lohman, Professor Emeritus at the University of Iowa.

An assessment of reasoning ability can identify where a pupil’s real strengths lie, free from the constraint of the curriculum and unencumbered by learning barriers. Assesses a pupil’s ability to reason with and manipulate different types of material, through a series of Verbal, Non-verbal, Quantitative tasks. Together, these three tests provide teachers with a comprehensive profile of a pupil’s reasoning abilities, and as such the core abilities related to learning.

The resulting data can then be used to identify a pupil’s strengths, weaknesses and learning preferences, providing accurate and reliable information that is essential for personalised learning. The more is known about a pupil, the better position should be in to offer a learning environment and ways of teaching and learning that allow pupils to maximise their potential. Information about a pupil’s reasoning ability will be the key to many decisions and should be considered alongside attainment data and other factors known to impact on learning, such as attendance and attitude. It helps identify gifted and talented pupils.

The Cognitive Ability Test Battery is divided into three main batteries viz., Verbal, Quantitative and Non-Verbal:-Figure 2.8
Traditionally, the general trait measured by cognitive ability tests is called "intelligence" or "general mental ability." If an individual score is computed for each of the
specific types of abilities (e.g., numeric, verbal, reasoning), then the resulting scores represent measures of the specific mental abilities as shown in figure 2.9

<table>
<thead>
<tr>
<th>Battery</th>
<th>Abilities</th>
</tr>
</thead>
</table>
| **Verbal Battery**    | • verbal inductive and deductive reasoning  
                          • flexibility, fluency and adaptability working with verbal materials and problems  
                          • skills measured after reading comprehension, critical thinking, writing and all verbal learning tasks |
| **Quantitative Battery** | • inductive and deductive reasoning in working with quantitative symbols and concepts  
                              • flexibility, fluency and adaptability  
                              • order, structure and give meaning to a set of numerals |
| **Non-Verbal Battery** | • use only geometrical shapes and figures  
                               • No reading and no outside fund of knowledge is required  
                               • requires reasoning but not spatial reasoning |

**Figure: 2.9 Measurement of Batteries**

**REASONING**

Success in the school depends upon on academic knowledge and skills in the domain of the study. It depends upon the ability to reason well in the symbol systems used to communicate new knowledge. The Reasoning abilities are important because they are the core
of human cognitive abilities, best predictors of success in school. It is most central cognitive ability.

Reasoning is the generation or evaluation of claims in relation to their supporting arguments and evidence. The ability to reason has a fundamental impact on one's ability to learn from new information and experiences because reasoning skills determine how people comprehend, evaluate, and accept claims and arguments. Reasoning skills are also crucial for being able to generate and maintain viewpoints or beliefs that are coherent with, and justified by relevant knowledge.

A number of cognitive skills would be expected to affect the quality of such reasoning. The first is the ability to fully comprehend the meaning of the claim being made. Understanding the conceptual content is crucial to being able to consider what other information might bear on the truth or falsehood of a claim. Other cognitive processes involved in reasoning include the retrieval of relevant knowledge from long-term memory, seeking out new relevant information, evaluating the validity and utility of that information, generating alternatives to the claim in question, and evaluating the competing claims in light of the relevant information. Reasoning essentially involves thinking.

While for reasoning one has to explore deep into the mind’s regions, do some mental acts, interpret symbols or make use of knowledge. It is education that transforms reasoning savage to reasoning human being. The test of reasoning is a method of measuring the mental capacities. It includes the ability to solve problems and arrive at answers in a logical way.

The underlying goal of general ability tests is to assess potential candidates in terms of their overall intellectual potential and build a profile of their individual strengths and weaknesses.

Everyday reasoning depends heavily on the efficacy of past reasoning processes (stored as knowledge) as well as the efficacy of present reasoning processes. An increasingly sophisticated knowledge base supports increasingly eight sophisticated forms of reasoning. A more sophisticated knowledge base has richer, more abstract associative connections between concepts and more metacognitive knowledge that links strategies to goals. This frees working memory resources for problem solving (Gobet & Waters, 2003; Feltovich et al., 2006; Horn & Masunaga, 2006; Proctor & Vu, 2006). The components of verbal, Quantitative and Non-verbal Batteries is as shown in figure 2.8.
Figure: 2.10 Classification of the cognitive Ability Batteries
Verbal Reasoning Or Verbal Battery

The Verbal Battery is used to assess a student’s vocabulary, efficiency and verbal memory, ability to determine word relationships, and the ability to comprehend ideas. The Verbal test is comprised of three subtests. Three subtests are: Sentence Completion, Verbal Classification, and Verbal Analogies. It is the best predictor of academic success. These three subtests combined make up the Verbal score as indicated in figure 2.9

![Diagram of Verbal Reasoning Subtests]

**Figure: 2.11 Subtests of Verbal Reasoning**

These tests usually involve grammar, verbal analogies and following detailed written instructions. They can also include spelling, sentence completion and comprehension. Verbal reasoning tests of intelligence provide an assessment of an individual's ability to think, reason and solve problems in different ways.

The verbal battery reflects the importance of verbal symbolism in education and is designed to test flexibility in the use of concepts. It consists of sentence construction, verbal classification and verbal analogies.

- Sentence construction requires the student to insert a word to make sense of a sentence.
- Verbal classification involves finding the word that belongs to the same set as three or four others.
- Verbal analogies items, the student is given two related words as an example. Another word is given and the student is required to select a same relationship to it.

**Quantitative Reasoning Or Quantitative Battery**

Quantitative Battery assesses students’ quantitative reasoning and problem solving abilities. This section also evaluates the students’ level of abstract reasoning. The Quantitative Battery is comprised of three subtests: Number Series, Number Puzzles, and Number Analogies. These three subtests combined make up the Quantitative score. It is the “number sense” ability to see the relationship of numbers.

The quantitative battery is designed to "require almost no reading of verbal symbols". It consists of quantitative relationships, number series and equation building.

- The quantitative relationship items require the student to state whether the first of a pair of numbers is greater than, equal to or less than the other.
- The student has to find the next term in a sequence in the number series items.

The equation building items require the students to arrange a series of numbers and operations to produce one of the listed results as presented in figure 2.11

![Diagram](image)

**Figure: 2.12 Non-Verbal Reasoning or Non-Verbal Battery**

The Non-Verbal Battery is used to assess a student’s reasoning abilities through the use of spatial and figural content. The test is useful for assessing the development of students who have trouble with reading, limited capability in language, or who have limited
opportunities. The subtests use geometric shapes and figures which have unlikely been seen by the students in their formal schooling. There is no reading required among the questions in the Nonverbal test. These three subtests are: Figure Matrices, Paper Folding, and Figure Classification. Best predictor of how fast the student learns. These three subtests combined make up the Nonverbal score.

Verbal reasoning and quantitative reasoning together are related to academic ability. The items in the non-verbal battery use neither words nor numbers and have little relationship with the formal school curriculum and it is claimed that this battery provides a measure of fluid intelligence. The non-verbal battery consists of Figure Matrices, Paper Folding, and Figure Classification.

- In the classification items, the student has to select a figure belonging to the same set as three others. Shading, closure, intersections, linearity and many other properties can classify the figures.
- In the figure analogies items, a figure and its image are given. The image corresponding to a new object is required.
- In the figure synthesis items several "component" shapes are shown and the student is required to specify which of a selection of shapes can be formed by from these components.

2.2.5 ACADEMIC ACHIEVEMENT

Academic performance is defined as "the assessment issued by the school as a particular kind of educational evaluation specially characterized by the decisions that trigger its realization" (Rodríguez & Gallego, 1992). In general terms, academic performance is classified as high, medium or low. Occasionally, such rating is quantitative Achievement tests.

- The achievement tests have been standardised for educational levels from preschool to college.
- They focus on educational attainment rather than psychological attributes.
- Any test that measures the accomplishments of an individual after a period of training or learning. The type of ability test that describes what a person has learned to do.

Functions of achievement test, provides basis for promotion to next grade, find out where each student stands in various academic areas, motivate the students before a new
assignment has taken up and expose pupil’s difficulties which the teacher can help them to solve.

Academic achievement has become an educational touchstone since the passage of the federal. No Child Left Behind Act in 2001, requiring all educators - to formally define how their programs impact students' academic growth and contribute to overall school success. It is important because it prepares students for future careers. It also allows students to enter competitive fields. Academic achievement is often a sign of a refined intellect, which can help students in all areas of their lives.

Academic achievement represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university. School systems mostly define cognitive goals that either apply across multiple subject areas (e.g., critical thinking) or include the acquisition of knowledge and understanding in a specific intellectual domain (e.g., numeracy, literacy, science, history). Therefore, academic achievement should be considered to be a multifaceted construct that comprises different domains of learning. Because the field of academic achievement is very wide-ranging and covers a broad variety of educational outcomes, the definition of academic achievement depends on the indicators used to measure it. Among the many criteria that indicate academic achievement, there are very general indicators such as procedural and declarative knowledge acquired in an educational system, more curricular-based criteria such as grades or performance on an educational achievement test, and cumulative indicators of academic achievement such as educational degrees and certificates.

All criteria have in common that they represent intellectual endeavors and thus, more or less, mirror the intellectual capacity of a person. In developed societies, academic achievement plays an important role in every person’s life. Academic achievement as measured by the GPA (grade point average) or by standardized assessments designed for selection purpose such as the SAT (Scholastic Assessment Test) determines whether a student will have the opportunity to continue his or her education (e.g., to attend a university). Therefore, academic achievement defines whether one can take part in higher education, and based on the educational degrees one attains, influences one’s vocational career after education. Besides the relevance for an individual, academic achievement is of utmost importance for the wealth of a nation and its prosperity.
2.2.6 COGNITIVE ABILITY AND ACADEMIC ACHIEVEMENT

Many researchers have examined cognitive ability and how it relates to academic achievement. Academic achievement or (academic) performance is the extent to which a student, teacher or institution has achieved their short or long-term educational goals. Cumulative GPA and completion of educational standards represent academic achievement.

General cognitive ability is a better predictor of future performance than grade point average (GPA). GPA measures academic achievement and can be influenced by a number of extraneous factors. Both GPA and general cognitive ability assess facets of performance; however they are completely distinct constructs (Atwater, 1992). More specifically, general cognitive ability and academic achievement are unable to reliably predict one another (Jensen, 1998) particularly in University settings (Furnham, Chamorro- Premuzic & McDougall, 2003). There is evidence that academic performance depends on cognitive variables: intellectual ability and prior knowledge (Carroll, 1993). In formal system of education mostly cognitive development of the child is regarded as one of the major indicator of quality education. The evaluation/examination plays major role in the assessment of the learner’s understanding level of the different subjects taught in the classroom.

The distinction between cognitive ability and academic achievement is important in the conceptual basis of under-achievement, particularly as educational systems around the world are increasingly concerned about student under-achievement (Phillipson 2008). Cog-g and ACH-g are separate but highly related constructs during childhood and adolescence and it was that s two different test batteries was consistent (Kaufman-et-al.-2012).

2.3 REVIEW OF RELATED STUDIES

Keeping in view the objectives of the present investigation, the review of literature is presented in a chronological order under the following headings:

A. Studies conducted on Verbal Ability.
B. Studies conducted on Quantitative Ability.
C. Studies conducted on Non-Verbal Ability.
D. Studies conducted on The Three Abilities (Verbal, Quantitative and Non-Verbal Ability)
E. Studies conducted on Cognitive Ability and Academic Achievement
F. Studies conducted on Verbal and Quantitative Ability
G. Studies conducted on Verbal And Non-Verbal Ability
H. Studies conducted on Cognitive Ability And Gender

2.3.1 Studies Related to Verbal Ability

The studies relating verbal ability and achievements have been reviewed. The details have been presented below.

Frederick and Patrick. (2015) investigated the effects of game and poem-enhanced instructional strategies on students’ interest in mathematics. The moderating effects of verbal ability were also examined on the dependent variable. A quasi-experimental design was adopted. Three hundred and forty four students in the sixth year of their primary education (primary 6 students) from 12 public primary schools in Ogbia and Yenagoa Local Government Areas of Bayelsa State, Nigeria, formed the sample of the study. The schools were randomly assigned to experimental and control groups. Seven reliable and validated instruments were used for the study. Three null hypotheses guided the study. Treatment had a significant effect on students’ posttest interest scores. Game and Poem-Enhanced Instructional Strategies and Verbal Ability improved students’ interest in mathematics more than the Modified Lecture Instructional Strategy. It was recommended that teachers, curriculum developers and authors should adopt games and poems to enhance students’ interest in Mathematics.

Gambari et al. (2014) studied the effectiveness of a computer-assisted pronunciation teaching (CAPT) package on the achievement of senior secondary students in oral English in Minna, Nigeria. It also examined the influence of CAPT on verbal ability and gender. The sample consisted of sixty senior secondary school students drawn from two coeducational secondary schools within the Minna metropolis. Stratified random sampling was used to select 60 students from each school: 15 males and 15 females; 10 high, 10 medium and 10 low verbal ability students. The results revealed that students taught oral English with the CAPT package performed and retained the concepts of oral English better than those taught with the traditional teaching method. Students with high verbal ability performed better than medium and low verbal ability students respectively.

Barmola (2013) explored the abstract and verbal reasoning (aptitude) among science and arts students. It is aimed to find out the difference between science and arts students in terms of abstract and verbal reasoning, and academic performance. A sample of 84 (42 each from science and arts group stream) students has been taken from a government school of
Tehri Garhwal (Uttarakhand-India). Data was collected by administering Differential Aptitude Test (DAT). It was examined through the significance of the difference between means. Results showed that there is significant difference found between science and arts students in terms of abstract and verbal reasoning (DAT).

Yadav (2013) Constructed and Standardized English Verbal Ability Test for School Students. The results showed there was no significant difference between mean score of 13 years old rural area boys and girls students on English Verbal ability test and English Verbal Ability of 15 years old urban area girls was higher than the boy’s school students.

Assouline et al. (2012) examined the cognitive and academic profiles of high ability students with autism spectrum disorder. Inclusion criteria were a diagnosis of autism (high functioning) or Asperger syndrome and at least one ability or achievement index standard score of 120 or above. Results indicated that despite the restricted range of cognitive abilities, students diagnosed with Asperger syndrome had significantly higher Verbal Comprehension Index scores than did students diagnosed with autism. However, students with autism had significantly higher scores on tests of math fluency and written expression than did students with Asperger syndrome.

Benichov et al. (2012) examined the effects of adult age, hearing acuity, verbal ability and cognitive function on the use of linguistic context in spoken word recognition. Fifty-three adults, aged 19 to 89, heard short sentences in which the final word was masked by multitasked babble. The level of babble was progressively reduced in 2 dB steps until the sentence-final word could be correctly identified. Published norms were used to construct sets of sentences in which the same word could be heard with three levels of predictability (low, medium, high) based on the linguistic context. Hearing loss had a significant effect on word recognition for words heard in a neutral context, but the effect of hearing acuity diminished progressively with increasing contextual probability of the target word. Cognitive function contributed significantly to the obtained variance in word recognition performance at all levels of contextual probability tested. Moreover, participant age accounted for a significant amount of variance even after hearing acuity and cognitive function were taken into account. Verbal ability in the range represented by the test participants did not contribute significantly to recognition performance in any of the context conditions.

Fuhs and Day (2011) studied Verbal ability and executive functioning development in pre-schoolers at head start. Research suggests that executive functioning skills may
enhance the school readiness of children from disadvantaged homes. This study examined the structure of executive functioning from fall to spring of the preschool year using a multi-method battery of measures. Confirmatory factor analyses revealed a uni-dimensional model fit the data well at both time points, and tests of measurement invariance across time points indicated that children's mean latent executive functioning scores significantly improved over time. Verbal ability was a significant predictor of longitudinal change in executive functioning.

Hughes et al. (2010) probed early individual differences in pro social behaviours are pivotal for children's peer relationships. To investigate the interplay among verbal ability, emotion understanding, and mother–child mutuality as predictors of pro social behaviours. They observed 102 children at the ages of two, three, and four. Regression analysis demonstrated robust associations between emotion understanding at the age of three and prosocial behaviour at the age of four. Path analysis showed that emotion understanding at the age of three mediated associations between verbal ability/mother–child mutuality at the age of two and prosocial behaviour at the age of four.

Aloe and Becker (2009) claimed that teachers’ verbal ability is among the most important predictors of school outcomes. Teachers’ verbal ability has been thought to predict student achievement ever since the relationship was found in the classic. By way of meta-analysis the authors examined the evidence on teachers’ verbal ability as a predictor of school outcomes. They found that the evidence was not as extensive as might be inferred from prior reports. Results of 19 studies indicated that teachers’ verbal ability was at best very weakly related to school outcomes, and the main evidence for this weak relationship arises from the EEO study. Other studies found that verbal ability was unrelated to school outcomes.

Heaton et al. (2008) explored on superior discrimination of speech pitch and its relationship to verbal ability in autism spectrum disorders. The findings revealed superior performance in ASD, although, like controls, discrimination of pitch in speech stimuli was poorer in this group than for non-speech stimuli. Whilst it was hypothesized that enhanced processing of speech pitch would correlate negatively with receptive language skills in ASD, the findings did not fully support this, and enhanced discrimination skills were observed in individuals without significant language impairment.

Abiodun and Folaranmi (2007) investigated the effects of verbal ability on students’ achievement with quasi-experimental one that used 3 x 3 x 2 factorial non-
randomized pretest -posttest – control group design. The independent variables were: verbal ability, error treatment strategies and gender. While verbal ability and error treatment operated at three levels each, gender operated at two levels. The dependent variable is students’ achievement in essay writing in English Language. Verbal ability was found to have significant effect on students’ achievement. All senior secondary school students in Osun State, Nigeria, constituted the population for this study. In view of the findings of this study, it was clear that students’ linguistic competence actually sets a limit to what they can do as far as essay writing in English is concerned.

Sampson, et.al. (2007) analysed disparities in verbal ability, a major predictor of later life outcomes, have generated widespread debate, but few studies have been able to isolate neighbourhood-level causes in a developmentally and ecologically appropriate way. The results indicated that living in a severely disadvantaged neighbourhood reduces the later verbal ability of black children on average by 4 points, a magnitude that rivals missing a year or more of schooling.

Andrew et al. (2005) suggested that verbal ability along with subject knowledge is sufficient for measuring good teaching. A small group of research studies called up on to support this contention. This study analysed the role of verbal ability in teaching, and presents research examination in the relationship of teacher’s verbal ability and teacher effectiveness. Research results indicate that for acceptable, good, very good, and outstanding teachers, there is no significant correlation between verbal scores and expert assessment of teacher effectiveness.

Petrides et al. (2005) presented the results from the first wave of longitudinal study examining the effects of various psychosocial variables on scholastic achievement and behaviour at school. The main aim was to investigate the nature and strength of the effects of major individual difference dimensions on important outcome variables at school level, including academic performance, truancy, and antisocial behaviour. The findings indicate that major individual difference dimensions like verbal ability and personality traits have a strong influence on important outcome variables at school level, including academic performance, truancy, and antisocial behaviour. Without fully acknowledging the crucial role of individual differences in shaping behaviour and achievement at school, the timely identification of pupils at risk, and the development of effective intervention schemes will be difficult.
Iyamu (2005) investigated the relationship between students' verbal ability and their achievement in Social Studies. The study used the grades of 2000 students in English Language and Social Studies for three years. These grades were converted to grade points and correlated, using the Pearson Product Moment Correlation and t-test. It was found that a significant positive correlation exists between the students' verbal ability and achievement in social studies. It was, therefore, recommended that strategies should be explored to facilitate the students' verbal ability so as to enhance their achievement in Social Studies.

2.3.2 STUDIES RELATED TO QUANTITATIVE ABILITY

Geary et al. (2016), assessed a suite of non-symbolic and symbolic quantitative competencies as well as their executive functions, verbal and nonverbal intelligence, pre-literacy skills, and their parents' education level. It was administered on the beginning of preschool (M = 46 months of age), 197 (94 boys) children. The children's Mathematics achievement was assessed at the end of preschool (M = 64 months). The results inform theoretical models of the foundations of children's early quantitative development and have practical implications for the design of early interventions for children at risk for poor long-term mathematics achievement.

Schalk et al. (2016) predicted the Relational Quantitative Reasoning in Kindergarten Mathematical Achievement in Third Grade, Tremendous variation in elementary school children’s mathematical achievement can partly be traced back to differences in early domain-specific quantitative competencies. A multiple regression analysis with mathematical achievement as outcome variable revealed a small but unique impact of children’s relational quantitative reasoning in kindergarten on their later mathematical achievement after controlling for general reasoning and reading abilities. Thus, a considerable amount of individual differences in Mathematics achievement in elementary school results from differences in early relational quantity understanding that emerge before systematic instruction starts.

Follette et al. (2015) reported on the development and validation of the Quantitative Reasoning for College Science (QuaRCS) Assessment, a numeracy assessment instrument designed for college-level general education science students. It has been administered to more than four thousand students over eight semesters of refinement. It is shown that the
QuaRCS is able to distinguish varying levels of quantitative literacy and present performance statistics for both individual items and the instrument as a whole.

**Finn et al. (2014)** studied the relationships between schooling, cognitive skills, and academic achievement in eighth grade students attending public schools in Boston. It was examined how schools influenced both test scores, which measure academic knowledge such as vocabulary and arithmetic, and fluid cognitive skills, which include the ability to reason and solve problems in novel situations. It was that students with high test scores and large improvements in test scores also have high levels of fluid cognitive skills.

**Warnimont (2010)** examined the relationship between students' performance on the Cognitive Abilities Test (CogAT) and the fourth and fifth grade Reading and Math Achievement Tests in Ohio. The sample utilized students from a suburban school district in Northwest Ohio. The correlation coefficient on all four achievement tests indicated strong positive significant relationships between scores on each achievement test and scores on the CogAT for the entire sample (n=292), while three of four of the coefficient correlations were weak for the below average group. Overall, the results indicated that the CogAT is significantly related to the fourth and fifth grade Reading and Math achievement tests, which indicates cognitive ability, and can be used to predict future academic achievement, while supporting the importance of making data-driven decisions.

**Adu et al. (2009)** investigated the relationship between quantitative ability (knowledge of Venn diagram; measures of central tendency; and percentage) and secondary school students’ achievement in Economics. The study adopted survey research design of the ex-post facto type. The findings revealed that students’ knowledge of measures of central tendency made the greatest contribution to their achievement in Economics (β = .653; p<.05). This is followed by Venn diagram (β = .580; p<.05). These two variables made contributions which are significant. Only Students’ knowledge of percentage made no significant contribution to their achievement in Economics (β = .450; p>.05). It is, therefore, recommended that these factors should be taken into consideration in order to enhance the understanding of Economics.

**Proctor (2005)** examined the relations between Cattell-Horn-Carroll Cognitive abilities and Math achievement. The Cognitive profiles of children with normative weaknesses in Math Calculation Skills or Math Reasoning were compared to those of their average-achieving peers. The cognitive profile of the low Math Calculation Skills group (n =
was similar to that of their average-achieving peers. The low Math Reasoning group (n = 52) scored lower than their average-achieving peers on the cognitive abilities as a set and on Fluid Reasoning and Comprehension–Knowledge. When individual profiles were considered, approximately half of the children with normative math weaknesses demonstrated commensurate weaknesses in one or more cognitive abilities, which may inform diagnostic models of learning disabilities.

Dwyer et al. (2003) discussed the construct of quantitative reasoning for assessment purposes within a construct validity framework that includes both a definition of the construct and threats to valid score interpretation. It is presented that for the quantitative reasoning it is necessary to utilize Mathematics content, almost exclusively in four areas well-defined by the NCTM’s and related standards: Number and Operations; Algebra; Geometry and Measurement; and Data Analysis and Probability. It is also found that, to ensure test fairness and score interpretability, solutions to test questions should not depend on a level of content knowledge beyond that which is assumed to be common to all of the test takers. Because this knowledge differs for different test-taking populations, tests of quantitative reasoning can be expected to vary with respect to the mathematical content of the questions.

2.3.3 STUDIES RELATED TO NON-VERBAL ABILITY

Bahar and Abdulkadir (2015) investigated problem solving as a core theme in education for several decades. Educators and policy makers agree on the importance of the role of problem solving skills for school and real life success. A primary purpose of this study was to investigate the influence of cognitive abilities on Mathematical problem solving performance of students. The author concluded that closed and open-ended problems require different cognitive abilities for reaching correct solutions. In addition, when combining all of these findings the author proposed that the relationship between cognitive abilities and problem solving performance may vary depending on the structure (type) and content of a problem. The author suggested that the content of problems that are used in instruments should be analysed carefully before using them as a measure of problem solving performance.

Sambo (2015) examined the students’ performance in Non-verbal Intelligence tests relative to academic achievement of some selected secondary school students. Two hypotheses were formulated with a view to generating data for the ease of analyses. Two non-verbal intelligent tests viz:- Raven’s Standard Progressive Matrices (SPM) and AH4 Part II Non-verbal Reasoning Tests were compared vis-à-vis the academic achievements in order to
determine the differences in students’ academic achievement. The findings therefore recommended that non-verbal intelligence test could be utilized to predict achievements especially where language problem seems to be prominent, thus, peaceful co-existence will prevail among student by streamlining their abilities in multi-dimensional approach.

**Ardoy et al. (2014)** analysed the effects of an intervention focused on increasing the time and intensity of Physical Education (PE), on adolescents' cognitive performance and academic achievement. A 4-month group-randomized controlled trial was conducted in 67 adolescents from South-East Spain, 2007. Three classes were randomly allocated into control group (CG), experimental group 1 (EG1) and experimental group 2 (EG2). CG received usual PE (two sessions/week), EG1 received four PE sessions/week and EG2 received four PE sessions/week of high intensity.

**Dinica (2014)** investigated Non-verbal communication - indispensable complement of oral and written communication. Animals communicate, but only humans communicate through language. These non-verbal ways of communication carry learned and sheared meanings and may also be considered languages of a kind.

**Ushie et al. (2014)** examined the effect of peer assisted co-operative instructional strategy on the ability levels of students. Two research questions and hypotheses were developed to guide the study. A nonrandomized pre-test and post-test control group design was adopted for the study. From the findings of the study, it was observed that peer assisted co-operative instructional strategy had effect on cognitive ability levels of chemistry students. The result also showed that there was no significant difference existing among the academic performance of male and female students taught with peer assisted co-operative instructional strategy.

**Vukovic et al. (2014)** investigated the longitudinal associations of domain-general and numerical competencies with individual differences in children's understanding of fraction. Mediation analyses controlling for general mathematics ability and general academic ability revealed that numerical and mathematical competencies were direct predictors of fraction concepts, whereas domain-general competencies supported the acquisition of fraction concepts via whole-number arithmetic computations or number line estimation. Results indicated multiple pathways to fraction competence.

**Gafoor and Remia, (2013)** observed that students lack mastery of elementary reading comprehension in Malayalam even by the end of 5-7 years of formal schooling, this
study applies multiple regression analysis for reading comprehension. Longitudinal survey data from a representative sample of 159 lower primary students from grade 2 to 4 revealed Reading Comprehension as significantly and positively related to Morphological Awareness, Phonological awareness and Ravens non-verbal ability. The three predictors account for near 1/3 of the variation in reading comprehension in Malayalam of elementary school learners.

**Giessman et al. (2013)** compared the performance of 5,833 second graders who took the CogAT6 and 4,038 kindergartners, first graders, and second graders who took the NNAT2 between 2005 and 2011 as part of a grade-wide screening for a gifted program. These results suggested that gifted programs should not assume that using a figural screening test such as the NNAT2, without other adjustments to selection protocol, will address minority under representation.

**Panc (2013)** explored the Impact of Personality upon the Response behaviour in Cognitive Ability Testing. This exploration study (N=162) correlating the 30 personality facets NEOPIR assesses and the scores at GAMA, revealed two significant correlations. Openness to experience - Aesthetics significantly correlated negatively with scores for cognitive ability ($r = -0.21$, $p<0.001$). The negative correlation pointed that the more open one was towards the aesthetics (such as the abstract design of the test stimuli therefore solve the test items as considered correct by the majority and obtain a higher score in the cognitive ability test.

**Flouri et al. (2011)** tested whether emotional arousal mediates the moderator effect of non-verbal cognitive ability on the association between cumulative contextual risk (number of proximal and distal adverse life events) and adolescent problem behaviour. Data from a UK community sample of secondary school aged children were used. They have implications for intervention design because they suggest that interventions carried out to enhance children’s emotion regulation skills in the presence of multiple adversities might be more effective if they target children who score low on non-verbal cognitive ability.

**Vitulić (2011)** predicted the students’ academic achievement: grade point average (GPA) and grades from specific subjects. The big five personality traits, included in the second step of analyses, significantly improved the prediction of grade in "psychology and didactics", for primary education students and overall grades for social pedagogy students, relative to the predictions based only on the cognitive abilities tests. Among the big five
personality traits, measured with BFQ (Caprara et al., 1997), conscientiousness was the only significant predictor of certain grades for both student group.

**Balboni et al. (2010)** did the concurrent and predictive validities of the Naglieri Nonverbal Ability Test (NNAT) and Raven’s Colored Progressive Matrices (CPM) were investigated in a large group of Italian third- and fifth-grade students with different sociocultural levels evaluated at the beginning and end of the school year. These two relatively simple non-verbal tests were commonly used to assess general ability; however, the study showed that they can also provide useful information for predicting the academic performance of students with different sociocultural levels.

**Lohman (2005)** discussed the role of nonverbal ability tests in the identification of academically gifted children. He noted that most non-verbal tests measure verbally mediated neither cognitive processes, that they are neither “culture free” nor “culture fair”. Therefore, the most academically talented minority students are those who show the strongest current achievement in particular domains and the best ability to reason in the symbol systems required for the acquisition of new knowledge in those domains. He also argued that, although current accomplishment can be measured on a common scale, judgments about potential must always be made relative to circumstances.

### 2.3.4 STUDIES RELATED TO THE THREE ABILITIES

**Logan et al. (2017)** explored the effects of general mental ability and motivation (operationalized as conscientiousness) on performance in an online distance education course. The results supported the hypotheses that both higher levels of motivation and higher general mental ability are positively associated with academic performance in a distance learning environment, while low levels of either motivation or general mental ability were associated with lower levels of performance.

**Bannink et al. (2016)** studied cognitive abilities of pre-primary school children without and with spina bifida in Uganda. Qualitative semi structured interviews and quantitative functioning scales measurements were combined and conducted with 133 parents, 133 children and 35 siblings. ANCOVA was used to test for differences in cognitive scores between children and siblings. Children of parents who have support had better motor functioning, and continence management. A holistic approach for children with spina bifida and their families, including community based rehabilitation; ensuring social support and
livelihoods for parents; and access to health and education services can contribute to better cognitive outcomes.

**Chi et al. (2016)** investigated the effects of cognitive ability, creativity, and self-esteem on kindergartners' problem behaviour. Participants were 203 children (mean age = 65.8 months) attending kindergartens in Korea. Data collection used the Korean version of Child Behaviour. There were four primary outcomes. First, there were negative correlations between children's problem behaviour (internalizing and externalising problems) and cognitive ability. Second, there was a negative correlation between internalising problems and fluency in creativity. No correlation was found between children's externalising problems and creativity. Third, there were negative correlations between children's problem behaviour (internalising and externalising problems) and self-esteem. Fourth, sequential processing, emotional competence, and fluency were revealed to be predictors of children's internalising problems. Social competency and sequential processing were found to be predictors of children's externalising problems.

**Cueto et al. (2016)** used the Young Lives longitudinal dataset in Peru to analyse if attending pre-school affects cognitive abilities at age five years, and if there is an interaction with HAZ at age one year. Using instrumental variables, they found that for receptive vocabulary, a positive effect of attending Jardines [216TDSDIF] (formal) pre-schools; the effect of attending PRONOEI (community-based) pre-schools was not significant. More years attending Jardines was more beneficial for children who were better nourished. It was suggested that working to improve the quality of PRONOEIs, and with teachers on targeting children of lower nutritional status.

**Haciomeroglu (2016)** investigated the object-spatial visualization and verbal cognitive styles among high school students and related differences in spatial ability, verbal-logical reasoning ability, and mathematical performance of those students. No significant differences were found between verbalizers and high spatial visualizers in their verbal-logical reasoning ability and mathematical performance scores. Results provided support for the existence of two contrasting groups of visualizers with respect to their spatial ability.

**Karamadi et al. (2016)** studied the impact of medium of instruction on verbal, numerical and reasoning abilities and academic performance of school students. The use of mother tongue against English, as medium of instruction, has created a wide spread debate all over the country. Decision about language (medium) of instruction in education policies is a
challenging task to the policymakers who have to give equal emphasis to students’ native language to maintain linguistic and cultural identity, and to English to promote students’ proficiency in the international language. The study investigated the impact of medium of instruction on verbal, numerical and reasoning abilities and academic performance of school students. It was hypothesized that the students who had their primary education in mother tongue medium and those who had studied in English medium do not differ significantly in their verbal, numerical and reasoning abilities as well as academic performance. The results revealed that students with primary education in English medium have significantly higher verbal ability, numerical ability and academic performance than those with primary education in mother tongue medium.

Mohammed (2016) aimed to identify the level of cognitive skills and abilities of children who suffer from the Attention Deficit and Hyperactivity Disorder (ADHD) and the differences in the level of cognitive skills and abilities according to the age group and the level of academic achievement. The results showed a low level of cognitive skills and abilities for the children with the ADHD and the absence of differences in the level of those skills and abilities depending on the different variables of age group and academic achievement.

Nisiforou et al. (2016) analysed the effect of mingling Students’ Cognitive Abilities and Learning Strategies to Transform CALL. Language researchers have identified a number of elements related to language performance. One of these factors is individual attributes of the language learners or their cognitive ability. The study found that the capacity to spontaneously shift back and forth between analytic and holistic modes of thought differs according to the nature of the learning task the learner is engaged with.

Adolphus et al. (2015) examined the association between habitual breakfast consumption frequency and Cognitive Abilities Test (CAT) performance, a reasoning test routinely used in UK schools. Adolescents aged 11–13 years (n=292; males: 53.8%) completed a questionnaire to report usual weekly breakfast intake frequency. Breakfast was subjectively defined by the participants. Habitual weekly breakfast consumption frequency was categorized as rare (0–2 days), occasional (3–4 days), or frequent (5–7 days). Contrary to expectations, there was no evidence to support the hypothesis that habitual breakfast skipping is negatively associated with CAT performance in this sample of 11-to13-year olds. The consistent null findings for verbal, non-verbal, quantitative, and overall reasoning ability indicated frequency of habitual breakfast did not influence performance on any CAT subtest.
Othman et al. (2015) focused on assessing the students' logical thinking and cognitive levels in an online collaborative environment. The aim was to investigate whether the online collaboration has significant impact to the students' cognitive abilities. The results revealed that the students at the early stage of learning programming are able to solve complex programming problems at the cognitive level Application and Analysis. There was also a strong correlation between students' logical thinking skills with their abilities to solve problems in an online platform with $r = 0.631$, significant at 0.012.

Sautelle et al. (2015) used social judgment theory to inform the design of processes to be used in selecting teachers for training programs. All included constructs were positively related to candidate selection, with Cognitive Ability the most valued attribute. Individuals clustered into three groups—one cluster high cognitive ability, a second cluster of people with high personality scores, agreeableness in particular, and a third characterized by high self-regulation and Resilience scores. Further research is required to validate the current findings however they lend support to the use of all six constructs in teacher selection, particularly cognitive ability.

Shweta (2015) investigated the effect of Shankhpushpi on cognitive abilities. Results found that the effect of Shankhpushpi would be dependent on duration also seems to be a true statement on the basis of these results as 20 days of Shankhpushpi was not effective, whereas 40 days of Shankhpushpi administration was effective in enhancing the abstract reasoning.

Pallabi Kalita (2013) studied creativity among the adolescents in relation to select variables-cognitive ability, socio-economic status and personality pattern. Findings indicated that the urban boys were significantly superior to the rural girls on the fluency component of verbal creativity. Though the urban boys scored higher than the rural boys and the urban girls scored higher than the rural girls, their difference was not significant.

Trapani (2013) studied differences in cognitive performance on verbal and quantitative measures among subjects of different ages. There is little difference in performance for 20-39 year olds on the verbal measure other than a positive effect for age at time of test. For the test-taker aged 40-64, there is a positive effect due to age, a positive cohort effect and a negative interaction effect between age and science study. Comparing the 20-39 year olds with the 40-64 year olds on the quantitative measure, the decline in performance for the older group was one-fourth the rate of decline in the younger group. For
the quantitative measure, after controlling for age, there was a positive cohort effect for both age groups.

**Gadke (2012)** probed agreeableness and cognitive ability, both powerful predictors of overt behavior, were explored for their influence on the selection of conflict resolution tactics and the display of overt behaviours in a naturalistic environment. Results indicating partial support for hypotheses about both Agreeableness and Cognitive Ability as separate predictors; however, there was no evidence of significant interaction effects for this study.

**Lakin (2012)** assessed the Cognitive Abilities of Culturally and Linguistically Diverse Students by Predictive Validity of Verbal, Quantitative, and Nonverbal Tests. Verbal and quantitative reasoning tests provide valuable information about cognitive abilities that are important to academic success. The two-year predictive relationship between ability and achievement scores revealed that nonverbal scores had weaker correlations with future achievement than quantitative and verbal reasoning ability for ELL and non-ELL students. Results do not indicate differential prediction and do not support the exclusive use of nonverbal tests for ELL students.

**Yashpal Azad (2012)** analysed the socio-economic status, subjective wellbeing and cognitive abilities among scheduled caste and non-scheduled caste students of urban and rural areas of Himachal Pradesh. The study intends to compare the scheduled caste and non-scheduled caste school students of rural and urban areas of Himachal Pradesh in terms of socioeconomic status, subjective well-being and cognitive abilities. The main effect of Locality was also found F (1, 476) = 18.40, p<.01 significant wherein the urban students were found better. There emerged a positive and significant relationships between socioeconomic status and Problem solving task (r = .201, p <.05) and its negatives with Free recall task i.e. Letters (r = -.203, p <.05) and planned composition tasks (r = -.383, p <.01) among urban scheduled caste school students.

**Jensen and Myriam E (2010)** studied the School counsellors influence the referral process and delivery of educational recommendations. Their perceptions of students’ cognitive abilities are likely to influence their referral decisions as well as their interpretation and use of the results of psychological testing. The Cattell-Horn-Carroll, (CHC), model of intelligence, is gaining acceptance owing to a growing mass of evidence supporting the theory’s diagnostic validity and potential utility in the field of education. Counter to
expectation, experience and education did not exert an influence on participants’ abilities to identify CHC Broad or specific broad abilities.

Wakode (2010) analysed prolonged deprivation and cognitive abilities of school going children. The results found that the non tribals had significantly better shape concept than the tribals: also the males were having significantly better shape concept than the females.

Floyd et al. (2007) employed structural equation modeling to examine the effects of Cattell–Horn–Carroll (CHC) abilities on reading decoding skills using five age-differentiated subsamples from the standardization sample of the Woodcock–Johnson III (Woodcock, McGrew, & Mather, 2001). Using the Spearman Model including only g, strong direct effects of g on reading decoding skills were demonstrated at all ages. Using the Two-Stratum Model including and broad abilities, direct effects of the broad abilities Long-Term Storage and Retrieval, Processing Speed, Crystallized Intelligence, Short-Term Memory, and Auditory Processing on reading decoding skills were demonstrated at select ages. The findings suggest that school psychologists should interpret measures of some specific cognitive abilities when conducting psycho educational assessments designed to explain reading decoding skills.

Strand (2004) evaluated and compared the consistency of VR, QR and NVR scores over a 3-year period, and explored the influence of the secondary school on pupils' progress in the tests. UK schools have a long history of using reasoning tests, most frequently of Verbal Reasoning (VR), Non-Verbal Reasoning (NVR), and to a lesser extent Quantitative Reasoning (QR). Results are used for identifying students' learning needs, for grouping students, for identifying underachievement, and for providing indicators of future academic performance. The results reveal high correlations in scores over time, ranging from .87 for VR to .76 for NVR, but also show around one-sixth of pupils on the VR test and one-fifth of pupils on the QR and NVR tests change their scores by 10 or more standard score points. Schools account for only a small part of the total variation in reasoning score, although they account for a much greater proportion of the variation in measures of attainment such as GCSE. School effects on pupils' progress in the reasoning tests between age 10 and age 13 are relatively modest.
2.3.5 Studies Related To Cognitive Ability and Academic Achievement

Cormier et al. (2016) investigated the role of broad cognitive abilities derived from the Cattell-Horn-Carroll (CHC) theory of intelligence in predicting skills associated with writing achievement. The normative sample from the fourth edition of the Woodcock-Johnson Tests of Cognitive Abilities and the Woodcock-Johnson Tests Academic Achievement were used to examine the relationships between broad CHC abilities and academic achievement in writing. The findings of this study suggested that the broad CHC abilities Comprehension-Knowledge, Processing Speed, and Fluid Reasoning are especially important predictors of basic writing skills and written expression during the school-age years. In general, changes in the strength of the association between cognitive abilities and academic achievement in writing were observed over time, as the cognitive demands involved in the writing increase in complexity in later grades.

Chong (2016), aimed to identify cognitive ability and academic achievement of undergraduates in University of Technology, Malaysia. In this study, cognitive ability is a combination of critical thinking, creative thinking, metacognition, and knowledge. A total of 336 undergraduates had participated in this study. Inferential analysis was used to explore the relationship between cognitive abilities and academic achievement of the respondents. The findings showed significant relationship between all cognitive abilities except knowledge and academic achievement. The multiple regression results showed that critical thinking, creative thinking, and metacognition has significant predictive power on undergraduates’ academic performance with $F(3,332) = 185.909, p < 0.001$. Critical thinking has the highest predictive power ($\beta = 0.491$) while creative thinking has the lowest predictive power ($\beta = 0.221$) on academic achievement. Future study can be done by applying group difference in order to understand more about the development of cognitive abilities among undergraduates.

Tong (2015) estimated the effect of human capital on leadership. Human capital measures included not only the traditional measures of education and on-the-job learning but also measures of cognitive and non-cognitive abilities. The measures of cognitive abilities included numeracy, literacy, and problem solving, and the non-cognitive abilities measures included perseverance, openness to learning, and social trust. Data came from the Programme for the International Assessment of Adult Competencies (PIAAC) survey for the United States. The results indicated that, in addition to education and on-the-job learning, both cognitive and non-cognitive abilities were significant and substantial determinants of leadership. More specifically, out of the cognitive abilities, the most important factor was
problem-solving ability; and among non-cognitive abilities included, perseverance was most important.

**Taub et al. (2014)** investigated the effects of general intelligence and seven specific cognitive abilities on college-age students’ mathematics achievement. The investigation went beyond previous research by employing structural equation modeling. The specific areas of intelligence demonstrating direct effects on the mathematics achievement dependent variable were Crystallized Intelligence and Fluid Reasoning. The effects of general intelligence were found to be "indirect" in the college-age sample.

**Alloway et al. 2013** investigated the impact of social networking sites (SNS) on cognitive abilities and reported levels of social connectedness in adolescents. In order to provide a reliable measure of cognitive skills, standardized tests of verbal ability, working memory, and academic attainment were administered. Students also responded to questions about the length and type of social media use (Facebook, YouTube, and Twitter). The findings indicated that young people who had used Facebook (but not YouTube) for more than a year had higher scores in tests of verbal ability, working memory, and spelling, compared to their peers who had used it for a shorter time period. The type of Facebook activities seemed to have an impact, as regression analyses confirmed that checking a friend's status updates was a significant predictor of verbal ability scores. However, regular or "active" engagement with SNS (each hour versus once a month) did not make a difference to their cognitive scores. Longer Facebook use, but not YouTube, was linked to higher reported levels of social connectedness. This pattern of results is interpreted in light of previous research, as well as the key physiological and social developments that occur during the adolescent period.

**Rudasill et al. (2013)** examined how children's cognitive abilities are related to their perceptions of their mothers' and fathers' parenting styles and the extent to which these relationships are moderated by race, sex, and age in a sample of gifted students. Participants (N = 332, ages 9-17 years) attended a summer residential program for gifted students and completed the Parental Authority Questionnaire and the verbal battery of the Cognitive Abilities Test. Three main findings emerged. First, factor analyses provided support for the use of the Parent Authority Questionnaire with gifted populations. Second, findings from regression analyses as well as examinations of mean differences by cognitive ability level were consistent with earlier studies suggesting that more cognitively able students were likely to perceive their parents as employing a flexible (i.e., authoritative) parenting style. Finally,
consonant with earlier studies with non-identified populations, age, sex, and race were associated with parenting styles as reported by this group of identified gifted students. Results provide further support for the notion that authoritative parenting promotes positive outcomes for children, particularly those who have been identified as gifted.

Karbach et al. (2013) investigated the incremental validity of parental involvement over GCA in the prediction of academic performance within the domains of math and language. They examined four dimensions of perceived parental involvement: autonomy supporting behavior, emotional responsively, structure, and achievement-oriented control. Results from a sample of 334 adolescents (“mean age” = 12.4, SD = 0.9, “range” = 10-14 years) showed that GCA was the strongest predictor of achievement in both domains. While autonomy support and emotional responsivity had no predictive value over GCA, high levels of achievement-oriented control and structure were detrimental to academic success. These findings provide new evidence for the significance of parental involvement in their children's achievement in school even after the most powerful predictor of academic success has been accounted for.

Kong (2013) examined the relations between cognitive ability, socio emotional competency (SEC), and achievement in gifted children. Data were collected on children between the ages of 8 and 15 years (n=124). Children were assessed via teacher reports of SEC, standardized cognitive assessment, and standardized achievement assessment. When gender differences were found (in some areas of SEC and in language achievement), they tended to be higher in females. Gender moderated the relation between SEC and composite achievement. The areas of SEC that best predicted achievement, over and above other SEC scales, were Optimistic Thinking, Self-Awareness, and Relationship Skills. While cognitive scores did not significantly predict achievement when controlling for SEC, SEC did significantly predict achievement over-and-above cognitive ability scores. Overall findings suggest that SEC may be important in children’s school achievement; thus it is important for schools and families to promote the development of SEC in gifted children, especially in the areas of optimism and self-awareness.

Hofer et al. (2012) studied predictive power of cognitive ability and self-control strength for self-reported grades and achievement test were studied. It was expected that the variables use of time structure, academic procrastination, and motivational interference during learning further aid in predicting students' achievement because they are operative in
situations of school-leisure conflict. Personality variables were better predictors of grades, while cognitive ability showed higher variance with the achievement test. Variables tapping aspects of self-control strength have been interpreted as key determinants of learning outcomes. The findings suggest that it might be useful to identify students who are at risk, allowing these students to train their ability to shield studying from leisure distractions.

Juarez (2012) examined whether certain specific cognitive abilities, supported by research and measured by the WJ III COG, affect reading above and beyond general intelligence. Preliminary evidence is provided that suggests generalizability of past results to children with low reading achievement. In particular, the cognitive abilities of auditory processing, crystallized knowledge, and processing speed are important in predicting the reading achievement of these children. The implications of such findings are considerable given the current debate within the field of school psychology.

Kaufman et al. (2012) examined the degree to which the conventional notion of g associated with IQ tests and general cognitive ability tests (COG-g) relate to the general ability that underlies tests of reading, math, and writing achievement (ACH-g). Although COG-g and ACH-g were not isomorphic, they correlated substantially, with an overall mean correlation coefficient of .83, and with the correlations generally increasing with age (ranging from .77 to .94). The nature of the relation between COG-g and ACH-g was explored and the best measures of COG-g were examined.

Kettler (2012), investigated the critical thinking skills of upper elementary students using two tests of critical thinking. Participants (n =208) were fourth grade students in a suburban school district in North Texas. Participants completed both the Cornell Critical Thinking Test and the Test of Critical Thinking. Existing data was collected from the school district, allowing for analysis of the relationships between critical thinking, cognitive ability, student achievement, and demographic variables. As part of the study, critical thinking skills were compared between identified gifted students and general education students. First the study found there was a significant relationship between the two measures of critical thinking (r =.60). Second, identified gifted students outperformed general education students on both measures of critical thinking (d =1.52 and d = 1.36). Third, evidence collected in the study supported significant relationships between cognitive ability and critical thinking as well as academic achievement and critical thinking. Data supported that cognitive ability and academic achievement were strong predictors of critical thinking.
Parkin and Beaujean (2012) analysed the effects of Wechsler Intelligence Scale for Children—Fourth Edition cognitive abilities on math achievement. This study used structural equation modeling to examine the effect of Stratum III (i.e., general intelligence) and Stratum II (i.e., Comprehension-Knowledge, Fluid Reasoning, Short-Term Memory, Processing Speed, and Visual Processing) factors of the Cattell–Horn–Carroll (CHC) cognitive abilities, as operationalized by the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003a) subtests, on Quantitative Knowledge, as operationalized by the Wechsler Individual Achievement Test, Second Edition (WIAT-II; Wechsler, 2002) subtests. Participants came from the WISCIV/WIAT-II linking sample (n=550). They compared models that predicted Quantitative Knowledge using only Stratum III factors, only Stratum II factors, and both Stratum III and Stratum II factors. Results indicated that the model with only the Stratum III factor predicting Quantitative Knowledge best fit the data.

Phillipson (2012) established that cognitive ability predicts academic achievement, and that parental involvement and expectations form part of the constellation of factors that predict their children’s academic achievement, particularly for families within the Chinese-heritage Cultures. The results support the hypothesis that parents help their children to actualize their cognitive ability by directly communicating their academic expectations to their children.

Proctor. (2012) studied the relationships Between Cattell–Horn–Carroll (CHC) Cognitive Abilities and Math Achievement Within a sample of College Students with Learning Disabilities. This study examined the relationship between cognitive abilities and math achievement within a sample of college students with learning disabilities (LD). Multiple regression analyses found that Processing Speed and Working Memory were related to Math Calculation scores and that Comprehension-Knowledge, Fluid Reasoning, and Working Memory were related to Math Reasoning. Implications for the assessment of math LD in the college populations are discussed.

Puar (2012) investigated the locale-wise differences among high school students on the basis of certain cognitive variables like general mental ability and academic achievement and non-cognitive variables such as anxiety, emotional maturity and social maturity. The study was conducted over a sample of 400 (200 boys and 200 girls) high school students studying in X class in 8 different schools (4 urban and 4 rural) affiliated to CBSE, New Delhi. Dr Ahuja's group test of intelligence, Sharma's general anxiety scale for children, Singh & Bhargava's Emotional maturity scale and Dr Nalini Rao's Social maturity scale were
employed to measure students' general mental ability, anxiety, emotional maturity and social maturity. The aggregate scores of the selected students in the C.B.S.E. board examination were taken to show their level of academic achievement. The results reported that Rural and Urban high school students differ significantly in their level of general mental ability and anxiety whereas no significant differences were found between them on the variables of emotional maturity, social maturity and academic achievement.

Thayer et al. (2012) assessed the Cognitive Genesis collecting achievement and ability test data from 2006-2009 for all students in Seventh-day Adventist schools in North America. Students were above average in achievement compared to national norms and achieved above that predicted by their ability scores. The more years students attended Adventist schools, the higher they achieved, compared to the norm group. Change in students' achievement and ability over 1-3 years was greater than the change in the norm group for both males and females and students in all ethnic groups. Change in achievement and ability for students of all ability levels was equal to or greater than the change in the norm group.

Postlethwaite (2011) meta-analytically examined the fluid ability, crystallized ability, and performance across multiple domains with a diverse set of over 400 primary studies spanning the past 100 years. With regard to academic performance, measures of fluid ability were found to positively predict learning (as measured by grades). These findings have important implications for both intelligence theory and selection practice. Contemporary intelligence theory has placed great emphasis on the role of fluid ability, and some researchers have argued that Gf and g are essentially the same construct. However, the results of this study, which are based on criterion-related validities rather than factor-analytic evidence, demonstrate that Gc measures are superior predictors in comparison to Gf measures.

Preckel et al. (2011) made a Meta-Analytic Investigation upon Chronotype, Cognitive Abilities, and Academic Achievement. Four meta-analyses examined relationships between morningness and cognitive ability (total N=2177), eveningness and cognitive ability (total N=1519), morningness and academic achievement (total N=3220), and eveningness and academic achievement (total N=700). The analyses focused on the population effect size (to reveal the effect across studies) and the homogeneity (to determine if the results of the several experiments are sufficiently similar to warrant their combination into an overall result). In all four cases, the aggregated correlations between chronotype and cognitive ability, as well as chronotype and academic achievement were found to be significant.
**Vock, et al. (2011)** analyzed the interplay of four cognitive abilities—reasoning, divergent thinking, mental speed, and short-term memory—and their impact on academic achievement in school in a sample of adolescents in grades seven to 10 (N = 1135). Our findings support the notion that mental speed and short-term memory, as ability factors reflecting basic cognitive processes, exert an indirect influence on academic achievement by affecting reasoning and divergent thinking (total indirect effects: \( \beta = 0.22 \) and 0.24, respectively). Short-term memory also directly affects achievement (\( \beta = 0.22 \)).

**Williams (2011)**, examined the four aspects of health and wellness and their relationship to academic achievement and cognitive ability. Information regarding students' general health, diet, sleep, and exercise was collected by the "Cognitive Genesis" research study. General health was found to have a strong effect on lower grade students, females, Black and White students, students from homes with much parental presence, and students in classes of 7-12 students. Diet showed a stronger effect on students in the upper grades, on Black and on White students, and on students from homes with significant amounts of parental presence than those with other characteristics. Sleep demonstrated a strong effect on lower grades students, males, students from homes with higher family income, White students and often Asian ones, those from homes with a strong parental presence, and students from small size classes.

**Elliott et al. (2010)** investigated the effects of broad cognitive abilities derived from the Cattell-Horn-Carroll (CHC) taxonomy, together with the effect of the general factor ("g"), on Wechsler Individual Achievement Test, Second Edition (WIAT-II) reading achievement. Results emphasize the importance of having a comprehensive cognitive assessment with the DAS-II in the evaluation of reading competency and disability. Links between CHC broad ability factors and neuropsychological constructs may provide a promising foundation for developing specific cognitive, academic, and behavioural interventions for children with reading SLD.

**Fuchs et al. (2010)** examined the interplay between basic numerical cognition and domain-general abilities (such as working memory) in explaining school mathematics learning. First graders (N = 280; mean age = 5.77 years) were assessed on 2 types of basic numerical cognition, 8 domain-general abilities, procedural calculations, and word problems in fall and then reassessed on procedural calculations and word problems in spring. Development was indexed by latent change scores, and the interplay between numerical and domain-general abilities was analysed by multiple regression. Results suggested that the
development of different types of formal school mathematics depends on different constellations of numerical versus general cognitive abilities. When controlling for 8 domain-general abilities, both aspects of basic numerical cognition were uniquely predictive of procedural calculations and word problems development.

Mcgrew et al. (2010) made a Contemporary study on Cattell–Horn–Carroll (CHC) theory of cognitive abilities that has evolved over the past 20 years which served as the theoretical foundation for a number of current cognitive ability assessments. The results suggest that narrow CHC abilities should be the primary focus of instructionally relevant intelligence testing. Furthermore, the finding that more than 90% of the available research is based on the Woodcock–Johnson Battery argues for significant caution in generalizing the findings to other batteries. CHC-based COG-ACH research with other intelligence batteries is recommended.

Floyd et al. (2009) investigated the general factor loadings and specificity of the broad ability composite scores from one such intelligence test battery, the Woodcock-Johnson III Tests of Cognitive Abilities Normative Update (Woodcock, McGrew, Schrank, & Mather, 2007). Results from samples beginning at age 4 and continuing through age 60 indicate that Comprehension-Knowledge, Long-Term Retrieval, and Fluid Reasoning appear to be primarily measures of the general factor at many ages. In contrast, Visual-Spatial Thinking, Auditory Processing, and Processing Speed appear to be primarily measures of specific abilities at most ages. We offer suggestions for considering both the general factor and specific abilities when interpreting Cattell-Horn-Carroll broad ability composite scores.

Haworth et al. (2009) made a twin study of the genetics of high cognitive ability selected from 11,000 twin pairs in six studies from four countries. Using data from 11,000 twin pairs (age range = 6-71 years) from the genetics of high cognitive abilities consortium, the investigation of the genetic and environmental etiologist of high general cognitive ability (g) was done. Age-appropriate psychometric cognitive tests were administered to the twins and used to create g scores standardized within each study. Liability-threshold model fitting was used to estimate genetic and environmental parameters for the top 15% of the distribution of g. Genetic influence for high g was substantial (0.50, with a 95% confidence interval of 0.41-0.60). Shared environmental influences were moderate (0.28, 0.19-0.37). It was found that the genetic variation contributes substantially to high g in Australia, the Netherlands, the United Kingdom and the United States.
Evans et al. (2008) examined the relative contributions of measures of Cattell-Horn-Carroll (CHC) cognitive abilities in explaining writing achievement. Drawing from samples that covered the age range of 7 to 18 years, simultaneous multiple regression was used to regress scores from the Woodcock-Johnson III (WJ III; Woodcock, McGrew, & Mather, 2001) that represent CHC broad and narrow abilities onto the WJ III Basic Writing Skills and Written Expression cluster scores. At the youngest age levels, Long-Term Retrieval demonstrated moderate to strong effects on Basic Writing Skills and moderate effects on Written Expression. Auditory Processing, and Phonemic Awareness demonstrated moderate effects on only Written Expression at the youngest age levels and at some of the oldest age levels. Fluid Reasoning demonstrated moderate effects on both writing clusters only during some of the oldest age levels. Visual-Spatial Thinking primarily demonstrated negligible effects. The results provided insights into the cognitive abilities most important for understanding the writing skills of children during the school-age years.

Taub (2008) investigated the direct and indirect effects of general intelligence and 7 broad cognitive abilities on mathematics achievement. Structural equation modelling was used to investigate the simultaneous effects of both general and broad cognitive abilities on students’ mathematics achievement. The following CHC broad cognitive ability factors demonstrated statistically significant direct effects on the mathematics achievement variables: Fluid Reasoning, Crystallized Intelligence, and Processing Speed. In contrast, across all age levels, the general intelligence factor demonstrated indirect effects on the mathematics achievement variable.

Chandra (2007) studied the effect of concept mapping on science achievement of secondary school students as moderated by cognitive ability, problem solving and scientific aptitude. Findings showed that the students of urban secondary schools belong to control and experiment group had similar pre-test scores of concept mapping in third trimester.

Daphne (2007) analysed the cognitive abilities underlying math excellence among children are examined, with a focus on children of mathematical ability. The relationship between cognitive functioning as defined by the Cattell – Horn- Carroll (CHC) theory and academic achievement among children who excel in mathematics is explored in order to understand whether strong math skills correspond to any typical” cognitive ability profile(s). Results suggest that Short- Term Memory, Working Memory and Visual thinking are significant predictors of strong and specific achievement in math calculation skills, whereas
Fluid Reasoning is a significant predictor of strong and specific achievement in math reasoning. The results outlined in this study may supplement the existing research body relating to the full range of mathematics ability.

**Deary et al. (2007)** examined the association between psychometric intelligence at age 11 years and educational achievement in national examinations in 25 academic subjects at age 16. The correlation between a latent intelligence trait (Spearman's g from CAT2E) and a latent trait of educational achievement (GCSE scores) was 0.81. General intelligence contributed to success on all 25 subjects. Variance accounted for ranged from 58.6% in Mathematics and 48% in English to 18.1% in Art and Design. Girls showed no advantage in g, but performed significantly better on all subjects except Physics. This was not due to their better verbal ability. At age 16, obtaining five or more GCSEs at grades A*–C is an important criterion. 61% of girls and 50% of boys achieved this. For those at the mean level of g at age 11, 58% achieved this; a standard deviation increase or decrease in g altered the values to 91% and 16%, respectively.

**Rhode (2007)** made a Prediction of Academic Achievement with Cognitive Ability. The study explained the variation in academic achievement with general cognitive ability and specific cognitive abilities. However, processing speed and spatial ability continued to account for a significant amount of additional variance when predicting scores for the mathematical portion of the SAT while holding general cognitive ability constant.

**Spinath et al. (2006)** examined the extent to which motivation contributes to the prediction of school achievement among elementary school children beyond general mental ability (g). Finally, commonality analyses revealed a substantial portion of common variance in school achievement explained both by g and motivation. In the light of these results it is argued that the study of motivation offers valuable clues for the understanding and improvement of school achievement.

**Emilio and Mcardle (2004)** examined the dynamics of cognitive abilities and academic achievement from childhood to early adulthood. Predictions about time-dependent "coupling" relations between cognition and achievement based on R. B. Cattell's (1971, 1987) investment hypothesis were evaluated using linear dynamic models applied to longitudinal data (N=672). Contrary to Cattell's hypothesis, a first set of findings indicated that fluid and crystallized abilities, as defined by the Woodcock-Johnson Psycho-Educational Battery-Revised (WJ-R; R. W. Woodcock & M. B. Johnson, 1989-1990), were not dynamically
coupled with each other over time. A second set of findings provided support for the original predictions and indicated that fluid ability was a leading indicator of changes in achievement measures (i.e., quantitative ability and general academic knowledge). The findings of this study suggest that the dynamics of cognitive abilities and academic achievement follow a more complex pattern than that specified by Cattell's investment hypothesis.

**Ferrer et al. (2004)** examined the dynamics of cognitive abilities and academic achievement from childhood to early adulthood. Predictions about time-dependent "coupling" relations between cognition and achievement based on R. B. Cattell's (1971, 1987) investment hypothesis were evaluated using linear dynamic models applied to longitudinal data (N=672). A second set of findings provided support for the original predictions and indicated that fluid ability was a leading indicator of changes in achievement measures (i.e., quantitative ability and general academic knowledge).

**Rescorla (2004)** explored the Growth in Test of Cognitive Skills (TCS) scores and Comprehensive Tests of Basic Skills (CTBS) reading, math, and total achievement scores from 3rd to 10th grade was studied in 328 public school students in a middle-class suburban community. Similarly, initial status in achievement predicted the intercept but not the slope in cognitive ability scores over time. Although replication is needed, this study illustrates how districts could use standardized test data to document growth of academic skills over time in high-, middle-, and low-achieving children: in racial or socioeconomic status subgroups; or in different classrooms, schools, or districts.

**Yen et al. (2004)** examined student learning behaviours in the context of cognitive ability and academic achievement. Three structural models were evaluated on a sample of 1304 students ranging in age from 6 to 17 years. Results supported the unique relationship between learning behavior and academic achievement, beyond cognitive ability. Multi-group structural equation modelling (SEM) analysis revealed that these findings were invariant across groups differing by gender and ethnicity. These findings are consistent with previous observations that children's behavioral features in learning situations will supplement the outcome-oriented standardized tests of cognitive ability.

**Lohman (2003)** investigated the concurrent validity of the Woodcock-Johnson III (WJ-III; Woodcock, McGrew, & Mather, 2001) and Form 6 of the Cognitive Abilities Test (CogAT; Lohman & Hagen, 2001). A total of 178 students in grades 2, 5, and 9 were administered 13 tests from the WJ-III and the appropriate level of the CogAT. Interbattery
confirmatory factor analyses showed that the general factors on the two batteries correlated $r = 0.82$. Correlations between broad-group clusters on the WJ-III and battery-level scores on the CogAT generally supported the construct interpretations of each, but also suggested important differences in the abilities measured by both batteries.

**Watkins (2000)** found out the Incremental validity of WISC-III profile elevation, scatter, and shape information for predicting reading and math achievement. Cognitive subtest profiles was used to hypothesize about children's learning strengths and weaknesses implicitly assumes, that subtest profiles are predictive of academic performance. Profile elevation was statistically and practically significant for both exceptional ($R = .36-.61$) and non-exceptional ($R = .72-.75$) students. Profile scatter did not aid in the prediction of achievement. Profile shape accounted for an additional 5%-8% of the variance in achievement measures. It was concluded that using WISC-III subtest scatter and shape to predict academic performance was not supported by the accumulated scientific evidence.

### 2.3.6 Studies Related To Verbal and Quantitative Ability

**Muamma (2015)** investigated the role of intelligence and self-control on academic performance of academically gifted and non-gifted students. Intelligence was measured by the Cognitive Ability Test (CAT) which consisted of two subscales: verbal subtest and quantitative subtest. Self-control was assessed by observing the level of students’ commitments to submit their assignments and homework timely. The sample consisted of 74 freshmen- male students. Academically gifted students were selected based on their academic performance as indicated by their GPA scores, the cut-off point was 3.50 out of 5.00. Intelligence and Self-control were entered a linear multiple regression model as independent variables whereas students’ GPAs in the first semester was entered as the criterion variable. The results showed that both intelligence and self-control correlated significantly with GPA for the whole sample, $r (74) = .31$ and $.58$ respectively (p<.01). Intelligence and self-Control did not correlate significantly with each other. The results also showed that for the whole sample both intelligence and self-control accounted for 42% of the variance in students GPAs. For the gifted sample, both intelligence and self-control explained around 59% of the variance in the GPAs.

**Olatoye (2011)** investigated the role of students’ verbal and numerical abilities in students’ performance on aptitude tests. Two hundred Senior Secondary School Science Students participated in the study. Thus, for students to perform well in the general aptitude
test, they need to have high numerical and verbal abilities. There is no significant difference between male and female students’ performance in verbal ability, numerical ability and general aptitude tests. This study provides an empirically based suggestion for students to develop high verbal and numerical skills in order to do well in aptitude test. The findings from this study also imply that verbal and numerical ability tests can be validated using a good aptitude test.

**Heaven and Ciarrochi (2008)** assessed whether perceived parental style influenced the extent to which adolescents became increasingly conscientious and whether changes in conscientiousness influenced academic grades 1 year later. Parental styles, conscientiousness, verbal, and numerical ability at Time 1 were measured. One year later conscientiousness was again assessed, and 1 year after the end-of-year exam results were obtained. More than 784 students (mean age = 12.3 years, SD = 0.49) participated in the 1st year. The data of 563 students were matched across the 3 years. Conscientiousness tended to decrease from Time 1 to Time 2. Structural equation modelling showed that adolescents with more authoritative parents experienced less of a decrease in conscientiousness at Time 2 than did students with less authoritative parents and the same baseline level of conscientiousness at Time 1. Additionally, the decrease in conscientiousness at Time 2 predicted worse grades at Time 3, even after controlling for baseline levels of academic achievement.

**Weymer (2002)** examined relationships between cognitive style, verbal ability, quantitative ability, prior knowledge, motivation, and achievement in modular technology education. Data were provided by 78 male and 64 female suburban sixth-grade students (N = 142). The Group Embedded Figures Test, Children's Academic Intrinsic Motivation Inventory, Comprehensive Testing Program III verbal and quantitative subtest scores, and a researcher-developed achievement test were used to collect data. The treatment consisted of three computerized activities. Statistically significant relationships, at the .05 level, were demonstrated in the bivariate analysis between achievement and: (a) cognitive style, (b) verbal ability, (c) quantitative ability, (d) prior knowledge, and (e) motivation. Multiple regression analysis revealed a statistically-significant model for prior knowledge and verbal ability (F = 46.52, df = 136, R2 = 63.1%, p < 0.05). The researcher observed that many students preferring a non-analytical cognitive style got lost in the CAI learning tasks used in this research. These students had difficulty separating important information from less important details. Field dependent and field intermediate students lacked the analytical skills needed to navigate the computer-based instruction program used in this study.
2.3.7 Studies Related To Verbal and Non-Verbal Abilities

**Rahim (2014)** focused on teaching instrumental music ensembles with credible music expression has been a challenging task for music educators. Then on-verbal and verbal instructions was proposed and highlighted by previous researchers, and music educators in solving the problems. It was mentioned that the combination of expressive voice, movements and metaphorical languages, were tools to the inspired musicians music interpretation and expression. Result of this case study justified that mentoring is able to assist the protégé’s to convincingly apply non-verbal and verbal instructions in his teaching, contributing to credible music interpretation and expression of the wind orchestra.

**Dalia et al. (2013)** identified gifted children in an interactive procedure consisting of two consecutive steps--screening for above-average cognitive abilities, followed by their monitoring. Teacher nomination is among the most widely used methods of screening. However, it is not free from bias. Results confirm the predictive power of the checklist. Mostly non-significant correlations with achievement outcomes indicate these children to be "underachievers". Confirmatory factor analysis indicated the two factors (verbal and non-verbal) underlying the cognitive performance of gifted children.

**Stanilova (2013)** surveyed on verbal and non-verbal behaviors in real and virtual world. It includes observations on specialized forums, comments under blog posts, news, etc. Its purpose is to be useful for counselors and therapists, who do not have experience on the web, and to help them understand their clients better and to detect the real problems with their client’s communication in virtual and real space. Basing on the Reichian theory of the five human characters, this survey is a brief comparison between typical verbal and non-verbal behaviors in real life and in the virtual world of the Internet. The main conclusion was that the behavior on the web is more congruent to the character than in real life communication.

**Sharma et al. (2011)** examined the Cognitive Correlates of Different Academic Subjects in School Setting. A multiple regression analysis revealed an interesting pattern of relationship. SPM has been found to be the best correlate of Mathematics and Science subjects contributing 53% and 58% of variance in males' sample and 32% and 36% of variance in females' sample. Whereas, GMAT, correlated best with languages and social science subjects accounting for 28% to 44% in males’ sample and 28% to 56% in females' sample.
2.3.8 Studies Related To Cognitive Ability and Gender

Dev (2016) investigated and analysed the relationship of General Mental Ability, Interest and home environment with Academic Achievement. The participants were 110 students drawn from three Kendriya Vidyalayas of Delhi. Their ages ranged between 13 and 14 with a mean age of 13.6 years. Two validated instruments were used to elicit responses from the participants-General mental ability test prepared by R. K Tandon (1972), Multiphasic Interest Inventory of S. K. Bawa (1998) and Home Environment Inventory of K S Mishra (1989) were administered on the selected sample. Whereas their annual examination grades of class VII were considered as academic achievement. Pearson-Moment Correlation Co-efficient and t-test were used to analyse the data. The study revealed that General Mental Ability, home environment, Interest and academic achievement are significantly and positively correlated. Whereas the high score of girls indicated that they are superior to boys.

Veas et al. (2016) examined the predictive effects of gender, intellectual ability, self-concept, motivation, learning strategies, popularity and parent involvement on academic achievement. Hierarchical regression analysis were performed with six steps in which each variable was included, among a sample of 1398 high school students (mean age = 12.5; standard deviation = .67) of eight education centers from the province of Alicante (Spain). The results revealed significant predictive effects of all of the variables, explaining 59.1% of the total variance.

Ruffing et al. (2015) investigated gender differences in the incremental contribution of learning strategies over general cognitive ability in the prediction of academic achievement. Results of multi-group analyses showed no gender differences in this prediction model. This finding provides further knowledge regarding gender differences in learning research and the specific role of learning strategies for academic achievement. The incremental assessment of learning strategy use as well as gender-differences in their predictive value contributes to the understanding and improvement of successful academic development.

Reilly (2012) studied the gender differences in cognitive abilities that are frequently reported, the magnitude of these differences and whether they hold practical significance in the educational outcomes of boys and girls is highly debated. Across all three domains, these differences were more pronounced at both tails of the distribution for low- and high-achievers. Considerable cross-cultural variability was also observed, and national gender differences were correlated with gender equity measures, economic prosperity, and
Hofstede’s cultural dimension of power distance. Educational and societal implications of such gender gaps are addressed, as well as the mechanisms by which gender differences in cognitive abilities are culturally mediated.

Blume (2011) studied that on average, girls do better in school than boys. Girls get higher grades and complete high school at a higher rate compared to boys (Jacobs, 2002). Standardized achievement tests showed that females are better at spelling and perform better on tests of literacy, writing, and general knowledge (National Center for Education Statistics, 2003). Girls continue to exhibit higher verbal ability throughout high school, but they begin to lose ground to boys after fourth grade on tests of both mathematical and science ability. These gender differences in math and science achievement have implications for girls’ future careers and have been a source of concern for educators everywhere.

Leeson et al. (2008) explored whether positive thinking predict variance in school grades over and above that predicted by cognitive ability. Six hundred and thirty nine high school students participated in a three-year longitudinal study that predicted grades using cognitive ability and three positive thinking variables – self-esteem, hope, and attribution style. Hope, positive attribution style and cognitive ability predicted higher grades, whilst self-esteem was a less consistent predictor of academic performance. Structural equation modelling revealed that significant paths from cognitive ability, gender and a second order positive thinking factor to grades. The results suggests that intelligence, gender, and positive thinking each play a unique role in predicting academic performance in youth.

2.4 SYNTHESIS OF THE REVIEWED STUDIES

The investigator has gone through several studies on Cognitive Ability and Academic Achievement. Most of the studies were done using Experimental, Quasi Experimental and Survey method. Random sampling technique was followed in the collection of data and the size of the selected samples ranged from 6 to 11,000 samples. Samples were covered from the age range of 2 to 18 years studying from kindergarten upto college level. In the greater part of the studies, the investigators have developed their tools based on their objectives of the studies. Many of the studies have made their investigations by utilizing Cattell-Horn-Carroll(CHC), Wechsler Individual
Achievement Test, Woodcock-Johnson III Tests of Cognitive Abilities Normative test, CogAT; Lohman & Hagen, 2001, Naglieri Non-Verbal Ability Test (NNAT) and Raven’s Colored Progressive Matrices (CPM). Few of the other investigators have also developed their tools based on their objectives of the studies. Different statistical techniques like Mean, Standard Deviation, Correlation Coefficient, ‘t’ test, Anova Ancova, Regression Analysis and Multiple Regression were used in most of the studies.

The findings of various studies revealed that the students with high verbal ability perform better than low verbal ability and have significant effect on students’ achievement (Gambari et al., 2014; Abiodin and Folaranni, 2007; Iyamu, 2005). The findings also revealed that Quantitative Reasoning had impact on mathematical achievement (Schalk, et al., 2016; Finn et al., 2014; Adu et al., 2009). The findings also revealed that Cognitive Ability can be used to predict future academic achievement (Cormier et al., 2016; Chong., 2016; Sambo., 2015; Warnimont., 2010; Kettler., 2012; Proctor., 2012; Taub., 2008; Emilio and Mcardle., 2004). The findings of Karamadi et al., 2016 revealed that students in English medium have significantly higher verbal ability, numerical ability and academic performance than those with primary education in mother tongue medium. PallabiKalita,(2013); Puar,(2012); Yashpal Azad(2012) indicated that the urban students were significantly superior to the rural students in Cognitive Ability. Phillipson (2012) revealed that parents help their children to actualize their cognitive ability.

The present study is unique for several reasons. It is understood that no study has been so far undertaken in India. Hence it is understood that the present study is the first in its kind in this aspect of Verbal Ability, Quantitative Ability and Non-Verbal Ability relating to academic Achievement. Several studies have been conducted on different groups with different variables. But it is understood that no study has so far been conducted on Eighth standard pupils, therefore the study stands unique.

As regards to Cognitive Ability, several studies have been conducted on students in relation to Academic Achievement. But this study is based on Verbal Ability, Quantitative Ability and Non-Verbal Ability is combined with variables namely Gender, Locality, Medium of Instruction, type of school, Parental Educational
Qualification and Parental Occupation and it is on this ground that it stands different from the rest of the studies conducted earlier.

It is to be noted that the study made on the relationship between Cognitive Ability and Academic Achievement in India numbers to just one. Therefore, it can be detained that this study is new and different. No Indian investigators have focused exclusively on Cognitive Ability in relation to Academic Achievement of Eighth Standard Pupils. A few studies pertaining to the academic achievements of the students, but none have linked academic achievement with Cognitive Ability. Therefore, the studies remain unique. The present study beyond any doubt differs from the above studies in many ways. No study has been found to combine the four variables of Verbal Ability, Quantitative Ability and Non-Verbal Ability and academic achievement. This is different from other in terms of population and sample. Therefore, it is only relevant for the investigator to carry out to study Verbal Ability, Quantitative Ability and Non-Verbal Ability in relation to academic achievement of Eighth Standard pupils.

2.5 DISCUSSION AND CONCLUSION

The cognitive ability or the cognitive skills possessed by a student has a strong influence on the academic achievement, socio-economic factors like gender, locality, type of schools, parents’ educational and occupational status. These factors influence both cognitive ability and academic achievement.

Based on the related review of literature, it is sensible to assume that cognitive ability batteries and academic achievement are highly related. It can be presumed that learners with a high cognitive ability would perform better academically. From the review of literature it becomes clear that cognitive ability test is a multifaceted topic of research. There are many articles, studies and reports on the necessity of cognitive ability test and academic achievement, but very few studies are being conducted in Tamil Nadu. The related review of literature reveals that cognitive ability is a necessity in school education. The investigator prefers to go forth to analyse statistically the relationship among these three batteries. This comprehensive review is followed by the methodology of the study in Chapter III.