A Systematic Review of Fluid intelligence Testing with the Raven's Coloured

Progressive Matrices and the Quality of Education in South Africa

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This dissertation is submitted in fulfilment of the requirements for the degree

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Supervisor: Prof. DJF Maree

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Declaration

Student number: 28025165

I declare that:

A Systematic Review of Fluid Intelligence Testing with the Raven's Coloured Progressive Matrices and the Quality of Education in South Africa is my own work and all the sources I used or quoted have been indicated and acknowledged by means of complete reference. This mini-dissertation has not been submitted before for any other degree or examination at this or any other university.

20 March 2023

_____   _____

Signature   Date

Dedication

This work is dedicated to my husband, Nico, who has supported me in so many ways throughout the process of writing this dissertation.

Acknowledgements

I would like to thank Prof David Maree, my supervisor at the University of Pretoria for all his advice and effort to help me succeed. I would like to thank my family for all their support in my academic endeavours.

Ethical Clearance Certificate

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23 March 2021

Dear Miss T Booyzen

Project Title:	Fluid Intelligence Testing with the Raven's Coloured Progressive Matrices and the Quality of Education in South Africa: A Comprehensive Literature Review
Researcher:	Miss T Booyzen
Supervisor(s):	Dr LM Eskell-Blokland
Department:	Psychology
Reference number:	28025165 (HUM002/0121)
Degree:	Masters

I have pleasure in informing you that the above application was **approved** by the Research Ethics Committee on 23 March 2021. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely,

Prof Innocent Pikirayi
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Ethics Statement

The researcher, whose name appears on the title page of this dissertation, has obtained, for the research described in this work, the applicable research ethics approval.

The researcher declares that she has observed the ethical standards required in terms of the University of Pretoria's Code of Ethics for researchers and the Policy Guidelines for responsible research.

20 March 2023

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Signature   Date

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04 April 2023

To whom it may concern,

This letter confirms that the manuscript detailed below was edited for proper English language grammar, punctuation, spelling, and overall style by a qualified and highly experienced native English-speaking editor:

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Neither the research content nor the author's intentions were altered in any way during the editing process. The editor makes no claim as to the accuracy of the research content or objectives of the author. The document above as edited is grammatically correct and ready for publication; however, the author has the ability to accept or reject the editor's suggestions and changes after the editing process is complete, and prior to submission to any journal or examining body.

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Abstract

This study conducted a Systematic Literature Review to investigate the available knowledge that explores fluid intelligence using Raven's Coloured Progressive Matrices in contexts where the quality of education may influence the assessment's results. International test norms may contribute to misleading results as the test utilised may not be in the home language of the learners who are assessed and may not consider the quintile group in which the learner is educated. For the investigation into the relationship between fluid intelligence measured by the RCPM and the quality of education, a systematic review was deemed appropriate to explore the existing knowledge on this topic. A systematic review is ideal for research that seeks to examine the possible implications of the topic, rather than measure its efficacy. Fifty seven percent of studies in the sample supported the notion that there is a relationship between lower local norms and lower performance of female participants' scores on the Raven's Coloured Progressive Matrices. Forty five percent of the sample population raised questions about the relationship between socioeconomic status and Raven's Coloured Progressive Matrices performance. All these studies were conducted in Africa, two of which were conducted in South Africa. Unfortunately, there are no publications available that directly attempt to investigate the relationship between quality of education and Raven's Coloured Progressive Matrices performance.

Keywords: Raven's Coloured Progressive Matrices; Fluid intelligence testing; Quality of Education; Quintile System

Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviations

CASP	Critical Appraisal Skills Programme
CHC	Cattel-Horn-Carrol
NNSSF	National Norms and Standards for School Funding
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
SA	South Africa
SASA	South African School Act
SES	Socioeconomic status
UK	United Kingdom
USA	United States of America

<div align="center">**Chapter 1: Introduction**</div>

1.1 Introduction

This study aims to conduct a Systematic Literature Review to investigate the available knowledge that explores fluid intelligence using Raven's Coloured Progressive Matrices (RCPM) in contexts where the quality of education may influence the assessment's results. This study will also explore the relationship between gender and RCPM results as well as socioeconomic variance and RCPM results. Counselling and educational psychologists in South Africa (SA) are dependent on accurate cross-cultural assessment for diagnosis, treatment, and possible placement of children (Bass, 2000). Out-of-date and culturally biased tests can result in misleading conclusions. Cross-cultural assessment refers to tests that can accommodate test-takers from different cultural, language, and socio-economic backgrounds (De Kock et al., 2013; Hambleton & Zenisky, 2011). Accurate screening and early targeted intervention based on valid and reliable tests minimises costs of managing problems and reduces demands on mental health care systems (Brown et al., 2009). This chapter will discuss the research problem, aims, and objectives, along with a motivation for the research and a broad overview of each chapter to follow.

1.2 Working Definitions of Key Terms

1.2.1 Fluid intelligence

According to Muniz and colleagues (2016), fluid intelligence refers to abstract reasoning and problem solving, independent of prior knowledge or familiarity with the content. Schneider and McGrew (2018) describe fluid intelligence or fluid reasoning as the ability to reason when presented with novel stimuli. These operations include relating ideas, problem solving, and

inductive and deductive reasoning. For the purpose of this study, fluid intelligence will be

described as the ability to reason and solve novel problems regardless of prior learning.

1.2.2 Quality of Education

Quality of education is a complex problem in SA. The quintile system is a unique

contextual feature to the South African educational environment that may influence fair

assessment. The quintile categorisation system was developed to address the wide economic

disparities and unequal educational opportunities resulting from the legacy of Apartheid

(Ogbonnaya & Awuah, 2019). The quintile system categorises public schools in SA into 1 of the

5 following categories: 1 represents the poorest 20% of students; 2 represents the next poorest

20% of students; 3 represents the middle 20% of students; 4 represents the second wealthiest

20% of students; and 5 represents the wealthiest 20% of students in the country (Ogbonnaya &

Awuah, 2019). The quintile categories were determined by measures of average income,

unemployment rates, and general literacy levels of the surrounding geographical area

(Ogbonnaya & Awuah, 2019). There is a direct equivalence between the schools' access to

resources and its quintile categorisation as quintiles 1 to 3 schools are government funded. This

means that quintiles 1 to 3 schools cannot provide the same quality of education that wealthy

schools do as they do not have the same access to resources.

1.3 Background of the Research

In SA, where there is a diversity of cultural groups, conducting psychometric assessments

in a learner's home language can improve the fairness and accuracy of assessing a learner's

ability. After the dismantlement of apartheid, a system that advocated for separate development

based on racial discrimination, questions arose about psychology's contribution to the

perpetuation of this system (Rushton & Skuy, 2000). Apartheid policies had a considerable

influence on assessment development and use as can be seen in standardised test results that have

been obtained from white-only samples and in the culturally biased content of the tests (Foxcroft

et al., 2013). Therefore, questions were raised about the use of Western norms to evaluate

assessments taken by Non-western groups (Rushton & Skuy, 2000). Despite this, it is still not

common practice to have multiple-language versions or multiple-quintile versions for all

assessment measures (De Kock et al., 2013).

      Due to the increase in testing in a variety of psychological domains, there is an intensive

focus on developing tests that are fair to different racial and ethnic groups (Suzuki et al., 2013).

Culturally fair assessment refers to tests that are unbiased towards all groups, regardless of their

ethnicity, education, and socio-economic backgrounds (Byrne & van de Vijver, 2010; De Kock et

al., 2013). Due to the difficulties related to culturally fair assessment, culture competence must

be cultivated. Cultural competence is an essential skill to develop, and refers to cultural

awareness, knowledge, and the ability to address cultural issues of tests (Suzuki et al., 2013).

      It is improbable that any measure can eliminate cultural bias entirely, especially when the

test content, language, and validity criteria are culturally bound. In the context of a multicultural

country such as SA, it is essential that test developers make tangible efforts to reduce cultural

bias, for example, avoiding oversampling of particular groups, statistical procedures to address

concerns, non-verbal tests, and fair scoring procedures (Suzuki et al., 2013). Rosselli and Ardila

(2003) stated that education, cultural background, and urban living may even influence non-

verbal test scores. For this reason, the quintile category of the schools the learners attend must be

considered when administering any assessment. Demographically focused research has shown

that intelligence test scores of English and Afrikaans first language speakers from advantaged

backgrounds (quintile 4-5 schools) differ significantly from those of African first language

speakers from disadvantaged backgrounds (quintile 1-3 Schools) (Shuttleworth-Edwards, 2017).

Accordingly, the impact of quality of education on fluid intelligence test scores must be

investigated if fair assessment is to occur in SA.

1.4 Justification for the Present Study

1.4.1 Justification for the Topic

International test norms may contribute to misleading results as the test utilised may not

be in the home language of the learners who are assessed and may not consider the quintile

group in which the learner is educated. This amplifies the need for local data that take the quality

of education into account for assessment instruments such as the RCPM, which is used as a

screening measurement in community outpatient settings. The RCPM is described as a culturally

fair assessment tool that is widely used in clinical settings (Oakland et al., 2015). Standardised

testing that does not consider the local context may perpetuate social and economic difficulties

confronting disadvantaged groups (Urbine, 2014). For this reason, translated tests with norms

that reflect the quality of education are necessary to improve the quality and efficiency of the

services clinicians provide. There is a scarcity of studies that attempt to make the RCPM relevant

to the South African context (Bass, 2000). This study represents the first attempt to evaluate and

synthesize current studies regarding the use of RCPM for measuring fluid intelligence, as well as

the relationship between educational quality, as measured by the quintile system, and

performance on this test. The value of this study is in its power to influence the direction which

future norming research will take.

1.4.2 Justification for the Research Method

Each research study builds upon an already existing body of knowledge. Each new

research study expands the existing knowledge on a particular topic and paves the way forward

for new research to be conducted (Gravetter et al., 2021). For the investigation into the

relationship between fluid intelligence measured by the RCPM and the quality of education, a

systematic review was deemed appropriate to explore the existing knowledge on this topic. A

systematic review is ideal for research that seeks to examine the possible implications of the

topic, rather than measure its efficacy. This study is interested in how this relationship evolved

over time and in different contexts, making a systematic review the most suitable approach for

exploring this topic thoroughly (Snyder, 2019). A collection of empirical studies was selected

following systematic review protocols. A shortage of incorporating systematic review methods in

the South African University curriculum justifies including them when researching a novel topic

(Laher & Hassem, 2020). More readily available South African systematic reviews will

encourage other South African scholars to use systematic reviews as a method of inquiry.

Fortunately, the use of systematic reviews in psychology has become increasingly popular as

their purpose is to observe current trends in literature and propose new topics for the future

(Laher & Hassem, 2020).

1.5 The Significance of the Study

This study argues that quality of education influences the results of the RCPM. This

systematic review explores the use of the RCPM in different contexts to question the relationship

between quality of education and fluid intelligence. This revelation could change the way

norming is conducted in developing countries. The practical motivation of this topic is to

improve scholarly knowledge regarding fluid intelligence testing in developing countries and to

pave a way forward for future research on the topic.

1.6 Research Aims

This systematic review seeks to explore the relationship between fluid intelligence testing using the RCPM, and the quality of education of those being tested. To achieve this, the systematic review is guided by the following core aims:

Aim 1: To investigate the influence of gender, as a factor of impoverished communities, on RCPM results.

Aim 2: To investigate the direct influence of socioeconomic variation on RCPM results.

Aim 3: To investigate the relationship between RCPM results and quality of education, as a n indicator of socioeconomic variance.

The focus of this study is to investigate the ways in which researchers have explored the connection between fluid intelligence test results using the RCPM, and quality of education. To do so, the context of gender and socioeconomic variances must be questioned as they are linked to quality of education.

1.7 Research Question

What is the relationship between quality of education and fluid intelligence, as measured by the RCPM?

1.8 Paradigmatic Perspective

1.8.1 Theoretical Framework

The RCPM is designed to measure a child's capacity for eduction (latent inferences), which aligns with the psychometric theory of fluid intelligence as proposed by the Cattel-Horn-Carrol (CHC) Theory of Cognitive Intelligence (Schneider & McGrew, 2012). This theory finds its origins in the development of Spearman's g-factor, or general intelligence factor. CHC theory understands intelligence as a "comprehensive taxonomy of abilities embedded in multiple

overlapping theories of cognition" (Schneider & McGrew, 2018, p. 74). This theory is used as it

provides a comprehensive description of the relationship between different cognitive abilities.

After the popularisation of CHC, incremental developments, rather than radical innovations,

occurred in human understanding of intelligence (Schneider & McGrew, 2018). The CHC theory

combines the theories of Cattell, Horn, and Carroll to define intelligence from a psychometric

background as a multi-dimensional and functionally integrated concept. Cattell, Horn, and

Carroll measured individual differences and made inferences about intelligence based on the

patterns of covariance between these differences (Schneider & McGrew, 2018).

1.8.2 Research Paradigm

According to Johnson and Stefaruk (2013) there is no single rational truth that describes a

contentious reality, but through dialectic pluralism and dialogical processes, a viable truth can be

found. According to Johnson (2011), dialectical pluralism integrates quantitative and qualitative

paradigms to synthesize knowledge and inferences from a variety of, often contradictory, sources.

This study is interested in synthesising knowledge from various journal articles. Johnson (2017)

describes dialectical pluralism as the careful, systematic, and thoughtful listening, understanding,

and learning from various disciplines, perspectives, ethnicities, methodologies, and paradigms

(Johnson, 2017). When applied to evaluation practices, this entails gathering data and

information from multiple stakeholders and working towards a conclusion that meets the needs

of multiple, often divergent, stakeholders (Johnson & Stefurak, 2013). This is the only way to

ensure that multiple perspectives are thoughtfully and carefully present in the evaluation of

literature and content from multiple sources. Critical dialectical pluralism allows the researcher

to draw probative inferences, which are conclusions that best explain the reality, given the

agreed-upon values and standards that researchers employ in their research (Johnson & Stefurak,

2013; Scriven, 2012). In other words, dialectical pluralism allows the researcher to integrate the

findings of qualitative and quantitative approaches and identify issues that emerge from the

juxtaposition (Mertens, 2018).

1.8.3 Methodological Paradigm

Both quantitative and qualitative research methods are supported by dialectical pluralism.

To gain insight into the relationship between fluid intelligence and quality of education, a mixed

methods research design was deemed appropriate. The systematic review enabled the researcher

to allocate sampled studies to identify and formulate themes from the findings.

1.9 Research Methodology

Figure 1 outlines the multimodal systematic review approach chosen for this study. The

comprehensive discussion of the summarised points in Figure 1 will follow in Chapter 3.

Figure 1

Outline of the Researcher's Methodological Choices

Research Question	• What is the relationship between quality of education and fluid intelligence, as measured by the RCPM?
Rationale	• Due to the legacy of apartheid, South Africa does not provide the same quality of education to all of its students. There are 5 quintiles, each representing a different 20% of the population's income brackets. • Fluid intelligence testing and norming have always sought to provide local norms to developing countries, these norms are often based on language and gender rather than socioeconomic background or quality of education.
Research paradigms	• Methodological: Dialectical pluralism (mixed methods) • Theoretical: CHC Theory
Research methods	• Systematic review including a sample of norming studies that were selected following the PRISMA statement.
Multimodal Systematic Review Methodology	• Sampling criteria: Peer-reviewed articles categorised as follows: • Quantitative normative studies of the RCPM • Qualitative studies that investigate the RCPM • Qualitative studies that investigate fluid intelligence testing in multiculutural contexts.

1.10 Chapter Outlines

This chapter, **Chapter 1**, serves as introduction to the research problem and objectives.

The next chapter, **Chapter 2**, discusses the literature review.

Chapter 3 discusses the methodology, the systematic review. The results from the literature

review will be presented in **Chapter 4**. In **Chapter 5** the results will be interpreted and discussed.

In the last chapter, **Chapter 6**, the limitations of the study will be discussed and

recommendations for future research will be made.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents the preliminary literature review. This chapter covers the historical creation of disadvantaged groups in SA; culturally fair assessment; fluid intelligence testing; and the RCPM. The initial literature overview explored and contextualised disadvantaged groups in SA with special attention to the quality of education available to these groups. The chapter then goes on to explore the conceptualisation of fluid intelligence and how the RCPM measures it. The relationship between the RCPM and the different contexts in which norms have been found for it was then considered. This was done with the aim to contextualize the concept of fluid intelligence and the use of the RCPM in disadvantaged communities with a quality of education lower than that of their wealthy peers. This contextualised understanding is necessary before data collection can start to attempt to understand the relationship between fluid intelligence test results and quality of education.

2.2 The historical creation of disadvantaged groups in SA

SA has a diversity of cultural groups within its borders. The variation of results of psychometric assessments is a function of ethnicity and socioeconomic status (SES) in SA, as described in the previous chapter. This is most likely due to the effects of Apartheid that still linger long after its disbandment in 1994. During the Apartheid era, the white minority implemented a system of statutory separation from, and discrimination against the African majority (Skuy et al., 2001). The African majority lived and were educated separately from the white minority. This resulted in unequal resources and opportunities for the African majority. After the dismantlement of apartheid, questions were raised about psychology's contribution to the perpetuation of this system (Rushton & Skuy, 2000). Apartheid policies, for example, had a considerable influence

on assessment development and use. This can be seen in standardised test results that have been

obtained from white-only samples and in the culturally biased content of the tests (Foxcroft et al.,

2013). Questions were raised about the use of Western norms to evaluate assessments taken by

Non-western groups (Rushton & Skuy, 2000). Yet, it is still not the norm to have multiple-

language versions or multiple-quintile versions for all assessment measures (De Kock et al.,

2013, Goldfinger, 2019).

2.3 Culturally fair assessment and SES

Extreme differences exist regarding the size and nature of cross-cultural differences in

psychological functioning (Van de Vijver, 1997). One of these differences is the presence of

measurement bias in cognitive assessment (Van de Vijver et al., 2011). Due to the increase in

testing in a variety of psychological domains, there is a serious focus on developing tests that are

fair to different racial and ethnic groups (Suzuki et al., 2013; Goldfinger, 2019). Culture can be

defined as explicit and implicit patterns of behaviour "acquired and transmitted by symbols,

constituting the distinctive achievements of human groups, including their embodiment of

artifacts; the essential care of culture consists of traditional (i.e., historically derived and

selected) ideas and especially their attached values" (Kroeber & Kluckhorn, 1952, p. 357).

Hofstede (1980) defined culture as a programming of the mind. These later definitions reflect the

development towards contextual definitions of culture rather than comprehensive definitions like

the one provided by Kroeber and Kluckhohn (Van de Vijver et al., 2011). For the purpose of this

study, culture can be understood as social, cognitive, and behavioural patterns which are

informed by psychological phenomena (i.e., mindset and values) and contextual phenomena (i.e.,

institutional and organisational shared customs) that facilitate how a person interacts with others

and make meaning of their experiences.

Test bias is the systematic overestimation or underestimation of the variable evaluated. If this systematic error occurs as a function of a cultural variable, then the test is referred to as being culturally biased (Reynolds & Suzuki, 2003). Culturally fair assessment refers to tests that are unbiased to all groups independent of their ethnicity, education, and socio-economic backgrounds (Byrne & van de Vijver, 2010; De Kock et al., 2013). Culture free assessment refers to tests that do not include culture related content. This is particularly difficult as most tests measure constructs created in Western contexts (Reynolds & Suzuki, 2003). Due to the difficulties related to culturally fair and culture free assessment, culture competence must be cultivated. Cultural competence is an essential skill to develop, and refers to cultural awareness, knowledge, and the ability to address cultural issues of tests (Suzuki et al., 2013).

It is improbable that any measure can eliminate cultural bias entirely, provided that the test content, language, and validity criteria are culturally bound. It is possible to increase the cultural fairness of a test by avoiding culturally loaded items that are biased against certain cultures (De Kock et al., 2013). In the context of a multicultural country such as SA, it is essential that test developers make tangible efforts to reduce cultural bias such as avoiding oversampling of particular groups; statistical procedures to address concerns; non-verbal tests; and fair scoring procedures (Suzuki et al., 2013). Rosselli and Ardila (2003) stated that education, cultural background, and urban living influence non-verbal test scores. For this reason, the quintile category of the schools the learners attend must be considered when administering any assessment.

Section 34(1) of the South African School Act 84 of 1996 ([SASA] Republic of South Africa, 1996) states that to "redress past inequalities the state must fund public schools on an equitable basis" (van Dyk & White, 2019, p. S1). The National Norms and Standards for School Funding

(NNSSF) aimed to improve funding equity by ranking schools into one of five quintiles that

function as socioeconomic categories (du Plessis, 2020). The quintile system categorises public

schools in SA into one of the following five categories: 1 represents the poorest 20% of students;

2: represents the next poorest 20% of students; 3 represents the middle 20% of students; 4

represents the second wealthiest 20% of students; and 5 represents the wealthiest 20% of the

students in the country (Ogbonnaya & Awuah, 2019). Demographically focused research has

shown a significant disparity in intelligence test scores between English and Afrikaans first

language speakers from advantaged backgrounds (quintile 4-5 schools), and African first

language speakers from disadvantaged backgrounds (quintile 1-3 Schools) (Shuttleworth-

Edwards, 2017). Jukes and Grigorenko (2010) suggested the following action to conduct valid

comparisons: stratified sampling strategies; the use of tests that are less sensitive to education

and socio-economic status; the inclusion of tests that value indigenous intelligence; careful

piloting and psychometric analysis; and a careful analysis of linguistic differences. These actions

can be considered for a study on test translation, adaption, or norming, to increase the validity of

the results.

Due to the legacy of Apartheid, culture and ethnicity are strong indicators of SES in SA.

Little research exists on the relationship between SES and fluid intelligence testing as fluid

intelligence can be described as the capacity for eduction (as it is described later in this chapter)

and should, theoretically, not be affected by SES. Anum (2022) states that this possible

confounding variable has not been adequately researched in the past. Research in SA and Ghana

have shown that fluid intelligence scores are much lower than the United Kingdom (UK) an

United States of America (USA) norms (Brouwers etal., 2009; Nijenhuis & van den Hoek, 2016;

Rushton et al., 2003; Wicherts et al., 2010). In the literature, this is attributed to an innate deficit

in intellectual capacity rather than test or cultural bias (Nijenhuis & van den Hoek, 2016; Rindermann et al., 2015). This notion has been contradicted by other studies that have shown that socioeconomic or socio-cultural factors contribute to the variability in test scores in Sub-Saharan Africa (Anum, 2014; Brown & Day, 2006; Knoetze, et al., 2005). SES and socio-cultural factors that have been identified, so far, include school attendance, school quality, educational attainment, home and schooling experience, parental characteristics (parents' level of education), and income (Gonzales & Roll, 1985; Olazaran et al., 1996; Shuttleworth-Edwards, et al., 2004).

2.4 Fluid intelligence

The RCPM measures a child's capacity for eduction, which is similar to fluid intelligence as proposed by the psychometric theory of intelligence, CHC Theory of Cognitive Intelligence (Schneider & McGrew, 2012). Fluid intelligence refers to abstract reasoning, problem solving, independent of prior knowledge (Muniz et al., 2016). Fluid intelligence is seen as a reliable construct for measuring general intelligence independent of prior learning (Das, 2004). Fluid intelligence or fluid reasoning refers to the ability to reason when presented with novel stimuli, regardless of prior knowledge (Schneider & McGrew, 2012). These operations include relating ideas, problem solving, and inductive and deductive reasoning. The RCPM mostly require the participants to use inductive reasoning to analyse the sets of information, establish the relationship between these sets of information, and organise them in a coherent way (Muniz et al., 2016).

Intelligence as understood by CHC theory is a "comprehensive taxonomy of abilities embedded in multiple overlapping theories of cognition" as seen in Figure 2 (Schneider & McGrew, 2018, p. 74). The CHC theory combines the theories of Cattell, Horn, and Carroll to define intelligence from a psychometric background as a multi-dimensional and functionally integrated concept.

Cattell, Horn, and Carroll measured individual differences and made inferences about

intelligence based on the patterns of covariance among these differences (Schneider & McGrew,

2018). In Figure 2, the constructs are theoretical entities that describe cognitive abilities.

Figure 2

A Hierarchical Structure of the g Factor (Figure 3.1. A tidy hierarchical structure from Schneider and

McGrew (2018:74))
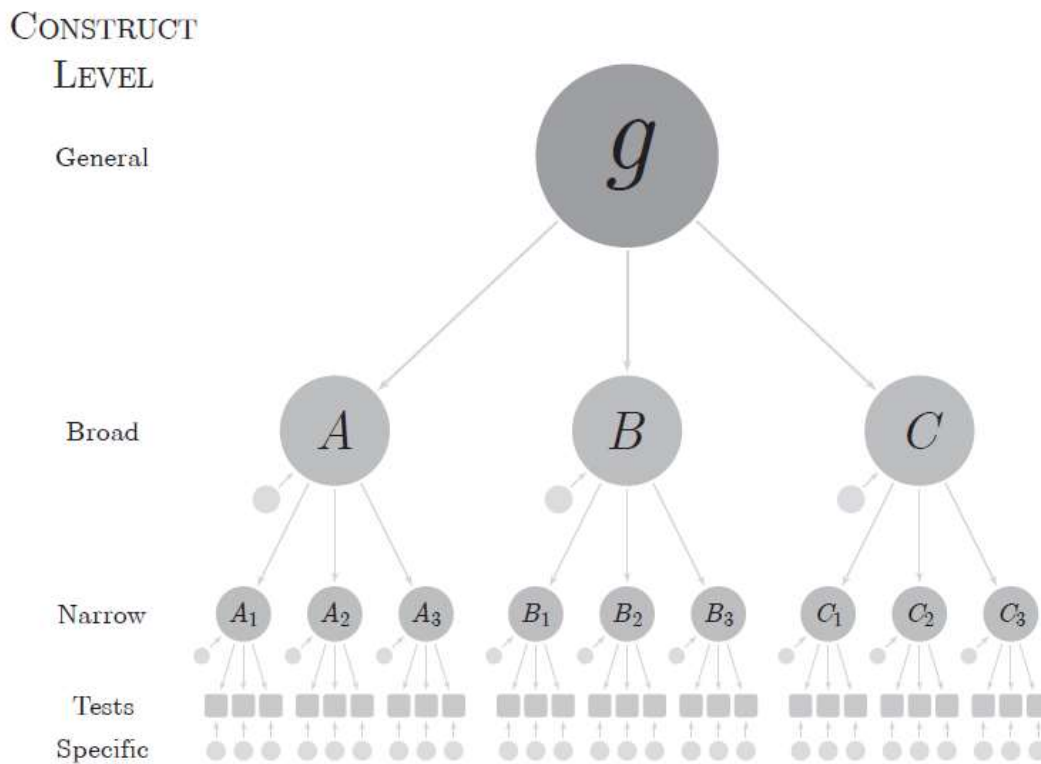
FIGURE 3.1. A tidy hierarchical structure.

Specific abilities are tied to specific tasks or tests and can be measured directly (Schneider &

McGrew, 2018). For example, the RCPM measures the ability to organise spatial perceptions

into coherent wholes. Narrow abilities refer to "clusters of highly correlated specific abilities"

(Schneider & McGrew, 2018, p. 74). For example, the RCPM measures the ability to reason by

analogy or adopt an analogy to make inferences about a pattern. Broad abilities are clusters of

narrow abilities that hold a higher correlation with one another than with other broad abilities

(Schneider & McGrew, 2018). For example, the RCPM measures the fluid intelligence of the test

takers or the domain-general reasoning capacity and is represented by Gf (General fluid

reasoning). Acquired-knowledge broad abilities include comprehension knowledge (Gc),

domain-specific knowledge (Gkn), reading and writing (Gw), and quantitative knowledge (Gq)

(Schneider & McGrew, 2018). There are domain-specific sensory abilities that include visual

(Gv), auditory (Ga), olfactory (Go), tactile (Gh), and kinaesthetic (Gk) as well as the

psychomotor ability factor (Gp) (Schneider & McGrew, 2018). There are three factors related to

memory: working memory capacity (Gwm), learning efficiency (Gl), and retrieval fluency (Gr).

Lastly, there are abilities related to speed: reaction/decision time (Gt), processing speed (Gs), and

psychomotor speed (Gps) (Schneider & McGrew, 2018). The broad and narrow abilities are

distinct from each other but form an integrated system that can be described as the process of

problem solving. The concept of general intelligence (g) is based on Spearman's theory that all

mental abilities are positively correlated (Schneider & McGrew, 2018). Many researchers and

psychologists have different views of Spearman's conclusion, but no explanation has dominated

the field (Mansolf & Reise, 2017; Schneider & McGrew, 2018). Spearman's (1904) efforts to

explain *g* led him to develop factor analysis. Factor analysis allows researchers to reduce many

variables into a smaller number of factors by extracting common variance among the variables.

Raymond Cattell (1941, 1943) developed the Gf-Gc theory to distinguish between fluid

intelligence (Gf), which refers to the ability to perceive conceptual relationships, and crystallized

intelligence (Gc), which refers to accumulated knowledge. Cattell (1941, 1943, 1971, 1987) cited

three lines of evidence to support this theory: fluid and crystallized intelligence can be

distinguished using factor analysis; fluid and crystallized intelligence have different

developmental growth curves; and different types of brain injury have different effects on fluid
and crystallized intelligence. Cattell explained his theory as a continuation of Spearman's *g*,
which builds upon Spearman's conceptualization of intelligence. Cattel presented "psychometric,
developmental, and neurological evidence that Spearman's *g* arose because of two different
processes," fluid and crystallized intelligence (Schneider & McGrew, 2012, p. 90). Cattel (1987)
explained the correlation between fluid and crystallized intelligence with investment theory,
which states that the correlation results from the continuous use of fluid intelligence to generate
new knowledge which accumulates to build up crystallized intelligence. From this definition,
fluid reasoning can be defined as deliberate and controlled processes to solve unfamiliar
problems that cannot be solved using one's accumulated knowledge. That is precisely what the
RCPM sets out to measure.

2.5 Raven's Coloured Progressive Matrices.

2.5.1 Test description

The RCPM is a form of Raven's Progressive Matrices (RPM), which is a non-verbal test that
measures fluid intelligence problems (Raven et al., 1990). The RCPM was created in 1947 and
revised in 1956 and is used with children aged 5 years and older. The test comprises visual
geometric designs featuring a missing piece, alongside a set of alternatives pieces from which to
choose. Among these alternatives, one piece is the correct match to complete the geometric
design. The Standard Progressive Matrices (RSPM) was developed in 1938 and was expanded to
include the RCPM and the Advanced Progressive Matrices (RAPM). In 1998, the SPM Plus was
made available, and the items were based on a parallel version of the SPM. The SPM Plus has
more difficult items in an attempt to correct the discrimination found in the original SPM, which
were prevalent among more abled adolescents and adults (Kaplan & Saccuzzo, 2012). The

RCPM was constructed to be used while working with children aged 5 to 11 years, the elderly, and the mentally and physically impaired (Bass, 2000). Among children, the results are used to infer the level of a "child's eductive capabilities and potential to create knowledge out of logical associations" (Muniz et al., 2016, p. 260). The RAPM were constructed to be used while working with adults and adolescents of above average intelligence (Domino & Domino, 2006). According to Muniz and colleagues (2016, p. 260), Pasquali and colleagues (2002) stated that "Raven used three theories to develop the Matrices" including the RCPM: Spearman's two-factor theory; Gestalt theory; and the theory of cognitive development. Spearman (1927) conceived intelligence as a *g* factor (general factor) and defined it as mental energy storage that requires 3 basic processes: apprehension of experience; eduction of relationships; and edcation of correlation. He developed a two-factor theory/ bifactor theory, which is composed of a general factor, an ability that is common to all skills, and one specific factor unique to each test. The theory proposes that both these factors are present in any intellectual activity (Muniz et al., 2016: 260). This assumes that every intelligence test demands general cognitive ability as well as a particular skill related to a specific activity. The RCPM attempts to measure a child's eductive ability, i.e., eduction of relationships in "which one has to find the links and associations among sets of information to conceive an idea" (Muniz et al., 2016, p. 260). The second theory, the Gestalt theory, grounds the construction of the items in the psychological test as it links the perception of the whole to the relationship between its existing parts (Muniz et al., 2016). In the case of the RCPM, the test taker must visualise a problem (an item) in its context to seek understanding based on the relationship between the item question and the alternative solutions. The RCPM's items were developed in such a way that each problem must be solved in a spatial or logical perception of one gestalt (Pasquali et al., 2002). A child's eduction of relationships and

eduction of correlations develop along with organic maturation (Muniz et al., 2016). This implies that a child will perform poorly in comparison to an adolescent taking the test. Raven proposed 5 successive levels of cognitive development in children 5 to 12 to solve problems: distinguish similarities and differences in figures; assess the orientation of the figure in the perceptual field regarding itself and the surrounding objects; perceive how two or more figures can form a whole; analyse the parts to perceive the whole; compare analogue changes in the perceived parts; and use it as a strategy of logical reasoning (Muniz et al., 2016; Pasquali et al., 2002).

While the RCPM is generally considered to be culturally fair, there are studies that contradict this (Bass, 2000; Knoetze et al., 2005; Linstrom et al., 2006). As a measure of fluid intelligence, it purports to measures an individual's ability to adapt to novel inputs (Das, 2004). It is an easily accessible pencil and paper test that consists of three sets of twelve problems (Raven et al., 1990). The 36 items assess mental development. The three independent sets (A, Ab, and B) provide three opportunities for examinees to develop a consistent process of thought (Raven et al., 1993). The items are ordered according to the ascending level and are increasingly complex. This allows the child to be gradually introduced to more complex types of reasoning. The child can use the strategies they used to solve the previous, less complex items, to develop logic-associative strategies to solve the more complex items (Muniz et al., 2016). The RCPM consists of coloured illustrations to keep the child stimulated and are presented in such a way that the problem can be solved with minimum verbal explanation. It provides the examiner with an opportunity to evaluate to what extent the examinee can reason by analogy i.e., to adopt analogy as a consistent way of inference (Raven et al., 1993). The individual items are created to assess the ability of individuals to organise spatial perceptions into coherent wholes.

Since the Progressive Matrices' primary objective is to assess the eduction of relationships, or inductive reasoning, the progressive matrices are uni-dimensional. The nature of the items in each set has unique characteristics that require "particularities in one's reasoning to achieve the correct response" as shown in the table below (Muniz et al., 2016, p. 261).

Table 1

RCPM Set Subdivision of Items

Items	Complement of	Perceptions related to
Set A		
Items A1 to A8	Simple, continuous pattern	Difference, identity, similarity, orientation, and gestaltic formation
Items A9 and A10	Pattern showing progressive changes in one direction	Difference, identity, similarity, and orientation
Items A11 and A12	Pattern showing progressive changes in two directions	Difference, similarity, orientation, gestaltic formation, and correlate-creation
Set Ab		
Items Ab1 to Ab3	Distinct patterns	Difference, similarity, identity, and orientation
Items Ab4 to Ab12	Distinct patterns involving apprehension of three related figures, to be completed by a	Difference, closed and open symmetry, orientation, changes of orientation, and

	fourth piece	oblique orientation of missing part
Set B		
Items B1 and B2	Distinct patterns	Difference, similarity, and identity
Items B3 to B5	Apprehension of three figures with the whole to be completed	Similarity, symmetry, and orientation of a missing part
Items B6 to B9	Concrete or coherent reasoning by spatial analogy with an asymmetric change in changed figure and oblique orientation of the missing part	
B10 to B12	Discrete or abstract reasoning by logical analogy	

The participant score 1 for each correct answer and a 0 for each incorrect answer, each item has only one correct response. The maximum score that can be obtained is 36.

2.5.2 Normative studies for RCPM

Norms generated by previous studies in SA were significantly lower than those obtained during the standardisation of the RCPM in the USA and the UK (Bass, 2000; Knoetze et al., 2005). This may be since the participants were not tested in their home language (Bass, 2000; Knoetze et al., 2005). This means that the results of South African test takers cannot be compared to USA and UK norms to evaluate responses as language may be a confounding factor when administering the RCPM. Normative data for the RCPM has been established with great success in various cultural settings including: Inuit children in Quebec (Wright et al., 1996); children in rural India

(Barnabas et al., 1995); children in Poland (Jaworska & Szustrowa, 1993) and children from

rural and urban Ghana (Anum, 2014).

Polish standardisation of the Raven's Progressive Matrices established local norms for the

various Raven's tests (Jaworska & Szustrowa, 1993). The RCPM sample consisted of 1185

children aged 3 years and 11 months to 9 years and 11 months (Jaworska & Szustrowa, 1993).

The study supported the cultural fairness of the various Raven's tests. In contrast, Anum's (2014)

study, which attempted to evaluate whether test scores were influenced by socio-cultural norms,

arrived at different conclusions. The sample consisted of 734 children aged 6 years and 0 months

to 11 years and 11 months from rural and urban areas in the Greater Accra region (Anum, 2014).

The study concluded that different norms are necessary for individuals from urban and rural

areas and therefore questions the cultural fairness of the RCPM.

Normative studies conducted in SA include a study in the Free State (Linstrom et al., 2006) and a

study in Grahamstown (Bass, 2000). The Education department of the Free State prepared a

sample of 2469 children ranging from 5 years to 12 years for Linstrom and colleagues (2006).

The study aimed to find local norms for the RCPM in SA and found that the test was culturally

fair to the sample. Bass (2000) conducted a normative study in Grahamstown, a peri-urban area

with a disadvantaged population. The study conducted by Bass (2000) administered a Xhosa

translation of the RCPM on a sample of 379 participants between Grades 2 to 7. The Xhosa

translation administered previously in the Grahamstown region by Vass in 1992 was used (Bass,

2000). The study concluded that local norms were significantly lower than that of participants'

Western counterparts and that the RCPM is described as a culturally fair assessment measure for

the sample as language and no prior learning influences the results. This implies that the RCPM

is designed to reduce the influence of culture on the test takers' responses. Bass (2000)

speculated that culture and socio-economic influences impact the results. The lack of necessary materials, i.e., paper and pencils, and the lack of experience with these materials may negatively impact the reproduction tasks, rather than a bias that exists with the item or test or a deficit in non-verbal intelligence.

2.5.3 Validity and reliability

The validity and reliability of the RCPM have been established in previous studies (Carlson & Jensen, 1981; Carpenter et al., 1990; Knoetze et al., 2005). Validity refers to the accuracy with which a test measures what it is created to measure (Urbine, 2014). Reliability refers to the consistency with which an instrument measures a construct (Roodt, 2013b). The RCPM measures intelligence validly in a factorial sense (Raven et al., 1993). Factor analysis searches for shared unobserved variables that can explain the variability among the observed variables. Various cross-cultural studies reported validity data that fall within the range 0.6-0.7 (Raven, 2003). The updated manual of the English RCPM confirms that the reliability of the test has been extensively studied and that the test-retest and split-half methods have proven that the RCPM can provide reliable results (Raven, 2003). Test-retest reliability compares the scores from two consecutive measurements of the same individuals to assess whether the test is reliable through calculating the correlation between the two measurements (Urbine, 2014). The test-retest reliability score over the entire range, from various studies, fall between 0.9-0.95 (Raven, 2003). Split-half reliability refers to splitting the items on a test in two and computing a separate score for each half that can be compared to test the reliability for the particular group of participants (Urbine, 2014). The split-half reliability score over the entire range, from different studies, fall between 0.85-0.9 (Raven, 2003). These results show that the English RCPM is a valid and reliable instrument for Western populations.

2.6 Conclusion

In Chapter 2, the historical creation of disadvantaged groups in SA; culturally fair assessment;

fluid intelligence testing; and the RCPM was explored. The initial literature overview explored

and contextualised the disadvantaged groups in SA with special attention to the equality of

education that is available to these groups. This chapter then investigated the conceptualisation

of fluid intelligence and how the RCPM measures it. The relationship between the RCPM and

different contexts in which norms have been found for it was then considered. This was done

with the aim to contextualise the concept of fluid intelligence and the use of the RCPM in

disadvantaged communities with a lower quality of education compared to their wealthy peers.

The next chapter will look at the methodology of the current study.

Chapter 3: Methodology

3.1 Introduction

In this chapter, the paradigmatic point of departure, critical dialectic pluralism, will be discussed alongside the systematic review method that was used to conduct the research set out in Chapter 1. Critical dialectic pluralism combines quantitative and qualitative paradigms to produce knowledge and make inferences from a variety of information sources. Dialectical pluralism can produce high quality equal-status mixed method research (Johnson, 2017). Rather than feeding into the "paradigm dialogue/war" where researchers must choose between a dichotomy or trichotomy of paradigms, dialectical pluralism makes an "and/both" statement, accepting more than one paradigm as appropriate (Given, 2012; Johnson, 2015). This is the ideal paradigmatic point of departure to conduct a systematic review as it incorporates various quantitative and qualitative techniques to conduct analysis and interpretation independently and combine insights and inferences from both quantitative and qualitative resources. In their book, *7 Steps to a comprehensive literature review: A Multimodal and Cultural Approach*, Onwuegbuzie and Frels (2016) recommend dialectical pluralism as a metaparadigm for conducting a mixed method systematic review.

3.2 Paradigmatic Point of Departure

A paradigm is a set of assumptions and preconceived notions that a person holds which informs any research they produce (Given, 2012). During the conceptualisation of the concept "paradigm", social scientists differentiated between positivism, for quantitative research, constructivism, for qualitative research, and the critical theory paradigm, which is a metaparadigm as it encompasses paradigms such as neo-Marxism, feminism, participatory research, poststructuralism, and postmodernism (Given, 2012; Mertens, 2018). With the

proliferation of paradigms in recent years, there are many paradigms to choose from when conducting research. Dialectical pluralism is an appropriate fit for a mixed method systematic review as it has a history of informing this methodology (Greene & Hall, 2010).

According to Johnson and Stefaruk (2013), there is no single rational truth that describes a contentious reality, but through dialectic pluralism and dialogical processes, acceptable outcomes can be achieved. In the case of this study, acceptable outcomes can be defined as conclusions made from peer-reviewed articles to answer specific research questions. The paradigmatic point of departure is based on Johnson's (2011) conceptualisation of dialectical pluralism. According to Johnson (2011), dialectical pluralism integrates quantitative and qualitative paradigms to synthesise knowledge and inferences from a variety of, often contradictory, sources. Johnson (2017) describes dialectical pluralism as the careful, systematic, and thoughtful listening, understanding, learning from various disciplines, perspectives, ethnicities, methodologies, and paradigms (Johnson, 2017). The essential ideas of dialectical pluralism as a metaparadigm are to (Johnson, 2017, p. 160):

> "(a) dialectically listen carefully and thoughtfully, to different disciplines, paradigms, theories, and stakeholder… perspectives; (b) combine important ideas from competing values and into a new workable whole for each research study/evaluation; (c) explicitly state and "pack" the approach with researchers' and stakeholders' epistemological and social/political values and construct standards to guide and judge the research…; (d) conduct the research ethically; (e) facilitate dissemination and utilization of research

findings; and (f) continually evaluate the outcomes of the

research/utilization process."

3.2.1 History of Dialectical Pluralism

"Dialectical" methods of dialogue are one of the oldest in history and can be traced back

to Socrates, Plato, and Aristotle (from the West) and Hindu philosophy, Jain philosophy, and

Buddhism (from the East). According to Socrates (Plato, 2004) a dialect involved the

questioning of others and helping them to see the error in their reasoning. Plato's dialogues, with

their back-and-forth interactions between speakers, are exemplifications of such dialect (Plato,

2004). Aristotle's (2012) definition of dialectical reasoning encompassed deductive and

inductive reasoning, as it was continual and produced novel insights throughout the process. In

the Eastern tradition, dialectical refers to the joining of two opposing parts to form a

complementary whole, as seen in the Taoist Yin Yang symbol where two parts flow around one

another but each is also a part of the other (Johnson, 2017). During the Middle Ages, Aristotle's

way of thinking was revived and combined with religion (Johnson, 2017). Later, during the 19th

century, Hegelian idealism evolved the idea of dialecticalism into the synthesis of logical

opposites with the expectation to produce reconciliation (Johnson, 2017). Currently, dialectical

thinking is being revised and used in many academic disciplines to attempt a reconciliatory

approach to contradictions and the changing nature of knowledge. The same is true for both

dialectical thinking and pluralism: both will keep on returning because reality is complex,

multifaceted, and difficult to describe.

Although dialectical thinking has a long and interesting history, dialectical pluralism was

first coined by W. J. T. Mitchell (1982) in his role as the editor of the Critical Inquiry Journal.

Mitchell (1982, p. 614) described dialectical pluralism "not [as] liberal toleration of opposing

views from neutral ground, but [rather] transformation" in the form of communication which

clarifies what is critical in any conflict. Much later, Jason Goertzen (2010) described the

following criteria for dialectical pluralism: (a) liking tensions from competing theories, (b)

calling for oscillation of convergent and divergent pluralism, and (c) resting on a foundation

called intercontextualism. Dialectical pluralism, as constructed by Johnson (2017) differs, as it is

a metaparadigm and a process philosophy, although there are some common features with

Mitchell's definition, and it does ascribe to Goertzen's first criterion. It goes beyond both as its

"meta" and process characteristics are defining features. Johnson (2017) requires the use of

multidimensional dialecticalism that asks of the researcher to appropriately listen to all that

needs to be listened to in order to answer the research questions and satisfy the needs of each

stakeholder. This broadened understanding of dialecticalism will enable "people to continually

interact with different ontologies, epistemologies, ethical principles, disciplines, methodologies,

and methods in order to produce useful wholes (Johnson, 2017, p. 158). The "dialectic" in

dialectical pluralism builds on the work of Jennifer Greene's conceptualisation of the dialectic

stance in mixed method research (Greene, 2007; Greene & Hall, 2010). Johnson's (2017)

"dialectical" adds the following value:

> "(a) articulate dialectical pluralism as an underlying process
> philosophy/theory in explicit depth… by specifically articulating its own
> philosophical assumptions; (b) shows how the dialectical pluralism process
> philosophy/theory dialogues at the level of ontology, epistemology, axiology,
> methodology, method and more; (c) provides a list of many different tensions
> that dialectical pluralism can help mediate; (d) provides the name "dialectical
> pluralism" which is slightly more descriptive than "dialectic stance" because it

includes the ontology (pluralism) and epistemology (dialectical) directly in its

name…; (e) directly builds on social psychological literature on negotiation,

conflict management, and group process for dealing with differences; (f) adds

useful insights from the philosopher John Rawls (e.g., reasonable pluralism);

(g) explains the concept of a metaparadigm as a specific strategy for dealing

with paradigm differences; (h) transforms the dialectical approach used in

mixed method research into a metaparadigm; and (i) provides a detailed list of

principles of mixed method research that follows from dialectical pluralism"

(p. 158).

3.2.2 Process Philosophy

Dialectic pluralism is a process philosophy typically employed to facilitate a dialogue

among multiple types of literature sources, thereby ensuring the production of inclusive

knowledge through the evaluation process (Johnson & Stefurak, 2013). Dialectic pluralism

developed from process philosophies, which can be described as centred around the assumption

that reality is plural and dynamic (Johnson & Stefurak, 2013). Dialectic pluralism is based on a

Rawlsion procedural justice model that Rawls (2001) described as reasonable justice.

Rawls described *justice as fairness* i.e., a society of free citizens that have equal basic

rights who are cooperating within an egalitarian economic system (Wenar, 2008). Dialectic

pluralism encourages researchers to work dynamically and collaboratively to build on how

reality is defined and represented differently by different cultures. This allows the researcher to

work towards the principles Rawls (2001) aims towards. Firstly, in his book *Justice is fairness: A

restatement*, Rawls (2001) states that democratic equality requires equal rights. This motivates

for action, which is represented by Rawls' second principle: to improve the quality of life of

those that experience the most disadvantage (Rawls, 2001). This dissertation can lead to change
in norming techniques in developing countries like SA.

In addition to these principles, Rawls also described the concepts of reasonable pluralism
where "society is composed of people with different traditions of thought and different cultures"
(Rawls, 1993, p. 160). According to dialectical pluralism there is not one static and knowable
reality, but rather, it changes depending on the individual who is viewing or experiencing that
reality. This provides the researcher with a process to explore multiple perspectives interactively,
even though they may appear contradictory. To conduct comprehensive research from a dialectic
pluralist framework, three critical characteristics are essential: dialectic listening,
epistemological grounding, and a focus on procedural justice (Johnson & Stefurak, 2013). Firstly,
the researcher must take in the content and interact with the differing views, theories, and
perspectives with great care and reflection. Secondly, the researcher should be grounded in the
research's stakeholders' epistemology and social political values, as this guides the researcher
regarding the values they should uphold during the research process. Lastly, procedural justice
allows the production of an inclusive evaluation knowledge generation, where practice-to-theory
and theory-to-practice evidence continually inform each other (Johnson & Stefurak, 2013).

3.2.3 Dialectic Pluralism in practice

When dialectical pluralism is applied to evaluation practices, it entails collecting data and
information from multiple stakeholders and striving to reach a conclusion that meets the needs of
multiple, often divergent, stakeholders (Johnson & Stefurak, 2013). This is the only way to
ensure that multiple perspectives are thoughtfully and carefully presented in the evaluation of
literature. Critical dialectical pluralism allows the researcher to make probative inferences, which
are conclusions that best explain the reality given the agreed-upon values and standards that the

researchers employ in their research (Johnson & Stefurak, 2013; Scriven, 2012). In other words,

dialectical pluralism allows the researcher to bring the results of qualitative and quantitative

approaches together to identify issues that arise from that juxtaposition (Mertens, 2018).

3.3 Research Strategy

A research strategy is informed by the research question and aims of the research (Gravetter et al,,

2021). The research question for the current study asks what the relationship is between the

quality of education and the scores on a fluid intelligence test, the RCPM. The study strategy was

in line with the following aims of the current study: (Aim 1) to investigate the influence of

gender on RCPM results; (Aim 2) to investigate the influence of socioeconomic variation on

RCPM results; and (Aim 3) to investigate the relationship between RCPM results and quality of

education.

A systematic review attempts to identify, review, and synthesize the knowledge sources

that are available and accessible to date (Tight, 2019). A systematic review ensures that the

research is done scientifically and soundly. Studies regarding the norming of the RCPM needed

to be rigorously analysed in a systematic way to avoid bias. Systematic reviews can be described

as a comprehensive search of literature that emphasises transparency in order to reduce bias. By

utilising predetermined inclusion criteria, systematic reviews aim to uncover all available

empirical evidence related to a specific research question (Snyder, 2019; Tight, 2019). A

concurrent mixed-analysis approach was used to analyse quantitative research article results and

interpret qualitative research articles. This technique allows the researcher to conduct analysis

and interpretation independently and combine insights and inferences from both (Onwuegbuzie

& Frels, 2016). Mixed-method research can be defined as the combination of quantitative and

qualitative research methods and sources to explore current knowledge (Johnson &

Onwuegbuzie, 2004). A concurrent mixed-analysis approach allows the researcher to synthesise the results of quantitative and qualitative articles to identify trends in the body of knowledge and to make meta-inferences about existing research (Onwuegbuzie & Frels, 2016). The seven main stages of a systematic review include: "writing the protocol (including the inclusion and exclusion criteria); searching and screening; 'scoping' or 'mapping' the research; extracting data from the included studies and quality appraising them; synthesising the studies in a narrative, and sometimes in a meta-analysis; writing and disseminating the report" (Tight, 2019, p. 5). The process of conducting a systematic review was in line with the eight steps (as shown in Figure 3) followed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement. A quality assessment rating was needed for each study, and an adapted version of the Critical Appraisal Skills Programme (CASP) tool was used (Laher & Hassem, 2020). These measures ensured that the study was as unbiased and accurate as possible. (Snyder, 2019)

Figure 3

The 8 Stages of a Systematic Review

1. Formulating the research question

2. Define inclusion and exclusion criteria

3. Develop search strategies and locate studies

4. Select studies

5. Extract data

6. Assess study quality

7. Analyse and interpret the results

8. Dissemenation of findings
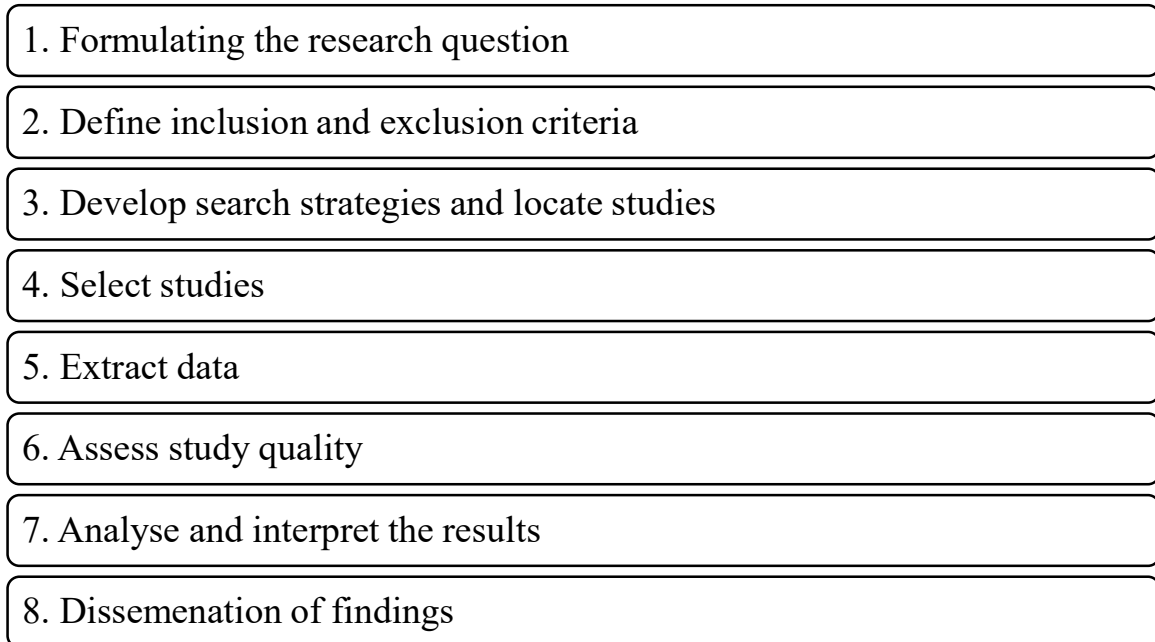
3.3.1. Formulate the Research Question

To conduct a systematic review, the research question must be able to answer an

important question or identify important areas in the field that need to be researched (Harris et al.,

2013). It is for this reason that the research question must be innovative and specific. Prior

research must also be conducted to narrow down the research question to a relevant and unique

question (Laher & Hassem, 2020). The research question should inform every step of the

research process from the paradigm to the methodology used to conduct the research (Snyder,

2019).

This study's research question is: What is the relationship between quality of education

and fluid intelligence, as measured by the RCPM?

3.3.2. Define Inclusion and Exclusion Criteria

Predetermined inclusion and exclusion criteria ensure that evidence from the collected studies is accurate and unbiased (Efron & Ravid, 2018). Criteria such as the ages of participants and composition of the sample need to be decided on a priori basis (Uman, 2011).

The search criteria for the selection of published articles utilised the following inclusion criteria:

- Publication Type

Published and peer-reviewed articles were selected from databases available to the library of the University of Pretoria.

- The Methodology of Empirical Study

This focused the search on research reports and eliminated essays, discussions, and general review articles.

- Timespan

The search included articles between the years 1992-2022.

- Language

The studies are limited to the English language.

- Samples

The studies are limited to samples that focus on the ages 5-12 years of age. Both genders were included in the study as well as participants from all races and ethnic groups.

- Study Designs

Studies that attempt to find local norms for the RCPM or intelligence with the RCPM were included.

The search criteria for the selection of published articles utilised the following exclusion criteria: the selection of studies that did not focus on (a) finding local norms for the RCPM or intelligence with the RCPM; and (b) the age group of ages 5-12 years of age.

3.3.3. Develop Search Strategies and Locate Studies

Search strategies include searching relevant electronic databases and going through reference lists (Uman, 2011). The researcher is required to find an optimal number of key studies by using an impartial search strategy (Harris et al., 2013). It is essential to set a limiter in the advanced search option to peer-reviewed journals to eliminate books, book chapters, and Ph.D. dissertations. This ensures that there is an added level of screening that will allow only worthwhile and legitimate articles to be included in the sample of the study (Gravetter et al., 2021).

This literature review was conducted by searching academic literature using key terms and Boolean functions with few limiters in various databases. Databases include the University of Pretoria library catalogue, EbscoHost, Emerald Insight, Proquest, PsychInfo, PsychArticles, and Science Direct. Table 2 presents the databases and the reasons for their selection.

Table 2

Database Selection and Reason for Selection

Search Engine	Reason for Selection
EbscoHost	It hosts quality databases that provide reliable and peer-reviewed articles from an abundance of journals (https://www.ebsco.com).
Emerald Insight	It describes itself as a "facilitator of impact, encouraging equitable, healthy and sustainable research and publishing for all" (https://www.emeraldgrouppublishing.com).

ProQuest	It is the largest single periodical resources available, bringing together complete databases across all major subjects (Swansea University, 2021).
PsychInfo	The American Psychological Association (APA) is the largest resource devoted to peer-reviewed articles in behavioural sciences and mental health (David L. Rice Library, 2021).
PsychArticles	It is published by the APA and contains more than 153 000 articles from nearly 80 journals (David L. Rice Library, 2021).
Science Direct	It is a full-text scientific database offering journal articles from nearly 2500 journals (City University of New York, n.d.).

An initial search was performed in the University of Pretoria library catalogue. This was followed by searches in Ebscohost, Emerald Insight, Proquest, PsychInfo, PsychArticles, and ScienceDirect. Initial key terms that were used include "Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system". Following this, information about the topic was explored and the search was refined by distilling the topic guiding criteria (Onwuegbuzie & Frels, 2016). Topic guiding criteria are guidelines that develop throughout the search, focusing it to ensure that only the most relevant and suitable information sources are found. Topic guiding criteria that developed after the initial search included the article focusing on the use of the RCPM.

Sampling theory from the statistics field is involved with the collection, analysis, and interpretation of data collected from random samples from the population of interest (Onwuegbuzie & Frels, 2016). In this case, the population of interest is the abstracts which were identified during the initial and subsequent searches in the databases.

The systematic review focused on identifying and selecting empirical studies to evaluate the research topic justifiably by following the systematic review methodology accurately, stringently, and reliably (Snyder, 2019). For the literature review, academic literature was searched with the following limiters: academic articles that have been published in English between 1992 and 2022.

Additional to reading a representative number of abstracts to glean information about the topic, the abstracts were used to select the articles that were most pertinent to the topic. These articles were read in their entirety, as suggested by Onwuegbuzie and Frels (2016). During the initial search, six articles were read in their entirety as suggested by Guest and colleagues (2006, p. 78) to develop "meaningful themes and useful interpretations". By reading at least six of the relevant sources found, the information can be contextualised. This is essential for understanding critical elements necessary for interpreting the information sources found during the search, as well as finding additional keywords and phrases that lead to a more focused search. The review questions and search strategy were constructed by using the SPIDER statement (Cooke et al., 2012). A summary of the SPIDER statement can be found in Table 3. This study is interested in children aged 5 to 12 who completed the RCPM to find local norms, to validate the RCPM or to establish its reliability. This study is interested in quantitative, qualitative, and mixed method studies.

Table 3

The SPIDER Statement

SPIDER	Element	Focus of Present Review
S	Sample	Children completing the RCPM
P of I	Phenomenon of Interest	Normative studies
D	Design	No limits placed on theoretical framework
E	Evaluation	Subjective and objective data regarding the use, norming, validity, reliability, and factorial structure of the RCPM
R	Research Type	Quantitative, qualitative, or mixed method research

Preliminary searches elicited little focus on the relationship between the RCPM local norms and the quality of education in SA. The search strategy was expanded to include data that relates to the RCPM and socio-cultural influences on local norms. The search strategy established was informed by the initial six articles found and through the consultation of a specialist librarian at the University of Pretoria library. A systematic search of 6 databases was conducted in May 2022 by entering a combination of selected search terms as shown in Figure 4. These search terms were used based on their relevance to the research topic.

Figure 4

A Visual Depiction of Search Terms and Boolean Operators Used in the Search Strategy

"Raven's Coloured Progressive Matrices" OR "Raven's CPM" OR "RCPM"	AND	"Norm*" OR "Validity" OR "Reliability"	AND	"Fluid intelligence" OR "Fluid reasoning" OR "Intelligence" OR "IQ"
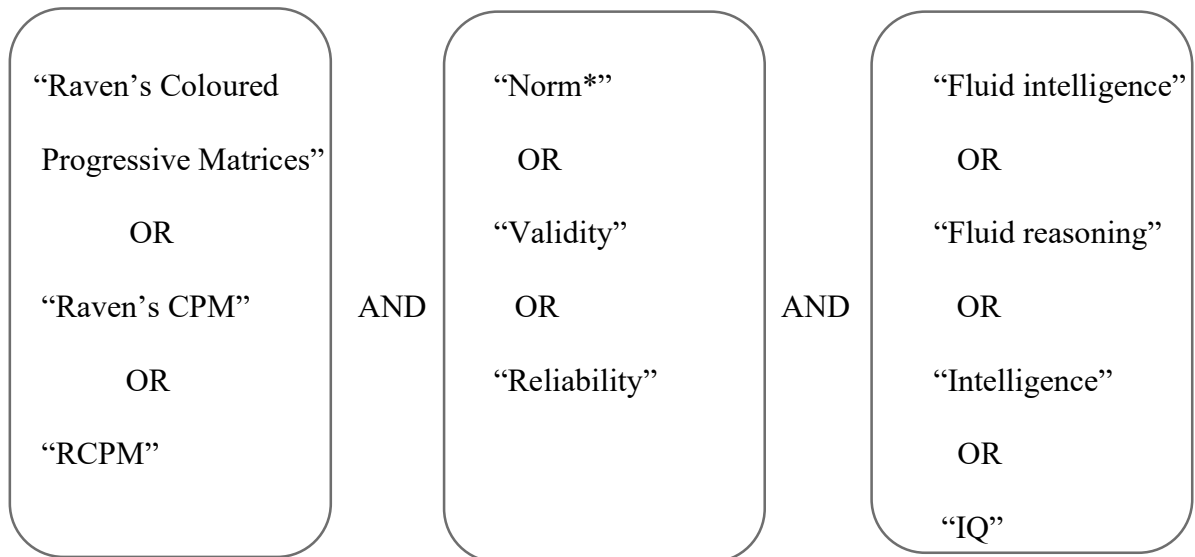
The necessity to focus the search is a reminder that a systematic review is a continuous and dynamic process. The task of focusing the search is dependent on the decisions, reflections, and interpretations of the researcher (Onwuegbuzie & Frels, 2016).

3.3.4. Selecting Studies

A reporting system like the PRISMA statement may be utilised for selecting eligible studies (Laher & Hassem, 2020). The PRISMA statement is an international statement for conducting and reporting systematic reviews and meta-analyses and is available at www.prisma-statement.org.

It is important to know how data is stored and organised throughout the search process and is essential to create an audit trail for reviewers. This includes raw data and process notes. Raw data refers to the literature found when using the topic guiding criteria, whereas personal

notes refer to summaries of articles, theoretical notes, methodological and critical selection notes, and reflective notes about the decisions made throughout the research process (Onwuegbuzie & Frels, 2016). Folders were created for each database, and articles were systematically saved using referencing software. The researcher used Mendeley as it is freeware and of good quality. The researcher kept track of studies reviewed, the citations, and reasons to include/exclude them in a data extraction form on Microsoft Excel (refer to Appendix A). Titles, abstracts, and full-text articles were assessed for eligibility by applying the inclusion and exclusion criteria to the studies. By using clear and orderly methods for finding academic articles, bias can be reduced. This allows for trustworthy findings from which conclusions can be made (Snyder, 2019).

The PRISMA statement report for this study is available in Figure 5. The PRISMA statement technique is comprehensive in identifying relevant studies for the research. The stages are: (1) a scoping search was conducted to search for primary studies on databases; (2) a database search using the identified search terms was conducted and recorded (see Appendix A); (3) a search of bibliographies and reference lists was done to identify key citations and a hand search was conducted to find these articles; (4) relevant papers that were missed by search strategies were verified and indexed; and (5) the eligible studies that were to be assessed for quality standards, bias, and coding were included.

3.3.5. Extract data

Once all the exclusion criteria have been adhered to, the eligible studies are identified for analysis, and the parameters of the studies are grouped on data collection forms (Harrris et al., 2013; Laher & Hassem, 2020). Then the research question guides the extraction of data. The included studies (N=9) were organised according to chronological and alphabetical order. The researcher ensured that multiple publications of the same study were not used, as that would bias

the results. The studies that were included and excluded were accurately recorded in the data

extraction form (Appendix A). Studies come from diverse countries across the globe. The 9

studies that were selected are reported on in Chapter 4.

3.3.6. Assess Study Quality

Each eligible study must be assessed for quality to gauge its bearing, research design,

research methodology, analysis, and findings (Uman, 2011). Researchers must exhaustively

report studies that do and do not support their theories (Kitchenham, 2004). Each selected study

must be assessed for its quality to reduce the possibility of bias slipping into the present study

(Laher & Hassem, 2020). Table 4 is a representation of the psychometric properties of the RCPM

according to the selected studies. This allows the researcher to weigh the importance of

individual studies when synthesising the results.

This study used the adapted CASP tool for quantitative articles, which consists of 11

items from Laher and Hassem (2020). The highest assessment score for quantitative studies was

11, and the cut-off score for inclusion was 4. The adapted CASP tool was used to assess the

quality of the articles that were included (See Appendix B). The questions in Appendix B guided

the evaluation of the articles. Table 5 expresses the potential risk of bias and the quality of the

articles. The researcher noted the overall quality of the studies after the analysis for potential risk

of bias and quality of eligibility criteria. The study has scores between 11 and 5 and the

researcher was satisfied with the overall quality of the studies.

Figure 5 is a funnel plot representation of the quality of the selected studies. The

researcher noted that several quality assessment questions lacked positive results after

conducting the quality assessment. The researcher used a funnel plot presentation as an

indication of which questions met the quality criteria (see Figure 6). The plot yielded the

following information:

Question 1: Clear Aim: 100%

Question 2: Appropriate methodology: 100%

Question 8: Statistical technique of analysis: 100%

Question 9: Rigorous data analysis: 100%

Question 11: Clear statement findings: 100%

Question 3: Appropriate research design to address the aims: 89%

Question 4: Appropriate recruitment strategy: 78%

Question 5: Data collection: 78%

Question 6: Justification of research methods: 67%

Question 7: Consideration of ethics: 56%

Question 10: Reliability and validity of psychometric instrument: 56%

The researcher interpreted the results from the analysis of the study quality assessment,

giving considerable attention to Question 10 (as highlighted in Figure 6). This question assessed

the reliability and validity of the psychometric instrument, in this case the RCPM. Another set of

questions were of considerable concern to the researcher – Question 4 and 7. Both questions

allude to the ethics of the study. Question 4 yielded a score of 78% and Question 7 yielded a

score of 56%.

Overall, the quality of the assessment yielded good quality assessment ratings for the

selected studies, with two major concerns being the reliability and validity of the RCPM in

different contexts, and the ethical considerations. The researcher presumes that this information

may influence bias.

3.3.7. Analyse and Interpret the Results

Conclusions can only be drawn from the results and future research recommendations can only be made after all the aforementioned steps have been taken (Harris et al., 2013). Conclusions are reached by interpreting the selected information sources to synthesise knowledge by making meta-inferences (Onwuegbuzie & Frels, 2016). Meta-inferences are deductions or conjectures that are combined to create a coherent narrative (Creamer, 2018).

This systematic review used qualitative data analysis for the application of various methods of analysis such as interpretive and integrative strategies (Laher & Hassem, 2020). For the analysis of the selected studies, attention is drawn to the quality of education in the region the RCPM is being normed. For the purpose of analysis, the researcher adhered to the steps encompassing the methodology of a systematic review as identified by the PRISMA statement (as shown in Figure 7). These steps involved the selection of studies based on predefined selection criteria, as well as quality assessment to detect bias.

3.3.8. Dissemination of Results

The last step is the distribution of findings through numerous publications (Uman, 2011). In the case of the present study this is in the form of a mini-dissertation as well as an article in an academic journal through the University of Pretoria.

Figure 5

The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews (Page, et al., 2021).
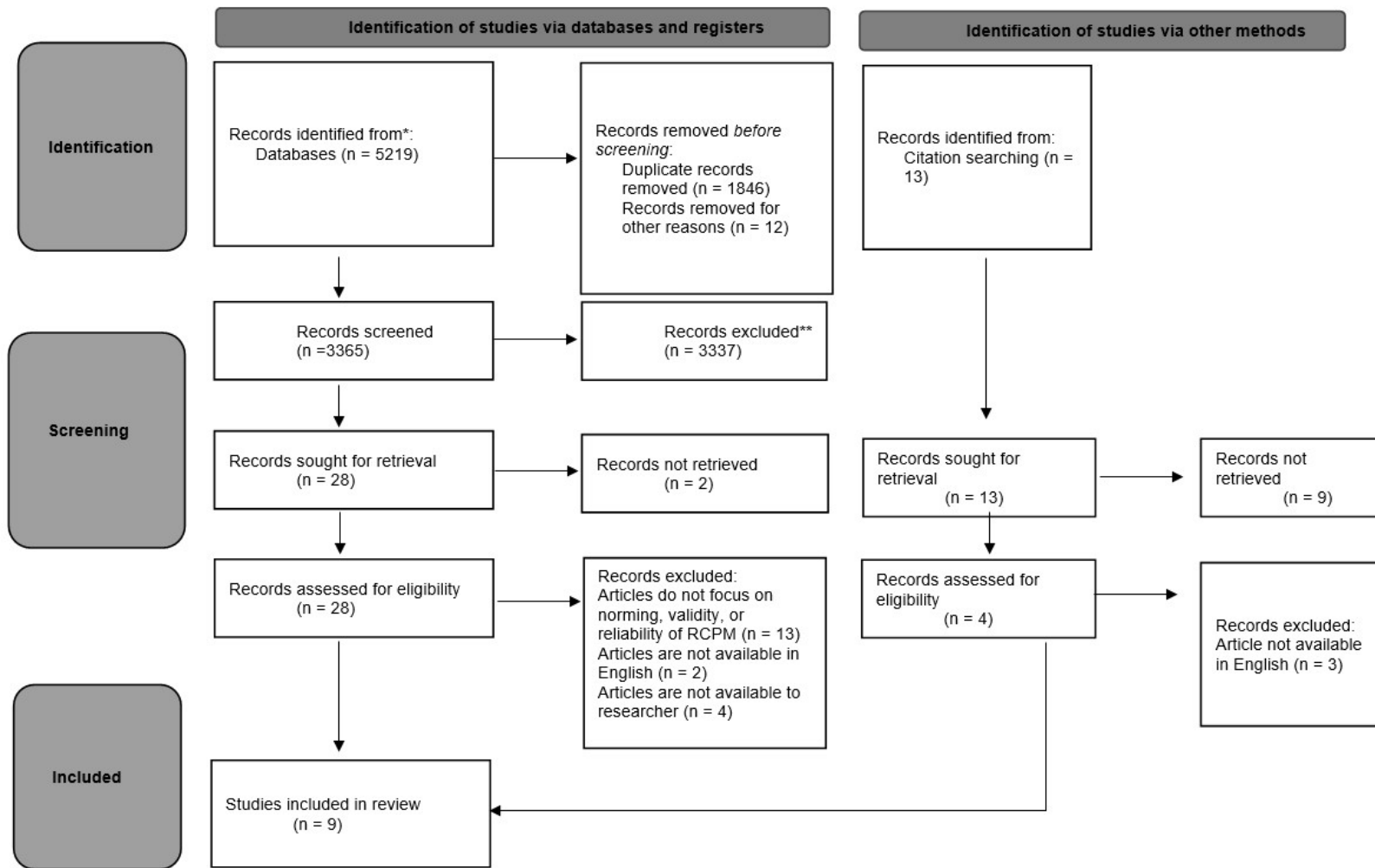
3.4 Ethical considerations

Sound ethical practices were followed during the research process and ethical clearance was gained from the University of Pretoria (HUM002/0121). The principle of non-maleficence was followed by not misrepresenting authors' claims. The principle of beneficence was followed by attempting to benefit the children who participate in fluid intelligence tests in SA by shedding light onto the factors that must be considered when conducting fluid intelligence tests. The principle of justice is essential to any study that follows a critical paradigm. It ensures that decisions made by the researcher during the research process remain impartial, fair, and, equitable to all parties who may be impacted by the publication of the results. The principle of integrity was followed to ensure that the researcher remains respectful and mindful of others' beliefs and ideas and reflects on their beliefs and biases throughout the research process. When dealing with a literature review, scholarly responsibility is an essential principle that must be adhered to throughout the research process. Scholarly responsibility refers to adherence to best practices by documenting and reflecting on decisions made throughout the research process (Onwuegbuzie & Frels, 2016).

The data is being stored in paper format and on a USB for a period of 15 years at the University of Pretoria in the Humanities Building room 11/23 and is accessible only to the supervisor and researchers at the University of Pretoria.

3.5 Conclusion

The characteristics and requirements of a systematic review were explained throughout this chapter. To ensure a comprehensive and impartial review, this systematic review adopted the eight stages commonly used in systematic reviews for its research methodology. The methodology showcased the process of extracting the studies and literature for the systematic

review and provided tabulated lists of the studies that were reviewed for the purpose of analysis.

Ethical considerations for the systematic review were explicitly stated. The sample of empirical

studies is analysed in the following chapter. The risk of bias can creep in during the any stage of

the research process. To combat this risk, the researcher adhered to the principles of transparency

and bias reduction throughout the study.

Chapter 4: Results

4.1 Introduction

The research methodology in Chapter 3 detailed the research design, strategy, sampling

procedure, and review protocol that were applied in the study. For the purpose of interpretation,

the researcher strictly adhered to systematic review protocols for the selection of studies that

were found to be eligible. The 9 studies were selected according to predefined eligibility criteria

and were assessed for their quality in order to avoid bias. In this chapter the results of the

systematic review have been detailed. Any norming, validity, and reliability studies have been

documented, along with their results and how they compare to the Western norms established by

Raven and colleagues (1990). During a systematic review, findings are compounded to produce

unbiased conclusions.

4.2 Population

The population includes the contextual information regarding the sample (participants)

from the selected norming studies. A total of 9 studies were included in the current study.

4.2.1 Contextual information

Figure 8 is a diagrammatic representation of the different contextual factors that were

used for the analysis of the population. The contextual information from the selected norming

studies have been tabulated for analysis. The contextual information is discussed with its

relevance to the tabulated data (see Table 6).

Table 4

Analysis of Contextual Information

Data source	Age of Participants			Gender		Participant Characteristics			Continent					
	-4	5-12	13+	M	F	Rural	Urban	Unspecified	Africa	North America	South America	Australia	Europe	Asia
1		1	1		908			1		1				
2		1		583	639			1	1					
3		1		329	286		1					1		
4		1	1	197	182	1			1					
5		1		1185	1284	1	1		1					
6		1		672	314			1						1
7		1		534	508			1						1
8		1		337	397	1	1		1					
9		1	1	6843				1						1
Total	0	9	3	3837*	3610*	3	3	5	4	1	0	1	0	3
Percentage	0	100	33	52*	49*	33	33	55	44	11	0	11	0	33

*Studies 1 and 9 are excluded from the total and percentage calculation as they do not provide the gender distribution of the

participants in their studies.

Figure 6

Diagrammatic Representation of the Analysis of Contexts in the Studies
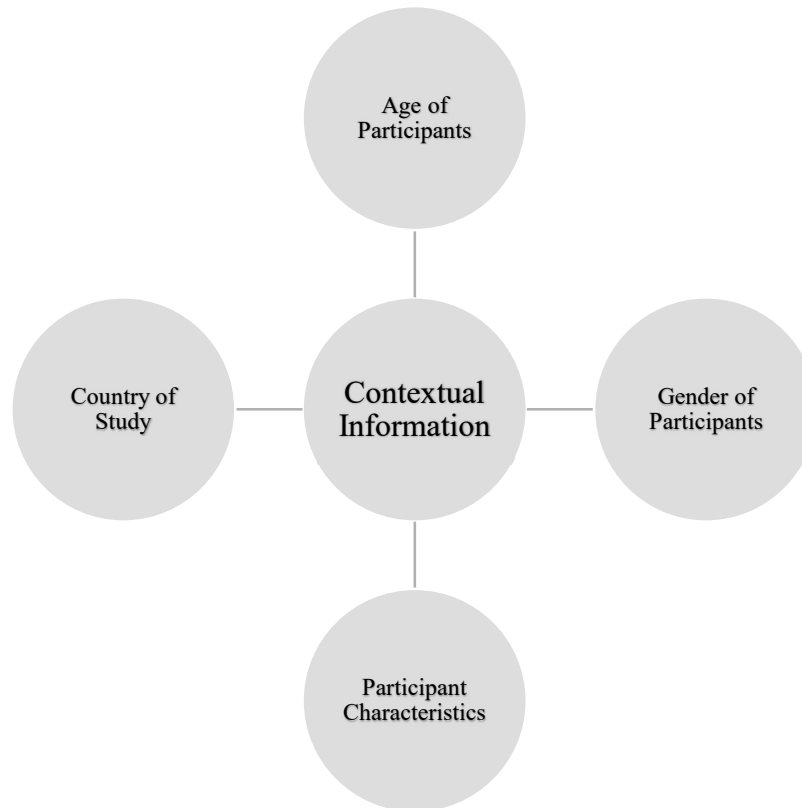
4.2.1.1 Age of Participants

In terms of the present study's selection criteria, the researcher chose to include participants between the ages of 5 to 12 (n = 6). The researcher made an exception with one study that had an older average sample (ages 5 to 20.5) than expected for primary school learners. There were also studies (n=2) where the age group went beyond primary school, but those learners were administered the Raven's Standard Progressive Matrices.

4.2.1.2 Gender of Participants

The gender distribution is known for 7 of the 9 articles. For the 7 articles, the participants' gender was not equally distributed as the males (n=3837) outweighed the females (n=3610). For

the 2 studies where the gender distribution is unknown, there is no reason given for omitting this

detail. The researcher surmised the reason for the larger number of male participants was due to

them being more willing to participate in the study. Alternatively, the male-female ratio in

schools where the samples were drawn from, could be skewed in favour of males.

4.2.1.3 Participant Characteristics

The characteristics of the participants were divided into 3 groups: rural area, urban area,

or unspecified. Most studies left this characteristic unspecified (n=5). For those who did not,

there is an equal distribution of children from urban (n=3) and rural areas (n=3) participating in

the study.

4.2.1.4 Continent of Study

The studies came from a total of (N=9) different countries, with researchers from Africa

(n=4) and Asia (n=3) producing the most studies out of the sample. The former produced studies

between 2001 and 2014 and the latter produced studies between 2008 and 2020.

4.3 Variables Featured in the Selected Studies

Four were chosen for analysis: RCPM performance, quality of education, gender

differences, and SES. These four constructs are in line with the topic, research question, and aims.

The contextual framework in Chapter 2 serves as a foundation for these variables to be clarified.

The researcher chose to extract information regarding any discussion on these variables from

each study to detect patterns or any discrepancies across studies. The variables that featured in

each of the selected studies were tabulated in Table 7.

Table 5

An Extraction of the Variables Featured in the Selected Studies

Data Sources	Variables			
	RCPM Performance	Quality of Education	Gender Differences	SES
MacAvoy et al. (1993)	The study suggests that the RCPM does not have the necessary item difficulty to measure giftedness for grades 3 and higher.	The study compares the performance of children from schools "on" and "off" the reservation, but do not speak to the quality of education provided by either.	The study related a significant difference between the performances of male participants compared to their female counterparts.	-
Costenbader and Ngari (2001)	The study suggests that the RCPM norms established in Kenya should	The study suggests that Kenyan norms differ from Western norms due to lack of	The study related that the male participants were able to complete on	The study suggests that Kenyan norms differ from Western norms due to lack of

	only be used for comparing Kenyan children and should not be used for comparison with other cultural or socioeconomic groups.	educational opportunities.	average 2 more items than the female participants. It is suggested that this is due to differential cultural expectations and child rearing practices.	socioeconomic opportunities.
Cotton et al. (2005)	The study contradicts the proposal that there is a change in a population's intellectual functioning over time.	-	The study related that male participant have higher mean scores than female participants.	-
Knoetze et al. (2005)	The study shows that the	The study argues that it is	Male participants	The study found that in rural

| | norms are consistently lower from the Grahamstown sample than those obtained from Western norming studies. | because the learners are experiencing difficulties in their academic development that their RCPM scores reflect lower mean scores than their Western counterparts. | scored significantly higher than the female participants. | communities like Grahamstown, the learner population can be much older and their RCPM scores are much lower than expected, due to economic and socio-political reasons. |
| Linstrom et al. (2006) | The study suggests that the English and Afrikaans speaking groups scored similar to Western norming studies, whereas the "other | - | - | The norms from learners who come from professional, administrative, and technical backgrounds were well above those for learners whose |

	language" groups fell well below the Western norms.		family members were laborers or were unemployed.
Khaleefa and Lynn (2008)	The scores obtained from this study, and Western scores are comparable and do not differ substantially.	This study suggests that young Yemeni learners do better than older learners because the West provides a more stimulating environment, which has a cumulative effect as the learners grow older.	There was no significant difference between the mean score of male and female participants.	-
Kazem et al. (2009)	The study aimed to produce Omani RCPM norms.	-	There was no significant difference between the	-

		mean score of male and female participants.		
Anum (2014)	The study suggests that overall, the Ghana norms lagged behind Western norms by 4 points. This study challenges the idea that the RCPM and other matric reasoning instruments measure an ability that is not influenced by sociocultural factors.	The scores of learners in the rural group were much lower than the scores of learners in the urban group, although the quality of education was not established for either.	There was no significant difference between the mean score of male and female participants.	The Ghana mean scores are much lower than Western norms.
Qiu et al. (2020)	The study	-	There was no	-

suggests that	significant
the RCPM is a	difference
valuable	between the
measure of	mean score of
intelligence for	male and female
children under	participants.
11 years of age.	

4.4. Outcomes

The outcomes of each trial are extracted and summarised in Table 8.

Table 6

Compilation of the Main Outcomes of the Selected Studies

Data Sources	Outcomes
1. MacAvoy et al. (1993)	The study supports the hypothesis that the RCPM is a developmentally sensitive measure as there is an increase in raw scores that correlate with an increase in age and/or educational experience. The study found that the RCPM scores of male learners were significantly higher than their female counterparts. The study suggests that the younger male learners may be more unilateral, relying on visual strategies, during their early elementary years. The "on" reservation learners (learners who are educated in a school that is on the reservation and managed by leaders in the Native American community) achieved higher scores on the RCPM than the "off" reservation learners (learners who are educated in a school that is off of the reservation and is managed by Western groups). This result is consistent with other Native American studies which reflect a higher performance in nonverbal measures of cognitive reasoning. The study found a high correlation between learners' RCPM performance and their academic scores in language achievement. The study also found a high correlation between RCPM scores and the Iowa Tests for Basic Skills (ITBS) scores, especially in the areas of vocabulary, spelling, and total language. The study concludes that the RCPM is not an appropriate measure to evaluate giftedness in children, as the assessment does not provide a sufficient score ceiling for grades 3 and higher.
2. Costenbader	The study found that the norms from the Kenyan sample and the norms reported for Western groups (such as the

and Ngari (2001)	Dumfries, Scotland norms and the United States norms) differ substantially, with the Kenyan learners performing much lower than the Western counterparts. The authors subscribe this to educational and socioeconomic differences between industrialized nations and emerging African nations. The authors suggest that local norms (established with learners from the same age, culture, and socioeconomic background) be used when comparing learners' RCPM performances. The study also found that male learners were able to complete two more RCPM items than the female learners. The authors suggest that this is due to differential cultural expectations and child rearing practices in Kenya. Many female learners are expected to fulfil traditional roles as mothers and homemakers, whereas male learners are expected to perform academically as they have more educated role models. The authors suggest that this supports previous studies that state that male learners perform better in visuospatial assessments than female learners.	
3. Cotton et al. (2005)	The study compared the learners' RCPM performances to a study conducted in 1975 and found that the performance of Australian children has remained stable over time. Due to this, the authors reject the generalized notion of the Flynn Effect. The norms from both Australian studies are almost identical to the 1982 Dumfries norms. For the total number of children, the reliability was high with the internal consistency score being .89 and the split-half reliability being .91. Item analysis revealed that the proportion of correct responses for some items were either too high (p> .80) or to0 low (p< .20). For the overall sample, there were 16 items with extreme p	

values. This indicates that there is a need to scrutinize the psychometric properties with special consideration of item difficulty and the appropriateness of the items for various age levels. Factorial analysis has indicated that the RCPM may be represented by a number of underlying factors, such as continuous and discrete pattern completion, pattern completion through exposure, and concrete and abstract reasoning.

4.	Knoetze et al. (2005)	The sample was more varied in age than would be expected from a primary school sample, with ages varying from 6 years and 7 months to 20 years and 4 months. The situation reflects learners who started school late or have been forced to miss school periodically due to economic and socio-political reasons. The norms of this study consistently reflect lower scores than those obtained in Western countries like the United States and United Kingdom. The lower norms could reflect the consequences of living under impoverished conditions, as the participating learners come from a disadvantaged background. If the norms are smoothed and only the lower age range groups are used, the norms produced by this study may be used effectively for isiXhosa-speaking primary school children in peri-urban areas in previously disadvantaged educational settings. It is noteworthy that the older children in the sample did not reach a ceiling in their performance of the test as proposed by Raven. This indicates that these learners are experiencing extreme difficulty in their educational development. It cannot be assumed that because learners have reached a certain age that a specific level of analogical thinking has been reached. This implies that the level of education attained, rather than age, correlates with the required skills of analogical

		thinking. This also supports the notion that a certain type of literacy is required to interpret non-verbal tests. Lastly, it cannot be assumed that because a test is non-verbal, that it is a culturally fair test.
5.	Linstrom et al. (2006)	The norms found for the English and Afrikaans speaking groups were higher than those for the combined "other languages" group. The English and Afrikaans norms are comparable to the norms found in Western countries such as the United States and the United Kingdom. The "other language" groups' norms are comparable to the norms found by Costenbader and Ngari's Kenyan study. This study found that norms from urban and rural settings did not differ as much as expected. However, there is a substantial difference in the norms of learners from households where the parents come from professional, administrative, and technical backgrounds and those learners whose parents are laborers or unemployed.
6.	Khaleefa and Lynn (2008)	The norms found in this study are comparable to the United Kingdom norms. The 6-year-old and 7-year-old age groups performed much better in relation to the United Kingdom norms, than the older children in the sample. The earlier items in the test measure visualization ability while the later items measure abstract reasoning. The authors suggest that as Yemen modernizes and westernizes, the younger learners develop abstract reasoning abilities quicker than their older counterparts, and that this has a cumulative effect as learners grow older. There was no significant difference between the means of the female learners and the male learners. This is unexpected as there is discrimination against girls and women in Yemen, and it is assumed that discrimination impairs intelligence.

7.	Kazem et al. (2009)	The study found that the average RCPM performance increased as the age of the Omani participants increased. There was also support that the RCPM increases in difficulty across the three sections (A, AB, and B). There were no age differences between male and female learners, except for the 5-year-old age group. The estimated reliability coefficient and calculated indices of construct and concurrent validity were in the acceptable range. The study found that the RCPM performance of learners showed a positive correlation with the test scores of another mental ability test, as well as the learners' academic achievement and the teachers' rating of learner intelligence.
8.	Anum (2014)	The study found there is an overall increase in total scores between the ages of 6 and 12-year-olds. The RCPM performance is much lower for the Ghanian participants when compared to the UK norms, especially among 9- and 11-year-olds. Learners living in urban areas outperformed those living in rural areas. This indicates that learners living in urban areas develop superior abstract reasoning skills, which gives them an advantage over children living in rural areas. This may be because urban areas have improved educational facilities and better infrastructure, whereas rural areas have a high prevalence of poverty and very high teacher-student ratios. There was no significant difference in performance between male and female participants. This study concludes that it is essential to standardize assessments on local populations before making assumptions about the test takers. This study challenges the notion that the RCPM measures an ability that is not influenced by socio-economic indicators such as educational facilities, the presence of poverty, and the presence of infrastructure.

9.	Qiu et al. (2020)	The 50th percentile of the RCPM scores increased as ages increased from 8 to 11 years. There was no significant difference between the performance of male and female learners' performances. There was a high correlation between learners' performance between the RCPM and the Standard Progressive Matrices (RSPM). The study suggests that the RCPM is not a sufficient instrument to evaluate Intelligence Coefficient (IQ) for ages above 10 years.

4.5. Conclusion

In the analysis of the 9 selected studies, attention was drawn to the quality of education in the region the RCPM is being normed for systematic review, by analysing the population (contextual factors), variables (RCPM performance, quality of education, gender differences, and SES), and the main outcomes of the trials. For the purpose of analysis, the researcher strictly adhered to the steps encompassing the methodology of systematic reviews as they relate to the selection of studies following predefined eligibility criteria and quality assessment for the risk of bias. Chapter 5 will present a comprehensive discussion of the results.

Chapter 5: Discussion

5.1 Introduction

Multiple language versions of the RCPM exist in SA. Unfortunately, no norming studies have been conducted for these versions. Lacking normative data, South African psychologists and psychometrists use Western norms to interpret a child's fluid intelligence. This is done independently of the child's home language or socioeconomic background. This can lead to inaccurate evaluation of children's potential as discussed in the problem statement in Chapter 1. A better understanding of contexts similar to the South African context can benefit the field of fluid intelligence testing by identifying confounding variables such as a gender difference in the performance of the test and the SES of the participants. This is the first literature review that enquires about the connection of RCPM performance, as a fluid intelligence test, and the quality of education that the learner received.

This discussion collectively encompasses the three core aims of the study as stated in Chapter 1, with the purpose of reporting on the relationship between quality of education, according to SES and gender differences in the results of the RCPM scores, and fluid intelligence testing with the RCPM. This chapter integrates the results from the interpretation of selected studies with the theoretical and conceptual framework to provide a discussion highlighting similarities and discrepancies.

5.2 The Relationship between Gender Discrepancies and RCPM Performance

In the initial literature review in Chapter 2, Bass (2000) found that there was a difference between male and female participants' scores on the RCPM, where male participants scored higher than their female counterparts. This is supported by a previous study that was conducted by Vass (1992), who found similar results in older children while using the Standard Progressive

Matrices. Both these studies found that the need for local norms was essential, as the local norms

for both studies were well below the Western norms. Both Bass (2000) and Vass (1992)

conducted their studies in SA, a developing country (https://www.worlddata.info/developing-

countries.php). This is supported by the findings of the current study. Results from MacAvoy

and colleagues (1993), Costenbader and Ngari (2001), and Knoetze and colleagues (2005)

showed that when the sample populations' RCPM norms are lower than the Western norms, the

male participants' scores are higher than the scores of their female counterparts. Costenbader and

Ngari (2001) suggest that this is a function of differential gender expectations among cultural

groups in developing regions. MacAvoy and colleagues (1993) studied Native Americans on a

reservation in the USA. Native American reservations resemble developing countries, as they are

isolated with high poverty and unemployment rates (Hollingsworth, 2017). These areas are

known for their poor infrastructure and few educational opportunities for youths. Costenbader

and Ngari (2001) conducted their study in Kenya, a developing country. They found lower local

norms as well as gender differences, where male participants scored higher than the female

participants. Knoetze and colleagues (2005) conducted their study in an impoverished

community in SA, a developing country, and found that the local norms were lower than the

Western norms. They also found that there was a gender difference between male and female

participants' performance on the RCPM.

Cotton and colleagues (2005) conducted their study in Victoria, Australia, which has a

poverty rating of 13.2% which is similar to Australia's overall poverty rating of 13.1% (Tanton

et al., 2018). The poverty rating among Victorian Aboriginals is 25.4%, which is almost double

that of the non-indigenous Victorian population. A Victorian census conducted in 2016 showed

that 21.5% of the population aged 5 to 14 was Aboriginal and Torres Strait Islander people

(Australian Bureau of Statistics, 2019). Cotton and colleagues (2005) recruited participants from a wide range of socioeconomic backgrounds. Unfortunately, the SES and ethnicity of the final sample were unavailable. With the poverty ratings and census data in mind, there is not enough evidence to support or contradict the assumption that there is a positive relationship between lower RCPM norms and gender differences in impoverished communities.

In the initial literature review for the current study there were studies which reported no gender differences, even in developing countries (Anum, 2014; Wright et al., 1996). As the study conducted by Anum (2014) is also part of the sample (N=9) for the current study, it will be discussed as part of the current study's findings. Wright and colleagues (1996) found no gender differences among Inuit children in Quebec. In the current study, there are studies that contradict the notion that there is a relationship between lower local norms and gender differences, where male participants outperform their female counterparts. Anum (2014) conducted a norming study in Ghana, a developing country, and found that the local norms were lower than Western norms. Anum (2014) did not find a significant difference between the performance on the RCPM between male and female participants. Kazem and colleagues (2009) focused on producing Omani norms but did not report on the relationship between Omani and Western norms. They also found no significant difference between the mean score of male and female performances. Oman is considered a developing country according to WorldData (https://www.worlddata.info/developing-countries.php). This study does not support the assumption that there is a relationship between lower RCPM norms and gender differences in impoverished communities, but it does not contradict it either. Khaleefa and Lynn's (2008) study showed that there was no comparable difference between Yemen and Western norms. They also found no significant difference between the mean score of male and female performance. Yemen

is a developing country according to the WorldData website

(https://www.worlddata.info/developing-countries.php). This contradicts the findings of the

previous studies (Costenbader & Ngari, 2001; Knoetze et al., 2005; MavAvoy et al., 1993) which

showed a connection between the lower local norms and lower performance of female

participants' scores on the RCPM.

Of the current sample (N=9), 57% (4 of 7) of studies which established local norms and

report on the gender differences in performance of the RCPM support the notion that there is a

connection between the lower local norms and lower performance of female participants' scores

on the RCPM. Twenty-nine percent (2 of 7) of the relevant studies do not support nor contradict

this connection, while 29% (2 of 7) contradict the relationship between the lower local norms

and lower performance of female participants' scores on the RCPM. As the majority (57%) of

the sample support the notion of a gender difference (with female participants scoring lower) in

communities with lower local norms compared to the Western norms, it can be stated that gender

is linked to RCPM scores in developing communities. One can even go as far as stating that due

to sociocultural factors, the RCPM has a gender bias when administered to impoverished

communities.

5.3 The Connection between SES and RCPM Performance

The preliminary literature review, in Chapter 2, found that little research exists on the

connection between SES and fluid intelligence testing. The difference between local norms for

impoverished communities, and UK and USA norms, have been attributed to an innate deficit in

intellectual capacity, rather than test or cultural bias (Nijenhuis & van den Hoek, 2016;

Rindermann et al., 2015). Recently, Anum (2022) stated that SES, as a confounding variable, has

not been adequately researched in the past. Other studies support the notion that socioeconomic

or socio-cultural factors contribute to the variability in test scores in Sub-Saharan Africa (Anum, 2014; Brown & Day, 2006; Knoetze, et al., 2005). Anum's (2022) study found that there is a significant correlation between SES on RCPM performance.

In the current study (N= 9), there were four studies that question the connection between socioeconomic variance and RCPM performance. These studies were conducted in Africa, two of which were conducted in SA. Costenbader and Ngari (2001) stated that there is a connection between fluid intelligence norms and the SES of the sample population. This is supported by Knoetze and colleagues (2005) who found that the learner population of impoverished communities can be much older and score much lower on fluid intelligence tests than expected due to economic and sociopolitical factors. Linstrom and colleagues (2006) found that English and Afrikaans speaking learners in SA scored similar on the RCMP as the established Western norms; whereas "other language" groups scored much lower than the established Western norms. Shuttleworth-Edwards (2017) stated that English and Afrikaans first language speakers from advantaged backgrounds (quintile 4-5 schools) score higher on intelligence tests than African first language speakers from disadvantaged backgrounds (quintile 1-3 schools). With this in mind, the researcher assumes that the Afrikaans and English-speaking learners in Linstrom and colleagues' (2006) study were from advantaged backgrounds (quintile 4-5 schools) and the "other language" group represent African first language speakers who were from disadvantaged backgrounds (quintile 1-3 schools). Linstrom and colleagues (2006) used parental education as a measure of SES and found that learners whose parents come from administrative, professional, and technical backgrounds score higher than those whose parents were laborers or unemployed. Anum (2014) found that Ghana's RCPM norms were much lower than Western norms and attributed this to socioeconomic and cultural factors.

Jukes and Grigorenko (2010) stated that to conduct valid comparisons between Western
and local norms, tests should be used that are less sensitive to education and SES. Considering
the four studies discussed in the above paragraph, the RCPM, although a non-verbal test, is still
sensitive to SES. While the RCPM is considered to be a culturally fair assessment, African
authors (Anum, 2014; Costenbader & Ngari, 2001; Knoetze et al., 2005; Linstrom et al., 2006)
showed that there is a connection between SES and RCPM performance. The supporting
evidence include the study by Anum (2022) as discussed in Chapter 2, as well as the 4 articles
which discuss SES and sociocultural factors as confounding factors in the sample of the current
study.

5.4 The Connection Between Quality of Education and RCPM Performance

The literature review has shown that variations of results of psychometric assessments, in
general, and fluid intelligence more specifically, is a function of ethnicity and SES in SA (Bass,
2000; Knoetze et al., 2005; Linstrom et al., 2006). For example, there is a connection between
language, as an indicator of ethnicity, and RCPM performance in SA. The current study enquired
after the connection between quality of education as an indicator of SES, and RCPM
performance in SA. This enquiry found the results of other studies of the RCPM in similar
contexts as SA to answer this question. Costenbader and Ngari (2001) found that Kenyan norms
differ from Western norms due the lack of educational opportunities in Kenya, a developing
country. Anum (2014) found that in Ghana the children's mean scores are much lower, especially
for participants from rural areas, than their Western counterparts. Both Kenya and Ghana are
developing countries, which places them at a socioeconomic disadvantage when compared to
Western countries (https://www.worlddata.info/developing-countries.php). South African studies
found similar results. Knoetze and colleagues (2005) concluded that in rural communities, like

Grahamstown, the learner population per grade can be much older and the RCPM scores much

lower than expected, based on Western norms. They attribute this to economic and socio-political

variables. These authors all conducted RCPM norming studies in developing countries in Africa,

and found that education, SES, and culture are variable in RCPM performance. In all these

countries SES influences the quality of education learners have access to. As discussed in

Chapter 2, in SA there is a quintile classification system to identify the quality of education

provided by each school depending on criteria such SES of the surrounding community.

As stated in the literature review, quintile 1 ranking indicates an impoverished school,

whereas a higher quintile ranking indicates a wealthy school. When it comes to state funding,

this ranking system requires the state to fund quintile 1 to 3 schools, as state funding should

support the most impoverished schools. The state, then, provides limited financial support to

quintile 4 and 5 schools. Quintile 4 and 5 schools do require school fees and have more affluent

school governing bodies (SGBs). According to Stott (2013), this means that higher quintile

schools (4-5) often have societal, material, and organisational benefits that lower quintile schools

lack. Quintile 1-3 schools are often characterised by few and ill-utilised resources with

underqualified teachers (Cross, 2018; Shuttleworth-Edwards et al., 2013; van Dyk & White,

2019). This leads to a two-tier system, where one tier (quintile 4 - 5) are well resourced and

advantaged and the second tier (quintile 1-3) are poorly resourced and disadvantaged (van Dyk

& White, 2019). Unfortunately, the relationship between quality of education and fluid

intelligence, such as RCPM performance, has not been researched in SA. There are many

possible reasons for this, such as methodological challenges, limited funding, and ethical

considerations. Studying the relationship between fluid intelligence testing and quality of

education can be difficult because both constructs are complex and multifaceted. It can be

challenging to design studies that measure these constructs accurately and reliably, and to control for other factors that may influence their relationship. Some researchers may be concerned about the potential implications of studying the relationship between intelligence and education, particularly if their findings suggest that some individuals are inherently more intelligent than others. There may be concerns about perpetuating stereotypes or discrimination, which can limit the scope and depth of research on this topic.

What can be concluded from the existing research from Chapter 2, and the current study's sample, is that there is a relationship between quality of education, as an indicator of SES, and RCPM results in Sub-Saharan Africa (Anum, 2014; Costenbader & Ngari, 2001) and more specifically in SA (Knoetze et al., 2005). Since quality of education is an indicator of SES of the test-taker (Anum, 2022), conducting norming studies according to the quintile ranking system, as an indicator of SES, may be a valid reaction to the disparity in quality of education among the different quintile ranks in SA.

5.5 Conclusion

This chapter presented a discussion of the results from the interpretation of the studies and the literature concerning the variables that influence RCPM scores, such as the quality of education, SES, and gender discrepancies. The results from the interpretation were integrated with the literature discussion to specifically target the third aim of the present review – the relationship between quality of education and RCPM scores. Gaps in the literature exist around the quality of education as a variable impacting RCPM scores. There are also contradicting results about whether gender discrepancies in RCPM performances are unique to disadvantaged communities. Chapter 6 concludes the systematic review by providing a conclusion of findings, the limitations of the present study, and recommendations for future research.

Chapter 6: Conclusion

6.1 Introduction

The study investigated the concurrent relationship between RCPM scores, quality of education, and SES in children aged 5 to 11. The study was navigated by three themes, namely, gender discrepancies as a factor of impoverished communities, SES as a direct influencing factor on RCPM scores, and the relationship between quality of education, as an indicator of SES, and RCPM performance. This chapter provides a brief outline of the chapters in the present study, the conclusion of findings, limitations of the present study, and lastly, recommendations for future research.

6.2 Overview of the Chapters

Chapter 1: Introduction

The introductory chapter gave a brief overview of key terms, as well as the background of the research. The chapter justified the importance of the study along with the objectives, and clearly stated the aims of the study. The introduction specified the research question, paradigmatic lenses, a summary of the research methodology, and an outline of the present study.

Chapter 2: Literature Review

The literature review provided the conceptual framework by providing a comprehensive collection of literature, which was arranged in a logical and coherent fashion. The literature commenced by introducing the historical creation of disadvantaged groups in SA and the need for culturally fair assessment, touching upon the CHC theory of fluid intelligence. The RCPM was described as well as its validity and reliability. Norming studies were explored in the context of culturally fair assessment.

Chapter 3: Research Methodology

This chapter detailed the methodological decisions that were made when the study was conducted. The characteristics of dialectical pluralism and a systematic review were discussed. The process of extracting studies was met with inclusion and exclusion criteria and followed the systematic protocols established in this chapter. A list of selected studies was categorised and tabulated and a quality assessment of the eligible studies was conducted. This chapter concludes with the ethical considerations of the study.

Chapter 4: Results

In this chapter, the results of the systematic review were discussed. The results of the sample of selected studies were provided, along with information about the population as contextual information, variables (RCPM performance, gender discrepancies, SES, and quality of education), and the outcomes that were found in the studies.

Chapter 5: Discussion

This chapter integrated the interpretation with the conceptual framework and academic literature concerning the relationship between RCPM performances, gender discrepancies, SES, and quality of education.

6.3 Conclusion of findings

When addressing the first aim, investigating the relationship between gender discrepancies and RCPM performance, 57 % of studies in the sample supported the notion that there is a relationship between lower local norms and lower performance of female participants' scores on the RCPM. Costenbader and Ngari (2001) suggested that this is a function of culture in the form of differential gender expectations among cultural groups in developing countries.

When addressing the second aim, investigating the relationship between SES and RCPM performance, 45% of the sample population questioned the relationship between SES and RCPM performance. All these studies were conducted in Africa, two of which were conducted in SA. This is supported by Shuttleworth-Edwards (2017) who stated that within SA, advantaged groups, identified as Afrikaans and English first language speakers originating most likely from quintile 4-5 schools, have higher RCPM scores than their disadvantaged counterparts, identified as African first language speakers originating most likely from quintile 1-3 schools.

When addressing the third aim, investigating the relationship between quality of education and RCPM performance, Costenbader and Ngari (2001), Knoetze and colleagues (2005), and Anum (2014) conducted RCPM norming studies in developing countries in Africa and found that education, SES, and culture are variable in RCPM performance. In Kenya, SA, and Ghana, respectively, SES influences the quality of education learners have access to. In SA there is a quintile classification system to identify the quality of education provided by each school. Unfortunately, there are no publications available that directly attempt to investigate the relationship between quality of education (as an indicator of SES) and RCPM performance.

6.4 Value of the study

This study has provided a comprehensive overview of literature relating to fluid intelligence testing with the RCPM and quality of education in South Africa and other developing regions. It synthesised the existing research into a coherent whole to strengthen the foundation of knowledge available regarding the relationship between RCPM results and quality of education. By doing so, it has highlighted a gap in the current knowledge regarding this relationship. This gap would not have been identified without collating the existing research into one coherent information product. This systematic literature review can thus act as a springboard

for researchers to further investigate the gap in literature regarding RCPM performance ad the

quality of education. This study also serves as an aggregate of critical information for

policymakers regarding regulations and best practice norming methods of the RCPM in

developing countries. Lastly, researchers and psychometrists can more efficiently move from

knowledge discovery to the implementation of the suggestions made in the *Future*

recommendations section of this chapter.

6.5 Limitations of study

The researcher noted the following limitations in the present study. Firstly, the sample

size consisted of 9 published articles. This is a small sample size, and a larger sample size is

needed for future studies. From the sample, reasonable conclusions could be drawn regarding the

relationship between lower local norms compared to Western norms and lower performance of

female participants. With SES and lower local norms, the conclusion is based on the results of

only 45% of the articles which discussed SES as a variable when it comes to lower local norms

compared to Western norms. Unfortunately, there were even fewer articles that discussed the

quality of education as a variable, although 34% of articles did state that quality of education is a

confounding factor in developing countries. South African studies, specifically, also lacked

quintile rankings as a variable. More sophisticated research is needed to include fluid intelligence

studies with quintile rankings as a variable.

Narrowing the search strategy down to only one fluid intelligence test for the sample also

had an impact on the number of articles found. The search strategies focused on the RCPM, as it

is most often used in impoverished communities in SA and other developing countries. This is

due to the fact that it is a non-verbal, paper-and-pencil test that is easily administered to larger

groups of test-takers. Another search strategy that includes more fluid intelligence tests could

have yielded more relevant studies for the sample, but it could have broadened the study to

include, for example, other age groups, which may make the results incomparable to each other.

The databases that were accessed through the University of Pretoria Library did not

always allow access to some of the studies that were found in reference lists. This indicates

limited access. Gaining access to the studies not provided by the University of Pretoria can

become too costly for the researcher. For this reason, two studies were excluded from the sample,

as the researcher could not gain access to these studies. Although a limitation of the study, the

impact is not as big as would be expected. The studies from Poland and India were more

removed from the South African context than the studies (from Kenya, and Ghana) that were

included in the sample.

The limitations of the systematic review methodology include the propensity to attempt

to research all available research, with an ever-increasing amount of research available and a

limited time available in which to conduct the search. This renders a fully-fledged systematic

review practically unfeasible as more recent articles could have been published after the final

search for the current review has been completed. Although the most recent articles were

excluded as the final search was conducted in May 2022, the sample is representative of the

research that is currently available on the topic of the current study.

Other limitations of a systematic review include having studies in the sample that are not

well-written, which demands that the researcher go through the time-consuming process of

obtaining the necessary information from the authors (Kitchenham, 2004; Mallet et al, 2012).

This limitation was not an obstacle in the current study. All the articles were well-written and

provided relevant information.

The systematic review of studies set limiters on the database searches. The limiters included:

- Publication Type

Published and peer-reviewed articles were selected from databases available to the library of the University of Pretoria. The University of Pretoria Library did not have access to all the databases required to access all the studies relevant to the topic in the current study.

- Language

Language limiters were set to English, which eliminated studies from other countries, particularly studies from Asia.

These limiters could exclude articles or other sources of information such as dissertations and theses. Although the researcher found one dissertation on the RCPM, there was fortunately an article which followed the original publication that the researcher could gain access to.

With all this said, there are strengths to the approach followed by the researcher. Firstly, this study's strengths is its specificity in the research question it answered: What is the relationship between quality of education and fluid intelligence, as measured by the RCPM? Secondly, the explicitly stated methodology used make the study methodologically transparent and reproducible. This replicability establishes a greater degree of trustworthiness to the results and findings of the study. Lastly, as the study conducted a thorough search of all the available academic research regarding the relationship between the RCPM and the quality of education, it created a comprehensive picture of the current state of knowledge regarding this relationship.

6.5 Recommendations for future research

The researcher encourages future research that questions the relationship between quality of education and fluid intelligence testing in SA. This can be done in one of the following ways:

- Other fluid intelligence tests

The impact of quality of education can be researched in the context of other fluid intelligence tests such as the Woodcock-Johnson Test of Cognitive Abilities and the Wesschler Intelligence Scale for Children. Once this has been done, the data can be collated and the true impact of quality of education on fluid intelligence testing can be established.

- Establishing SES indicators relevant to fluid intelligence tests

In SA, studies regarding the impact of SES on fluid intelligence test scores should be preceded by studies which establish the best indicator for SES when it comes to fluid intelligence testing. Only then can local norms be established according to the most relevant SES indicator.

- Establishing the relationship between multiple language norms and quality of education norms

South African norms are established according to the home language of the test-takers, the relationship between language as an indicator of culture and ethnicity and the quality of education as an indicator of SES must be established in SA. This can be done in SA as there are 11 official languages and the quintile ranking system exists as a factor of SES.

- International studies

Disparities in education are not unique to SA (van Dyk & White, 2019). Even in developed countries such as the USA, differential opportunities to quality education exist because of their historical, institutional, and social origin. They could be continuing and increasing the disparities between wealthy and impoverished communities by using the same

norms to establish academic potential or fluid intelligence in learners. Research that establishes

norms for wealthy and impoverished communities respectively may lessen the gap between these

two groups in terms of educational opportunities.

6.6 Conclusion

Clarification of the relationship between quality of education and fluid

intelligence – tested by the RCPM – steered this study. The study was navigated by three aims to

investigate the influence of socioeconomic factors unique to impoverished countries and regions

on RCPM performance and gender discrepancies. The systematic review enabled the researcher

to map the connection between possible confounding variables at play when comparing learners'

RCPM performance to their SES, combine the state of knowledge, and make recommendations

for future research. The systematic review investigated academic literature to fill the gaps that

exist in our knowledge about the relationship between RCPM performance and SES, and the

implications for gender discrepancies in RCPM performance in impoverished areas. The

literature review encompassed definitions and theories of fluid intelligence and a test description,

norming studies, and the validity and reliability of the RCPM. RCPM studies conducted in

impoverished communities were explored and contextualised. A timeline of RCPM norming

studies was made to keep abreast with RCPM research and encompass the trends in RCPM

studies. RCPM studies have constantly adapted to the context of the region where the study

occurred and due to this review's semi-systematic and flexible nature, the researcher was able to

reposition the current study to obtain logical and coherent conclusions. The studies that were

selected for the systematic review were interpreted and the results were discussed by combining

information from the interpretation with the theoretical framework. The study recommended how

fluid intelligence testing with the RCPM can be improved within the South African context.

Recommendations for future research could lead to further possible insights into culturally fair fluid intelligence testing with the RCPM, for evaluation of cognitive potential and potential placement in schools.

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Appendices

Appendix A: Search History and Results

Appendix B: Adapted CASP Tool for Quantitative Studies

Appendix A

Search ID#	Search Terms	Advanced Search Options	Databases	Results
S1	"Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	UP Library Catalogue	0
S2	"Raven's coloured progressive matrices" and "norms" or "validity" or "reliability"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	UP Library Catalogue	105
S3	"Raven's coloured progressive	Limiters applied: Year of Publication: 1992-2022; Peer-	UP Library Catalogue	18

	matrices" or "Raven's CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	reviewed Journals; Language: English; Search modes: Boolean/ Phrase		
S4	"Raven's coloured progressive matrices" or "Raven's CPM" or "RCPM"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	UP Library Catalogue	1
S5	"Raven's coloured progressive matrices"; "South Africa"; "quality of education";	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	EBSCOHost	0

	and "quintile system"			
S6	"Raven's coloured progressive matrices" and "norms" or "validity" or "reliability"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	EBSCOHost	44
S7	"Raven's coloured progressive matrices" or "Raven's CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	EBCOHost	19
S8	"Raven's coloured progressive	Limiters applied: Year of Publication: 1992-2022; Peer-	Emerald Insight	0

	matrices"; "South Africa"; "quality of education"; and "quintile system"	reviewed Journals; Language: English; Search modes: Boolean/ Phrase		
S9	"Raven's coloured progressive matrices" and "norms" or "validity" or "reliability"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Emerald Insight	10
S10	"Raven's coloured progressive matrices" or "Raven's CPM" or "RCPM") and ("fluid intelligence"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Emerald Insight	4

	or "intelligence"			
S11	"Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Proquest	0
S12	"Raven's coloured progressive matrices" and "norms" or "validity" or "reliability"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Proquest	20
S13	"Raven's coloured progressive matrices" or	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals;	Proquest	0

	"Raven's CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	Language: English; Search modes: Boolean/ Phrase		
S14	"Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	JStor	0
S15	"Raven's coloured progressive matrices" and "norms" or "validity" or	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes:	JStor	0

	"reliability"	Boolean/ Phrase		
S16	"Raven's coloured progressive matrices" or "Raven's CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	JStor	0
S17	"Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Elsevier	0
S18	"Raven's	Limiters applied:	Elsevier	0

	coloured progressive matrices" and "norms" or "validity" or "reliability"	Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase		
S19	"Raven's coloured progressive matrices" or "Raven's CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Elsevier	0
S20	"Raven's coloured progressive matrices" or "Raven's CPM" or	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes:	Elsevier	1141

	"RCPM"	Boolean/ Phrase		
S21	"Raven's coloured progressive matrices"; "South Africa"; "quality of education"; and "quintile system"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Taylor & Francis	0
S22	"Raven's coloured progressive matrices" and "norms" or "validity" or "reliability"	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English; Search modes: Boolean/ Phrase	Taylor & Francis	3535
S23	"Raven's coloured progressive matrices" or "Raven's	Limiters applied: Year of Publication: 1992-2022; Peer-reviewed Journals; Language: English;	Taylor & Francis	303

	CPM" or "RCPM") and ("fluid intelligence" or "intelligence"	Search modes: Boolean/ Phrase		

Appendix B

1. Was there a clear statement of the aims of the research? □Yes □Can't tell □No

Consider: What was the goal of the research? Why it was thought important? Its relevance

2. Is a quantitative methodology appropriate? □Yes □Can't tell □No

Consider: If the research seeks to examine a relationship between variables or comparison of groups. Is quantitative research the right methodology for addressing the research goal?

Is it worth continuing?
Detailed questions:
3. Was the research design appropriate to address the aims of the research? □Yes □Can't tell □No

Consider: If the researcher has justified the research design (e.g., have they discussed how they decided which method to use)?

4. Was the recruitment strategy appropriate to the aims of the research? (Assess selection bias)
□Yes □Can't tell □No

Consider: If the researcher has explained how the participants were selected, are the individuals selected to participate in this study likely to be representative of the target population? If there are any discussions around recruitment (e.g., why some people chose not to take part)

5. Was the data collected in a way that addressed the research issue? □Yes □Can't tell □No

Consider: If the setting for data collection was justified. If it is clear how data were collected. Were data collection tools shown to be valid? Were data collection tools shown to be reliable? If methods were modified during the study. If so, has the researcher explained how and why?

6. Were the research methods justified by the researcher? □Yes □Can't tell □No

Consider: If the researcher has justified the methods chosen. If the researcher has made the methods explicit.

7. Have ethical issues been taken into consideration? □Yes □Can't tell □No

Consider: If there are sufficient details of how the research was explained to participants for the reader to assess whether ethical standards were maintained. If the researcher has discussed issues raised by the study (e.g., issues around informed consent, anonymity, and confidentiality or how they have handled the effects of the study on the participants during and after the study). If approval has been sought from the ethics committee

8. Was the correct statistical technique used to analyse the data? □Yes □Can't tell □No

Consider: Was descriptive data provided? Was the sample size large enough for the statistical technique carried out? Were basic assumptions of the statistical test utilised met? Were both significant and insignificant results reported? Did the statistical technique used effectively answer the research question?

9. Was the data analysis sufficiently rigorous? □Yes □Can't tell □No

Consider: If there is an in-depth description of the analysis process. Were the statistical methods appropriate for the study design? If sufficient data are presented to support the findings? To what extent contradictory data are taken into account? Were potential sources of bias discussed?

10. Were psychometric properties discussed? □Yes □Can't tell □No

Consider: Were reliability and validity of the instruments used discussed or analysed

11. Is there a clear statement of findings? □Yes □Can't tell □No

Consider: If the findings are explicit. If there is adequate discussion of the evidence both for and against the researchers' arguments. If the findings are discussed in relation to the original research question.

Appendix C

Table 7

Psychometric Properties for the RCPM as Presented by Other Studies

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
1	MacAvoy et al. (1993)	Examine the Raven performance of elementary and secondary Navajo students attending the	United States of America (Language not reported)	506 Grade 2-6 learners. Full-blood Navajo students were selected from Grade	The assessments were completed over a 2-year period. The RCPM were administered	Descriptive analyses of the RCPM raw scores were obtain normative data. Correlation analyses were	Not reported	Percentile Ranks (Grouping interval: Grades 2-6)	The RCPM does not contain the necessary item difficulty to measure giftedness in learners

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		Flagstaff schools.		2-12 (ages 7- 17). The RCPM was administered to the Grade 2-6 population.	in group settings, per grade, with a maximum of 25 learners per group.	conducted to examine the relationship between the RCPM's t-scores and the NCE scores for the ITBS (Grades 2-8). Correlations were derived			Grade 2 to 6 as the RCPM does not contain a sufficient score ceiling.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						for "on" and "off" reservation variation as well as a t-test analyses were conducted to establish whether there was a difference in			

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						score between male and female participants.			
2	Costenbader and Ngari (2001)	Standardise the RCPM on a representative sample of Kenyan children.	Kenya (English and Kiswahili)	1222 (male: 583; female: 639) learners in Nakuru was assessed via the RCPM	The primary researcher and 10 assistants administered the booklet form of the	Descriptive statistics such as means and standard deviations were generated separately for	Validity is shown by the linear progression in raw scores. Consistenc	Smoothed percentile scores (Grouping interval: Yearly for ages 6-10)	The Kenyan norms and the UK and USA norms differ substantially.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				with approximately 100 males and 100 females at each age group.	RCPM to randomly selected children (Standard I to V) at their school (16 schools in total) in groups (maximum of	males and females at year intervals. Smoothed percentile scores were then calculated.	y reliability established using Cronbach's alpha (0.87). Test-retest product-moment correlation (0.84) was		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				8 children).			also established.		
3	Cotton et al. (2005)	Generate RCPM norms for Australian primary school aged children from the State of Victoria and	Australia (English)	618 (male: 39; female: 286; not recorded: 3) children from 8 state schools,	Trained clinicians administered the RCPM on a one-to-one basis.	Descriptive statistics were established such as the mean and standard deviation for each age level	Split-half reliability ranged from 0.81 (10 to 11 year olds) to 0.90 (9 year olds)	Percentile ranks (Grouping interval: Yearly for ages 6-11)	Significant age group differences were found for the total RCPM score, $F(5,612) =$ 54.48, p <

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		compare these results to those established in Queensland, Australia. The study also aims to describe the characteristics and reliability		which was randomly selected, participated in the study.		and an ANOVA was conducted to determine the effect of age and developmental changes on the mean scores. The student-Newman Keuls	Internal consistency ranged from a low 0.76 (11 year olds) to a high 0.88 (8 to 9 year olds).		0.01, η^2 = 0.31, reflecting a general increase in score with increased age. With the Student-Newman Keuls test,

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		of the RCPM with the sample from Victoria.				test was conducted to analyse age differences. Independent t-tests were conducted to analyse the sec differences across age levels.			they found that children 10 years and older had significantly higher mean scores that children younger than 10 years. With the

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
									independent t-tests, they found that for the 6 year old age group, males have a higher mean score than their female counterparts, $t(48) = 2.714$,

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
4	Knoetze et al. (2005)	Develop local norms for the RCPM in the Eastern Cape, SA.	South Africa (isiXhosa)	380 isiXhosa speaking children (male: 197; female: 182) were sampled from a primary	The test administrator was a first isiXhosa language speaker and administered the test in group settings.	Descriptive statistics such as mean and standard deviation were established and used to calculate the percentile rankings.	Not reported	Percentile ranks (Grouping interval: half-yearly for ages 7-20.5)	p= 0.009. The mean scores consistently reflect lower score than those obtained from the UK and USA norms.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				school in the area of Grahamstown.					
5	Linstrom et al. (2006)	Establishing South African norms from a representative sample of children.	SA (Language not reported)	2469 (male: 1185; female: 1284) children were administere	Data collection was carried out by Adien Linstrom in 2001.	Percentile rankings were established.	Not reported	Percentile ranks (Grouping interval: half-yearly for ages 6-12)	The norms for the English and Afrikaans speaking groups are similar to the UK norms,

Study no.	Author (year)	Aims	Location and Test administra tion language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				d the RCPM.					while the Joza-Xhosa norms are lower than the Free-State All-other-languages group, and that the All-other-languages

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
									group have similar norms as those found in Kenya by Costernbader and Ngari.
6	Khaleefa and Lynn (2008)	Report on the standardisation of the RCPM in Yemen.	Yemen (Language not reported)	986 children (male: 672; female: 314) were tested in socially	Secondary data from the normative study conducted by	Percentile rankings were established and compared to the British	Not reported	Percentile ranks (Grouping interval: yearly for	The IQ UK equivalent (81) is near the study conducted by

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				representative schools.	Al-Heeti, Ganem, Al-Kubaldl, and Al-Nood (1997) was used.	standardisation (1979) of the Standard Progressive Matrices.		ages 6-11)	Al-Heeti and colleagues (1997) (85). The 6- and 7 year olds performed better than their older counterparts. There were no significant

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
									gender variances among the performance of the children.
7	Kazem et al. (2009)	Prepare tables of norms for the RCPM that can be used to	Oman (Language not reported)	1042 children (male: 534; female: 508) were	The learners were administered the RCPM and the Otis	Descriptive statistics such as mean and standard deviation were	Validity is established as high and acceptable according	Percentile ranks (Grouping interval: yearly for	The study showed: a significant gradual difficulty of

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		evaluate Omani children.		selected from 70 schools in all regions of the Sultanata of Oman.	Lennon test. The teachers' were asked to complete a checklist of the students' intelligence.	calculated. Correlations were established between the participants' performance on the RCPM and their academic achievement,	to concurrent and construct validity methods. Pearson's correlation coefficient with overall	ages 5-11)	the RCPM test groups; a significant difference of test performance among the different age groups; and a non-significant

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						their results on the Otis-Lennon test, and the teacher's rating of their intelligence. The Pearson correlation coefficient was established for	achievement of learners is 0.405 (p<0.01). Pearson's correlation coefficient with the Otis-Linone test		difference between males' and females' performances on the RCPM.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						each correlation.	is 0.641 (p<0.01). Pearson's correlation coefficient with teacher's rating is 0.412 (p<0.01). To support		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
							the construct validity, the researchers' cite the gradual difficulty of test groups and age		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
							differentiation ("F" value was statistically significant with p<0.001 and an effect size of 0.224). Reliability		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
							is established as high and acceptable according to test-retest, split-half methods. The test-retest		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
							correlation coefficient was 0.56. The split-half reliability ranges from 0.705-0.858 with a median of		

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
							0.777. The Cronbach's alpha coefficient ranges from 0.-81 – 0.91 with a median of 0.88.		
8	Anum (2014)	Establish normative	Ghana (English)	734 children (male: 337;	The RCPM was	Descriptive statistics such	Not reported	Percentile ranks	The ANOVA results

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		data for children in Ghana.		female: 397) were selected from private and public, urban and rural areas within the Greater Ghana Region.	administered in group context in a congenial environment.	as mean and standard deviation was established. The norms for urban and rural samples were established separately. ANOVAs were conducted to		(Grouping interval: half-yearly for ages 6-12)	showed significant main effects for age group ($F(6,734)$ =34.60, p < 0.001), and for location ($F(1,734)$ = 71.53, p < 0.001), but

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				Multi-stage random sampling and convenience sampling was used to obtain participants from publics schools in		test for differences between age groups, urban and rural areas, and male and female children. Percentile rankings were calculated			not for gender.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				urban (4) and rural (6) areas. Stratified random sampling was used to select 6 private schools to participate		from the raw scores.			

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
				in the study.					
9	Qiu et al. (2020)	Explore the intelligence among children and adolescents, gender differences in intelligence, and differences	Shanghai (Not specified)	6843 children between the ages of 8-16. A representative sample was gathered from public	Children and adolescents completed two forms of the matrices, the RCPM and the RSPM. These administratio	Raw scores from the RCPM and RSPM were converted into z-scores and then to IQ scores. The difference between	Not reported	Percentile ranks (Grouping interval: Yearly for ages 8-16)	The study demonstrated that the RCPM should be used for children below 11 years and the RSPM should be used for

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
		between boarding students and day students in Eastern China.		and private schools through proportionate stratified random sampling.	ns were supervised by their teachers.	boarding students' scores and day students' scores were calculated with the Mann-Whitney U test. The difference in boys' scores			children 1 and older. No significant gender difference was found among ages 8-10 years. Few families to send children below 12

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						compared to girls' scores were expressed using Cohen's-d. To calculate the differences between RCPM and RSPM scores, Spearman's rank-			years to boarding school.

Study no.	Author (year)	Aims	Location and Test administration language	Sample	Method of data collection	Method of data analysis	Reliability and validity of the test	Norms	Main results
						correlation coefficient was used.			

Table 8

Analysis of the Potential Risk of Bias and Quality of the Eligible Articles

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total
MacAvoy et al. (1993)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	91%
Costenbader and Ngari (2001)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	91%
Cotton et al. (2005)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%
Knoetze et al. (2005)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%
Linstrom et al. (2006)	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	No	Yes	64%
Khaleefa and Lynn (2008)	Yes	Yes	Yes	Can't tell	Can't tell	No	No	Yes	Yes	No	Yes	55%

Kazem et al. (2009)	Yes	Yes	Yes	Can't tell	Can't tell	No	No	Yes	Yes	Yes	Yes	64%
Anum (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	91%
Qiu et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	91%
Percentage	100%	100%	89%	78%	78%	67%	56%	100%	100%	56%	100%	-

Figure 7

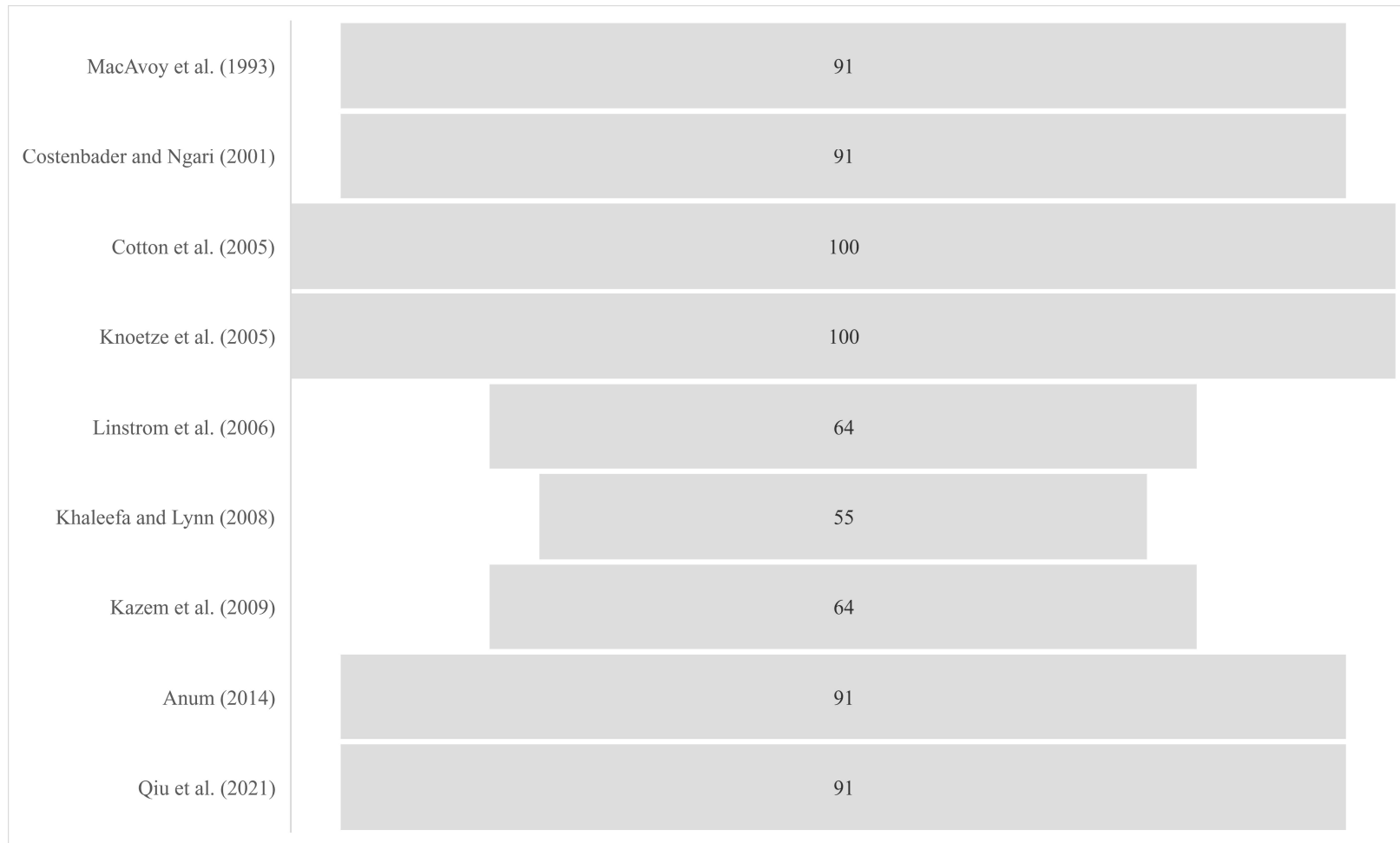*The Overall Quality of Assessment of Ratings*

Figure 8

Frequency of Quality Assessment Question Being Fulfilled by Selected Studies

Question	Frequency
1	100%
2	100%
3	89%
4	78%
5	78%
6	67%
7	56%
8	100%
9	100%
10	56%
11	100%