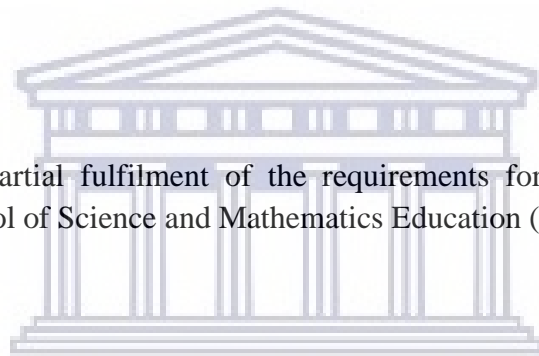


PRE-SERVICE MATHEMATICS TEACHERS' ENGAGEMENT WITH THE EVALUATION
AND CONSTRUCTION OF ALTERNATIVE MATHEMATICAL MODELS FOR THE SAME
PHENOMENA

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of
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the Western Cape



NOVEMBER 2020

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SUPERVISOR: PROF. C. JULIE

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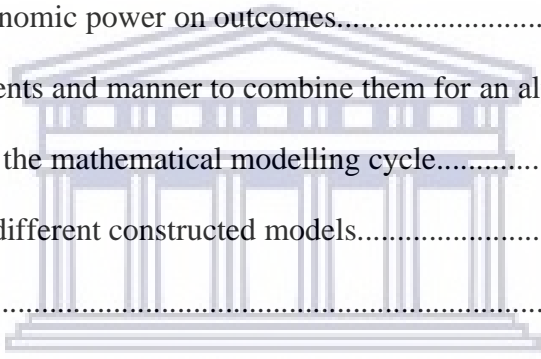
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LIST OF ACRONYMNS

AP	Alternative Prosperity
BEE	Black Economic Empowerment
CAPS	Curriculum and Assessment Policy Statement
DTI	Department of Trade and Industry
FET	Further Education and Training
GDP	Gross Domestic Product
HDI	Human Development Index
ICTMA	International Community of Teachers of Mathematical Modelling and Applications
JSE	Johannesburg Stock Exchange
MRTEQ	Minimum Requirements for Teacher Education Qualifications
MST	Mathematics, Science and Technology
NEF	National Empowerment Fund
StatsSA	Statistics South Africa



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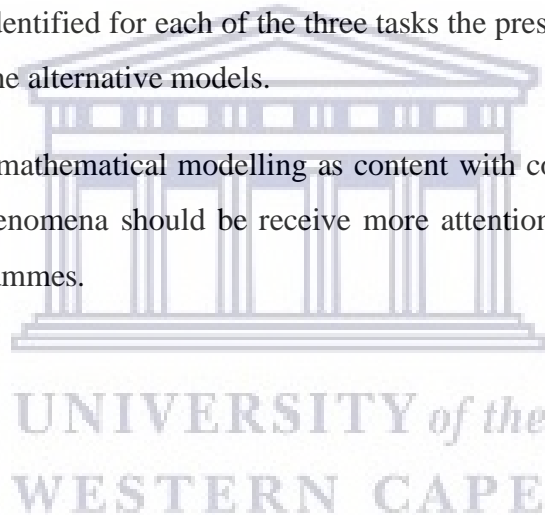
ABSTRACT

The overarching purpose of this research study was to ascertain the deliberations preservice mathematics teachers engage with when they construct alternative mathematical models for social phenomena. The study is situated within the mathematical competencies and, in particular, on the evaluation competency with the possibility of developing alternative models flowing from the evaluation.

Twenty fourth-year pre-service mathematics teachers participated in the completion of three different mathematical modelling tasks on which the analysis was based. The data collected was analysed qualitatively. The researcher exploited a thematic analysis design to investigate how pre-service mathematics teachers build alternative models.

Different themes were identified for each of the three tasks the preservice teachers engage with when they constructed the alternative models.

It is recommended that mathematical modelling as content with concomitant interdisciplinary knowledge of social phenomena should be receive more attention in preservice mathematics teacher education programmes.



KEY WORDS

Mathematical modelling

Thematic analysis

Pre-Service Teacher Education

Critical mathematics education

Competencies

Real-world



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DECLARATION

I declare that

Pre-service mathematics teachers' engagement with the evaluation and construction of alternative mathematical models for the same phenomena

Is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Belinda M Cornelissen

Belinda M Cornelissen



November 2020

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CHAPTER 1

INTRODUCTION AND OVERVIEW

1.1 Introduction

This chapter serves as an introduction to the research study. It begins with an explanation of the motivation and background of the study as contained in section 1.2 below, followed by the significance of the study, the research objectives and research questions as well as the scope of the study. The chapter concludes with an exposition of the thesis as set out in section 1.6.

1.2 Motivation and background of the study

During the late 1970s substantial emphasis was placed on the use of a problem as a tool and motivation to understand and to improve the teaching of mathematics, with two paradigms, viz: problem-solving, where the emphasis was on the use of heuristic approaches to solving mathematical problems (Polya, 1963; Schoenfeld, 1980) and mathematical modelling, a process of solving a particular kind of problem by conforming to real-world situations (Pollak, 1979; Niss 1987).

Problem-solving in mathematics has several descriptions in the literature. Polya (1945) provides a standard reference for problem-solving by which he indicates the iterative nature of the process to solve mathematical problems. His method is to focus on problems which basically have a single “correct” answer, albeit that different pathways can be used to arrive at that answer. Mathematical modelling, on the contrary, differs in that different models can be obtained for the same phenomena. Mathematical modelling remains a pivotal topic in mathematics education.

One of the current challenges in teacher education in South Africa is the recruitment of competent students for such education. These issues came to the fore in a report by the Ministerial Task Team on Mathematics, Science and Technology (MST). One of its recommendations, listed as priority 2, is to “address teachers and teaching issues”. The fourth bullet under this priority states the following about pre-service teacher education:

There is a critical need to intervene in pre-service teacher production in order to ensure that Higher Education Institutions (HEIs) produce competent and credible new

teachers of sufficient quality and in sufficient quantities to service the MST needs of the school system (Department of Basic Education, 2011:12).

Teacher education in South Africa has undergone several reforms since the advent of democracy in South Africa. One of the most significant of these reforms was the decision by the South African government to make teacher education in South Africa a competence of higher education institutions. Thus, from 1998 till 2001, there was a massive restructuring of teacher education, with all Colleges of Education eventually being closed.

The South African economy is currently experiencing skills shortages in many important forms of employment, such as engineering, science and technology, in public decision-making, leadership and management and medicine. These are the direct causes of widespread unemployment and the resultant poverty experienced by many. According to the expanded definition, the unemployment rate for the youth (younger than 25) is about 55.2 per cent. The majority are considered to have skills that are not in line with the requirements needed to address these shortages. (StatsSA, Quarterly Labour Force Survey for the 1st Quarter of 2019).

The South African Government has attempted to address these shortages with many interventions over the last decade. However, to be successful these interventions would require the youth to have a sound background in mathematics. The reality is that the school system is currently failing to produce learners with the necessary mathematical competencies to address the skills shortages. Too many learners without the relevant and crucial basic mathematical skills are moving through the South African schooling system and, as a consequence, these learners cannot be fast tracked by way of exposure to skills development intervention strategies planned to address the skills shortages. The focus now should be twofold: policies must be put in place to get many more learners to study mathematics and then to equip these learners with the necessary tools to understand and bring change to their circumstances, thus, impacting on the South African economy and, potentially, the world at large. Mathematical modelling can play a significant role in equipping learners with the tools required to master mathematics.

The issue of how mathematical modelling should be handled in teacher education has been debated extensively (Julie & Mudaly, 2007). The primary focus of the debate was on the purpose of mathematical modelling teaching and contextual authenticity. The crux of the deliberations was the use of mathematical modelling as a vehicle for the development of mathematics or whether it should be regarded as content in itself. Julie & Mudaly (2007) posit

that the use of mathematical modelling as a vehicle should not be represented in isolation, but rather in some context. The researchers extend their argument by reasoning that the purpose for embedding mathematics in contexts is not the construction of mathematical models as such, but rather the ability to use contexts and mathematical models as mechanisms for the learning of mathematical concepts, procedures, conjecturing and at times developing context-driven justification for conjectures.

From the above it is apparent that mathematical modelling as content entails the construction of mathematical models of natural and social phenomena without the prescription that certain mathematical concepts and procedures should be the outcome of the model-building process.

I am supportive of the idea that mathematical modelling is an area of mathematics education that has been neglected. However, during recent years there has been a move towards re-inclusion of mathematical modelling in the South African school curriculum. Based on this, De Villiers (2007) affirms the importance of the “new South African mathematics curriculum which highlights a more suitable approach focusing on mathematics applications to the real-world.” By implication, this alludes to the use of mathematical modelling competence. De Villiers (2007) further posits that the focus on mathematical modelling is commensurate with curriculum development of several other countries.

A review of the relevant literature pertaining to mathematical modelling in education reveals that many studies have been conducted on the topic (Blum & Niss, 1991; Boaler, 1993; Stillman, 1998; Cheng, 2001; Blum, 2002; Niss & Jensen, 2006; Blomhøj & Jensen, 2007; Blum, 2007; Galbraith, 2007; Blum, 2011, Niss, 2012). These studies primarily focused on:

- the definition of mathematical modelling; the difference between mathematical modelling and models;
- the mathematical modelling process; the role of context in the mathematical modelling process;
- the relevance of mathematical modelling in the school and pre-service curriculum; mathematical competencies; and
- the inclusion of mathematical modelling in mathematical education etc.

However, few studies have been conducted in South Africa in relation to the use of mathematical modelling and models in the classroom with the aim of solving real-world problems.

Advocates of teaching mathematical modelling as content argue that the dominance of practising mathematical modelling as a vehicle undermines the development in students of the ability to analyse the world mathematically. Originality is reduced if every problem encountered in the school mathematics curriculum is contrived for the sake of developing mathematical skills and mathematical skills only. Alternatively, Julie (2002) suggests that mathematical modelling competence should be targeted and a mathematical orientation to looking at the world should be instilled. In addition, other researchers such as Govender (2017) focus on mathematical modelling competencies required to solve real-world problems.

Pollak (1969, p.401) states that “honest” problems should be employed to enable the student to comprehend the relationship between mathematical modelling and real-world problems. Furthermore, the student must through the necessary assumptions be able to draw inferences from the model as well as have a basis for validation and interpretation using real-world measures as a standard. Additionally, Julie (2002, p. 4) is of the view that the moment students realize that problems being dealt with in mathematical modelling could be relevant to their lives it could change their attitudes to mathematics. Julie refers to this characteristic as “usability”. Many research studies have been done on how mathematical modelling problems are used and generated (Galbraith, Stillman, & Brown, 2010). Galbraith (2007) reported on the difference between the teaching of mathematical modelling problems that are relevant to students’ lives and mathematical modelling problems that serve a specific content area of mathematics.

Mathematical modelling is a prescribed topic in the South African Curriculum and Assessment Policy Statement (CAPS, 2011). The key purpose of Mathematics in the Further Education and Training (FET) band is the formation by students of proper connections between the application of mathematics in real-world situations and mathematics as a discipline (Department of Education, 2003a). One of the aims of the Curriculum and Assessment Policy Statement (CAPS) is that “mathematical modelling” should be “the focus of the mathematics curriculum and real-world problems should be integrated into all sections where applicable.”

The National Curriculum and Assessment Policy Statement Grades R-12 (2012, p. 5), states that learners should “identify and solve problems and make decisions using critical and creative thinking” and “demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.” The afore-mentioned standards can be attained through exposing learners to suitable mathematical modelling tasks.

This underscores the point that the inclusion of mathematical modelling in mathematics education in the pre-service teachers' curriculum is crucial. Huntley & James (1990) assert, however, that mathematical modelling is not a new discovery, but in fact has been with us through the ages.

From the literature review, it is obvious that the emphasis of mathematical modelling researchers is principally on the mathematical modelling cycles and processes in which pre-service mathematics teachers participate. However, not much focus is given to the development of the construction of alternative models for decision-making with the use of critical thinking as a subset of mathematical modelling. This entails the scrutiny, critique, extension and adaptation of existing models with the intention of coming to grips with the underlying mechanisms of mathematical model construction and the assessment and evaluation of constructed mathematical models (Julie & Mudaly, 2007). This is essential in the attempt to understand the relationship between critical thinking and the construction of alternative mathematical models from a socio-critical perspective.

Current research aims to shed more light on the approaches of pre-service mathematics teachers to the construction of alternative models. In view of the above, the purpose of this study is to explore how pre-service mathematics teachers construct alternative models simulated under real-world situations or problems. I have embedded this study within a socio-critical perspective to understand the thinking and reasoning processes of the research participants.

1.3 Significance of the study

The gap I have therefore identified in current research is one that focuses on the capabilities of pre-service mathematics teachers in the Further Education and Training (FET) phase to develop alternative mathematical models. I have become very interested in investigating the relationship between their thinking and reasoning in solving real-world mathematical problems. Beyond a personal interest, I believe this research can have an impact on the way we train our pre-service mathematics teachers for the FET phase, as well as inform the continued support we could provide for them during their first few years of teaching. My intention is that the study should produce enough data to help us design learning environments for improving mathematical modelling capabilities. This in turn would hopefully shed more light on the quest for optimum pre-service education of mathematics teachers.

In summary, the rationale for the study was embedded in a personal interest and experience of working with and educating mathematics pre-service teachers, an empirical gap in the research literature on pre-service mathematics teachers in the FET phase, and an intention to add value to the pre-service education programmes of secondary mathematics teachers at tertiary institutions.

1.4 Research objectives and research questions

The focus of this qualitative study is to explore how pre-service mathematics teachers construct alternative mathematical models simulated under real-world situations or problems. In pursuit of this objective, I investigate the development of alternative mathematical models for three different tasks. The following research questions served as a guide for the study:

1. How do pre-service mathematics teachers approach mathematical modelling when facing tasks designed from a socio-critical perspective?
2. How do pre-service mathematics teachers construct alternative mathematical models while engaged in mathematical modelling?

1.5 Scope of the study

This research study focuses on the emergence and display of the relevance of mathematical modelling in the pre-service mathematics teacher education curriculum. Much of the data upon which this research is based was gathered during the real-time construction of alternative mathematical models. The study was conducted at a university in the Western Cape Province of South Africa. Participation in the study was voluntary. Twenty-four fourth year pre-service mathematics teachers completed the mathematical modelling tasks which formed the basis of the data analysis and research findings.

1.6 Exposition of this thesis

The thesis comprised five chapters which can be portrayed as follows:

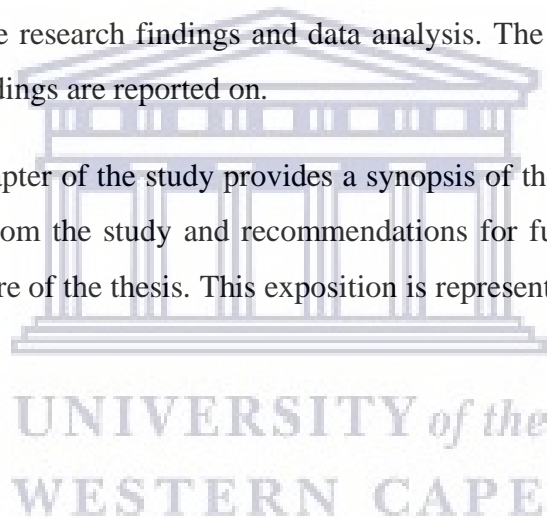
Chapter one gives an overall introduction to the study. The chapter describes the background and significance of the study, the rationale of the study, the research objectives of the study and lastly, the scope of the study.

Chapter two deals with the literature review of the study. The chapter focuses on the definition of mathematical modelling, a description of mathematical modelling and mathematical models, the role of context in mathematical modelling, the relevance of mathematical modelling in the pre-service teachers' curriculum, mathematical modelling competencies, mathematical modelling paradigms and the applications for teaching mathematical modelling in mathematics.

Chapter three deals with the research design and theoretical framework. It primarily focuses on the research approach to the study, the reflexivity of the research design, the analytical process, research instrumentation used, aspects of validity and reliability and ethical considerations. The emphasis was on the epistemological considerations, research methodological choices, research strategy and data collection and data analysis.

Chapter four relates to the research findings and data analysis. The results of the tasks are examined and the key findings are reported on.

Chapter five, the final chapter of the study provides a synopsis of the study, the implications and conclusions drawn from the study and recommendations for future studies. The figure below outlines the structure of the thesis. This exposition is represented in Figure 1, below.



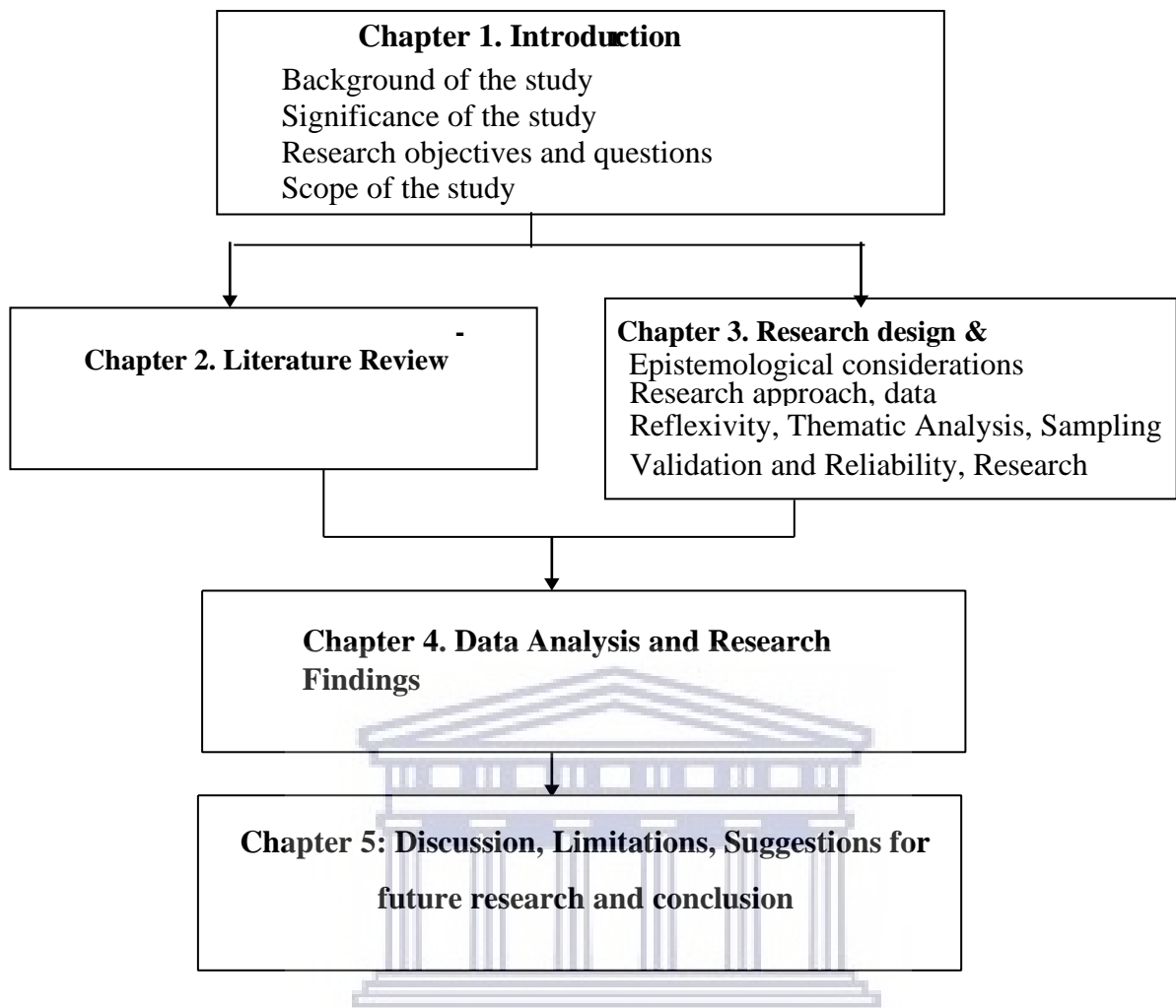


Figure 1: Exposition of the research study

1.7 Conclusion

This chapter summarises the research study and presents the focus, the significance and relevance thereof. The next chapter provides a literature review of mathematical behaviour in a mathematical modelling educational context and, in so doing, sets out the theoretical framework for the research and interpretation of the research findings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Limited literature exists in South Africa about the mathematical knowledge and understanding of pre-service mathematics teachers of mathematical modelling. Literature on the role real-world situations play in enhancing pre-service mathematics teachers' strategies in teaching mathematics is even less evident. Ostler (2003) argues that secondary school mathematics teachers are faced with a new milieu of instruction, namely, mathematical modelling. He also states the importance of the continual growth of these mathematics teachers with respect to the pedagogical techniques that have the greatest classroom potential. He emphasises that a great deal of effort is required to research these techniques in making them usable and applicable in the classroom. Furthermore, he argues that good educators would concur that using real-world resources in the classroom lays a foundation for successful mathematics teaching.

A researcher can undertake various types of literature reviews. Grant & Booth (2009) identify the following types of literature reviews:

1. Scoping reviews
2. Systematic literature reviews
3. Narrative literature reviews

Scoping reviews serve as a process to identify the existing literature on a specific research question. It also clarifies concepts in the literature and define gaps in the body of knowledge. The aim is not to produce a critically appraised and synthesised result or answer to a particular question, but rather to provide an overview or map of the evidence (Munn et al, 2018).

Scoping reviews are "systematic-like" and require a rigorous approach. The search is systematic and in-depth of which the methods are documented thoroughly. It may be the precursor to a full systematic review.

A systematic literature review (SLR) identifies, select and critically appraise research to answer a clearly formulated question (Dewey & Drahot, 2016). Systematic reviews follow a clearly defined protocol or plan with clearly defined criteria which precede the actual review process. It is a comprehensive, transparent search conducted over multiple databases and grey literature that can be replicated and reproduced by other researchers. It is underpinned by a

well thought out search strategy, with a specific focus or answers to a defined question. The review identifies the type of information searched, critiqued and reported within known timeframes (Munn et al, 2018).

A narrative or traditional literature review is a comprehensive, critical and objective analysis of the current knowledge on a topic. This is a critical part of the research process and assist to the establishment of a theoretical framework and focus on the context for the research. Onwuegbuzie & Frels (2016, p. 24) define a general literature review, with respect to narrative review, as providing “a review of the most important and critical aspects of the current knowledge of a topic. It forms the introduction to a thesis or dissertation and is defined by the research objective, underlying hypothesis or problem or the reviewer’s argumentative thesis.”

For this study I did a narrative literature review as it assisted me to identify patterns and trends in the literature that enabled me to identify gaps or inconsistencies in the body of knowledge. It led to the identification of a particular “research gap” and situate my study in the research literature of my topic.

Hence, this literature review attempts to provide an understanding of the competencies pre-service mathematics teachers need to acquire for the successful teaching of mathematics and how to learn to construct alternative mathematical models.

For the purposes of this study, I present only the work of researchers who address issues related to the main focus of the study, i.e. mathematical behaviour in a modelling context.

2.2 What is mathematical modelling?

Cheng (2001) views mathematical modelling as a process of representing real-world problems in mathematical terms, in pursuit of solutions to the problems. A mathematical model can be considered as an abstract representation in mathematical form of a complex situation in the world; in short, a conversion of a real-world problem into a mathematical problem.

2.3 Mathematical models and mathematical modelling

Based on the definition above, mathematical problems can then be solved using whatever mathematical techniques can generate a mathematical solution. Huntley and James (1990) state that it is important to distinguish between mathematical models and mathematical modelling. They maintain that both constructs have a distinctive role to play in the teaching of

mathematics. They state that there is a vast difference between the active experience of formulating a model and the ‘passive’ experience of using someone else’s model. In the ‘passive’ role, the student is concerned with applying a mathematical technique to a set-piece model with the intention of solving the problem presented by the model. These exercises have a vital role to play in the teaching of mathematics as they assist the learner to illustrate the usefulness of the technique being taught. Conversely, the ‘passive’ exercises do not provide insight into the process of model formulation and therefore should not be regarded as mathematical modelling.

Blum et al. (2007) also distinguish between *applying* mathematics – the solving of real-world problems – and the *application* of mathematics, which deals with the solving of real-world problems by means of mathematics. Hence, Blum et al. (2007) posit that the term “modelling” tends to focus on the movement *from* reality *to* mathematics and emphasises the processes involved. So, with modelling we are standing *outside* mathematics looking *in* and asking ourselves: “Where can I find some mathematics to help me solve this problem?” On the other hand, Blum et al (2007) state that the term “applications” tends to focus on the opposite direction, on movement *from* mathematics *to* reality. Hence, the emphasis is on those parts of the real-world which are made accessible to mathematical treatment and to which corresponding mathematical models exist. Essentially, with applications we are standing *inside* mathematics looking *out* and asking ourselves: “Where can I use this particular piece of mathematical knowledge?”

Blum & Borromeo Ferri (2009, p. 46) outlines the process of mathematical modelling as follows:

The process of modelling consists of (1) a problem, situated in the “real-world”, called the *real situation* – which is often formulated in everyday knowledge; (2) the need for students to “understand the task”, to make a *mental representation of the situation* – how they think about the problem; (3) to come up with a “real model” – an *externalised representation* by simplifying, filtering and idealising the information from the task; (4) to translate the “real model” from the “real-world” with the use of extra-mathematical knowledge to the “mathematics world” by *mathematizing* these criteria and creating a “mathematical model”; (5) to work *mathematically* in the “mathematical world”, to produce the “mathematical results”, (6) to *interpret* the “mathematical results” and *transform* them into “real results” by moving back to the “real-world” and *validating* the “real results”; and (7) to *restart* the

modelling process if the “real world” *invalidates* the results, necessitating that the student include other aspects. This process is represented in Figure 2.1, below.

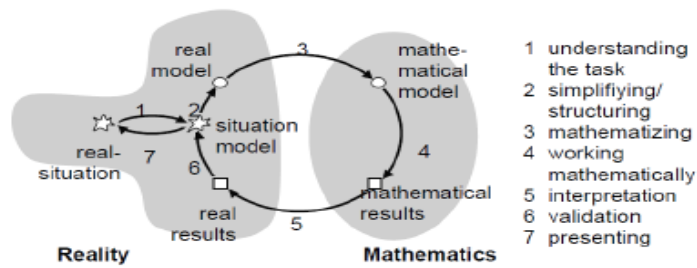


Figure 2.1: Mathematical modelling process
 Source: Blum & Borromeo Ferri (2009), p.46

Blomhøj & Jensen (2007) describe the process of mathematical modelling as consisting of six sub-processes (a-f) and it is split into two domains. The one domain is referred to as reality (the extra mathematical world) and the other domain is called mathematics (the intra mathematical world). The three ellipses in the centre in Figure 2.2 show that the epistemological base for the sub-process is theory, experience or data (Blomhøj & Kjeldsen, 2006). The action/insight in Figure 2.2 or action/realization (Blomhøj & Jensen, 2007), is described as new insight gained from the investigated phenomena which may be put into action if it is supported and validated by the empirical data given. The validation process (f) in Figure 2 is a second validation and refers to the questioning of the entire modelling process. Therefore, new data is needed if this validation process is followed (Blomhøj & Jensen, 2003). For Blomhøj and Jensen (2003), the modelling process illustrated in Figure 2.2 can be used as a tool to investigate mathematical models, modelling processes behind models and to analyse and define modelling competence. This ‘mathematical process’ is displayed in Figure 2.2 below.

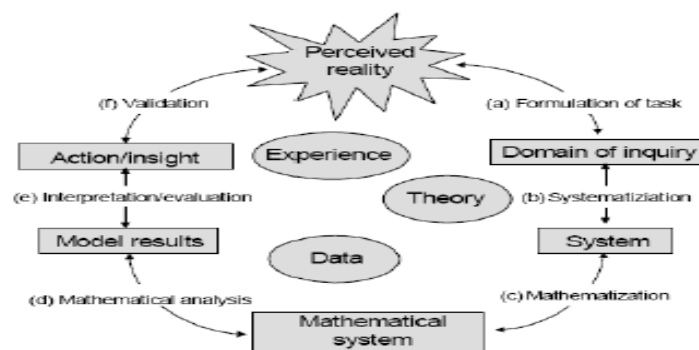


Figure 2.2: Mathematical modelling process
 Source: Blomhøj & Hoff Kjeldsen (2006, p. 166) adapted from Blomhøj & Jensen (2003; 2007).

There are many similarities in the modelling process as represented in Figure 2.1 and Figure 2.2. In order to investigate a situation in the perceived reality, a task is formulated to identify important aspects in the situation or as Blum & Leiß's (2007) would describe this, to make a mental representation of the situation. Blomhøj & Jensen (2007), state that the task is framed in the domain of inquiry. This is not done explicitly in Blum & Leiß's (2007) description. Another difference is that the arrows go back and forth in Blomhøj & Jensen's description of the modelling process, but not in the modelling process as described by Blum & Leiß. In addition, the three ellipses in the centre of figure 2 do not appear in Blum and Leiß (2007). These ellipses are supposed to show that the epistemological base for the sub-process is theory, experience or data (Blomhøj & Kjeldsen 2006). The validation process in two steps as described by Blomhøj & Jensen (2003) is combined in Blum & Leiß's (2007) description. In general, however, the representations in Figures 2.1 and 2.2 are essentially the same.

2.4 The role of contexts in the mathematical modelling process

Context plays a critical role in mathematical modelling. Hence, it is necessary to explain what is meant by *context*. The term 'context' within mathematical modelling, often refers to a real-world situation. Blum et al (2002, p.12), refer to this extra mathematical world as including the broad contexts of "the world around us," "everyday problems" and "preparing for future professions."

As per the definition, a relationship exists between the context of a problem-solving task and the real-world, or, simply, reality. Stillman (1998, p.46) distinguishes between "three levels of embeddedness of context." These three levels describe the extent to which the real-world situation remains pivotal to the solving of the task as the situation is simplified by the teacher for use in the classroom. Stillmann says these levels of embeddedness vary "from almost non-existent to pseudo-real to real." She names these levels *border*, *wrapper* or *tapestry*. A brief description of each of one of these levels is given below.

Border level: The mathematics and task context are entirely separate in *border* problems. The task solver can ignore the real-world context. Knowledge of the context is of no help in "understanding or solving the problem or interpreting or validating the solution".

Wrapper level: In this kind of problem, the task solver must engage with the real-world context to "find" the mathematics which is hidden within the context. However, Stillman (1998) argues that although the context can be used to ascertain if a solution makes sense, the real-world can be ignored as only the mathematics is needed for solving the problem.

Tapestry level: This level occurs when the real-world task context and mathematics are closely bound up with each other. According to Stillman (1998), throughout the solution process, the task solvers need to move between the two, “continually crossing the boundary between the real-world and the mathematical world.”

Boaler (1993) states that the abstractness of mathematics causes many people to view it as a cold, detached and remote body of knowledge. She argues that this image may be broken down by the use of context, which is more subjective, more personal and in this way improves the ability of students to interpret events around them. Furthermore, the use of real-world, local community and even individualised examples which students may analyse and interpret are thought to present mathematics as a means with which to understand reality. Boaler (1993) concludes that when learners make connections between the real-world and mathematical concepts, mathematics becomes relevant to them. Bottle (2005) supports this view and posits that the best opportunity for learners to become fluent in using mathematical skills and procedures is by allowing learners to use real contexts for their problem solving. She concurs with Boaler and adds that if mathematics is made more meaningful for learners by relating mathematics to their interests, the learners will be more likely to see its relevance and usefulness.

Galbraith (2007) distinguishes between word problems and real-world problems. He argues that word problems are widely perceived as close relatives of mathematical modelling problems, since both modelling problems and word problems are couched in verbal clothes. However, he maintains that modelling problems and word problems differ significantly, specifically with respect to meaningfulness and purpose, seeing that modelling problems have real-world connections which word problems often do not have. Galbraith (2007) further explains the interrelationship between a word problem and a real problem. A word problem may be understood in the language of the real-world but is irrelevant in terms of the application of decisions to the real-world, as it does not demonstrate the application of mathematics to enhance the understanding of real problems.

2.5 Relevance of mathematical modelling in the school and in the pre-service teachers’ curricula

Mathematical modelling tasks should provide significant mathematical ideas and themes and should challenge students’ curiosity. The mathematical solutions to the tasks are then translated and interpreted in real terms. For Breen & O’Shea (2010), “mathematical modelling

tasks should encourage the formation of new concepts and build on students' previous knowledge." Mathematical modelling has contributed to many diverse professions, such as economics, engineering, geology, medicine, etc. Mathematical modelling involves looking at a real-world problem or situation, asking questions about the situation, formulating mathematical models which depict the situation like graphs, equations, etc. and then extending these models to learn new things about the situation. In recent years, many of these depictions have been extensively acknowledged in mathematics education.

Blum & Niss (1991), argue that the inclusion of modelling, applications and problem-solving in the daily teaching and learning of mathematics would have important consequences in the classroom. It would result in the growth of critical competence, it would promote mathematics learning, it would demonstrate the utility of mathematics, it would play a formative role in the life of learners and develop a new picture of mathematics and its role in the life of the individual and society. Blum & Niss (1991) expand on the five arguments for the use of teaching applications, problem-solving and modelling in the classroom as follows:

1. **Critical competence** – refers to the ability of learners to understand, critique, judge, assess, recognise and analyse the use of mathematics in society. Through this, learners will become critical private and social citizens with meaningful participation in society. The inclusion of modelling, applications and problem-solving in the teaching of mathematics will enable learners to develop critical competence.
2. **The promotion of mathematical learning** – including problem-solving, applications and modelling in teaching mathematics will assist learners to obtain and learn methods, notions and mathematical concepts. This will allow learners to select, think and perform mathematical techniques during intra- and extra-mathematical contexts. This argument concurs with the epistemological process of mathematical modelling pointed out by Borromeo Ferri (2013).
3. **Utility of maths** – this refers to the utility argument which emphasises that mathematics instruction should prepare learners to utilize mathematics to describe aspects of specific extra-mathematical areas and situations or for problem-solving, whether referring to other subjects or occupational contexts.
4. **Formativeness** – this refers to the inclusion of modelling, applications and problem-solving in the teaching of mathematics with the objective of nurturing the development of useful competencies and attitudes in learners to enable them to become good future

citizens. These competencies and attitudes include problem-solving strategies, creativity, open-mindedness, confidence and self-reliance.

5. **A picture of mathematics** – modelling, applications and problem-solving in the teaching and learning of mathematics will create a new, positive picture of mathematics. It will enable learners to view mathematics as a human activity, where creative mathematical procedures lead to creative new mathematics or to opportunities to employ existing mathematical knowledge.

2.6 Mathematical modelling competencies

It is appropriate at this stage to define the term *competence*. Blomhøj & Jensen (2007) define competence as someone's insightful readiness to act in response to a given challenge. According to this definition competence is "heading for action." The authors further argue that "action" must be interpreted broadly as the "readiness to act" which could imply a positive decision to refrain from performing a physical act or indirectly being guided by one's awareness of certain features in a given situation. Conversely, no competence follows from being insightful if this insight cannot be activated in this broad interpretation of "action".

In accordance with this definition of competence, *mathematical modelling competence* is defined as someone's insightful readiness to carry through all parts of a mathematical modelling process in a given situation (Blomhøj & Jensen, 2003).

Similarly, Niss, Blum & Galbraith (2007) describe *mathematical modelling competency* as the ability to identify pertinent questions and variables in a given situation; make assumptions and formulate relations between variables identified; translate these variables into mathematics and solve the emergence of mathematical problems; interpret and validate these solutions in terms of the situation as well as the ability to critique models. Blomhøj & Jensen's definition of mathematical modelling competency is a synopsis of the definition given by Niss, Blum & Galbraith (2007) with the ability to critique existing models as the only addition.

Henning & Keune (2007) describe the process of mathematical modelling competence as consisting of three levels and outline the process of mathematical modelling competence in more detail as follows: (1) the recognition and understanding of modelling where learners are able to recognize, characterize and distinguish between the different phases of the modelling process; (2) independent modelling which allows individual students to solve a mathematical modelling problem whilst adjusting their models and techniques whenever the context

changes; (3) meta-reflection which is the ability to critically analyse modelling, characterize the criteria for model evaluation and to reflect on the purpose of modelling.

Niss & Jensen (2006) maintain that an individual’s possession of a given mathematical competency includes three dimensions. They refer to these three dimensions as a *technical level*, *radius of action* and *degree of coverage*. A presentation of the three-dimensional model is shown below.

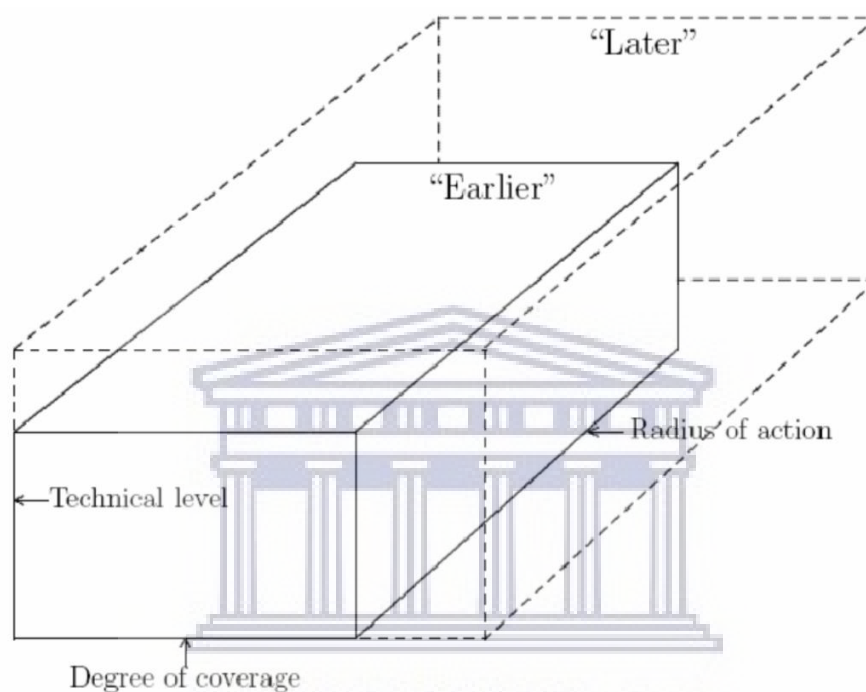


Figure 2.3: The three-dimensional model

Source: Niss & Jensen (2006), p. 9

Firstly, the *technical level* indicates how the student can use the tools to activate a certain competence. Secondly, the *degree of coverage* describes the extent to which a student is developing a specific competence in terms of the given characteristics. Lastly, the *radius of action* illustrates a range of contexts in which a student can activate a competence in a given situation.

One of the competencies in mathematical modelling that come through from the above discussion is the evaluation of models. This is contained in the competencies of the interpretation and validation of a model (Niss, Blum & Galbraith, 2007). They also refer to this as the critique of models. Kaiser (2007, p. 111) states that this competency is the ability “to challenge solutions and, if necessary, to carry out another modelling process.” This thesis is about this critical competency and not at about all the mentioned competencies in the

modelling process. It thus focuses on the deliberations of pre-service teachers when they engage with the evaluation of models to construct alternative models and engage with the debates about the critiques of a model.

2.7 Mathematical modelling paradigm

Niss (2012), argues for the inclusion of mathematical modelling in the school curriculum because it will introduce the use of mathematical knowledge for application purposes, like model-construction and modelling. He terms this the “application of mathematics to utilize extra-mathematical contexts for extra-mathematical purposes.” Subsequently, Borromeo Ferri (2013), describes the process of mathematical modelling in school mathematics across Europe as being based on three main perspectives, namely epistemological, realistic and educational. (i) The epistemological perspective sees modelling as an activity for learning and for developing mathematical knowledge. (ii) The realistic perspective of modelling is an activity for solving actual problems and not for developing mathematical theory. There is a strong resemblance between the perspectives as outlined in the aforementioned and the processes of Niss (2012) as discussed above. (iii) Finally, it is evident that “the educational perspective is an approach between realistic modelling and epistemological modelling” (Borromeo Ferri, 2013, p. 22). Merriam (2009), posits that an epistemological perspective provides a framework for predicting, describing, empowering and deconstructing population-specific world views, increasing the base of knowledge.

Worldwide, these approaches constitute different perspectives in the teaching and learning of mathematical modelling. Contrary to the above, Julie (2002) argues for a different reason for the inclusion of mathematical modelling in the school curriculum. He suggests that mathematical modelling be treated as content with the importance of competencies as the developing process in learners. He (Julie 2002, p.3) describes “mathematical modelling as content that entails the construction of mathematical models for natural and social phenomena without prescription that certain mathematical concepts or procedures should be the outcome of the model-building process.” Thus, the relevance of mathematical knowledge to learner’s lives will become clear. For Julie, this notion of mathematical modelling as content is pivotal to supplement assessment, teaching and learning as it is the basis of teaching and learning of the different mathematical modelling competencies. due to the lack of teachers’ mathematical modelling competencies.

2.8 Applications for teaching mathematical modelling in mathematics

In a study done by Julie (2002), the mathematical modelling behaviour of both teachers and learners is dominated by mathematical modelling as a “vehicle for entry into mathematics.” Julie (2002) asserts that “this mitigates against the development of a mathematical temper.” There appears an urgency to get to the mathematics only. The crux of mathematical modelling practice – the requirement of a high level of communication skills in various forms like speaking, listening and writing – is disregarded. The return to the real-world situation for review and reflection of the appropriateness or suitability of the obtained mathematical solution is ignored. Furthermore, the studies by Julie (2002) reveal that more emphasis should be placed on “mathematical modelling as content.” This study distinguishes “modelling as content” from “modelling as a vehicle.” The former emphasizes the development of the competencies needed to model real-world situations. The latter views modelling as a tool for teaching mathematical concepts.

Niss, Blum & Galbraith (2007) establishes the origin of understanding how to model. The research shows that the ability to model is a learned skill. He observed that the teaching of mathematical modelling can be approached through “emergent modelling, scaffolded approaches or modelling eliciting activities.”

A study done by Rangnes, Herheim & Kajerca (2017) discussed the complexity of pre-service teachers’ shifting of perspectives that emerge when indices and the society’s use of indices are presented. The researchers use the concepts polyphony and centrifugal forces as theoretical hooks to explore how teachers express their position and how they move between divergent beliefs, ways and aims of expressing knowledge about indices. In addition, pre-service teachers position their utterances from their awareness of themselves as students who focus on learning, as critical citizens who serve the purpose of a parent or friend and as teachers. Based on the findings of Rangnes, Herheim & Kajerca (2017), it can be argued that the potential for learning mathematics and the critical awareness in the tension between the different constructs of comprehension and mathematical representations are expressed from different positions.

Many research studies have investigated and reported on the development of alternative mathematical models which utilised a single topic only, i.e. the Body Mass Index (BMI) or soccer rankings in mathematical modelling. This study focuses on the development of alternative models for three different topics namely, soccer rankings, a newspaper clip dealing

with black ownership through shareholding on the Johannesburg Stock Exchange (JSE) and Olympic medals.

While Julie (2002), Niss (2007) and Rangnes et.al (2017) share similarities in their approach to mathematical modelling i.e. the relevance of mathematical modelling in the school and pre-service teachers curriculum and the use of mathematical content to solve real-world problems, there are key differences in their research. Julie is primarily concerned with mathematical modelling as a vehicle to solve real-world situations; Niss focuses on the teaching of mathematical modelling in schools and the capability of teachers and Rangnes et. al (2017) focus on the insights of pre-service teachers and how it influences their perspectives of dealing with complex issues. From the above it is evident that the study of the emergence and display of the relevant competencies during the real- time construction of models remains under-researched. This particular “research gap” forms the cornerstone of this research study.

2.9 The role of mathematical modelling in pre-service teacher education in South Africa

Limited empirical evidence could be found of the inclusion of mathematical modelling for pre-service mathematics teachers in the South African curricula at universities. Some universities who approach the notion of modelling, mathematical modelling and real-world problem-solving did it through research -based projects. Various research studies conducted in South Africa confirm the need for the inclusion of mathematical modelling in the pre-service teacher’s curriculum. In response to the call for research contributions to the 18th International Community of Teachers of Mathematical Modelling and Applications (ICTMA) Study on the Sense-Making in Mathematical Modelling and Applications Educational Research and Practice, Govender (2017) describes how South African pre-service mathematics teachers interpreted the mathematical modelling process and developed the competence to solve real-world problems. Govender established during his research that pre-service mathematics teachers could grasp the concepts of the modelling process and demonstrated adequate mathematical competencies to solve a real-world problem.

Another study by Durandt & Lautenbach (2017) outlines how South African pre-service mathematics teachers interpreted the modelling cycle and evolved their mathematical modelling competencies as modellers. The study further reports how the pre-service mathematics teachers formulated a coherent mathematical modelling process whilst revealing deficiencies associated with the teaching of mathematical modelling. After a research study

done by Pournara & Lampen (2007), the authors conclude that teacher education must provide opportunities for pre-service teachers to learn and to undertake mathematical modelling as well as to involve themselves with the actual teaching of mathematical modelling at different grade levels. They posit that a mathematical modelling course should address both the teaching and learning of mathematical modelling. They conclude by recommending that undergraduate teacher education must provide opportunities for both learning and doing mathematical modelling whilst engaging with the realities of teaching mathematical modelling at school level.

Due to the autonomy universities have to design their own curriculum content and the absence of prescribed curricula for universities, no trace could be found of an interface between the Minimum Requirements for Teacher Education Qualifications (MRTEQ) and the approved curricula for universities with regard to the teaching of modelling and mathematical modelling.

2.10 Conclusion

The literature indicates a genuine need in South African research to investigate the inclusion of mathematical modelling, applications and problem-solving in the teaching and learning of pre-service mathematics teachers. Parallel studies based on strengthening alternative mathematical modelling competencies of teachers might aid in the identification of best practice. However, few such studies can be found in the literature. The use of mathematics applications and modelling should be an integral part of the teaching strategies for solving real-world mathematical problems. Therefore, tertiary institutions should ensure that the development of the capacity or competencies of pre-service teachers in the application and modelling of mathematics finds expression in the pre-service education curriculum.

This chapter presented an exploration of literature relevant to the research study. The literature focused on concepts and terminology that were discussed across this study. Furthermore, theoretical literature was employed in the data analytical framework. The next chapter presents the research design theory.

CHAPTER 3

RESEARCH DESIGN AND THEORETICAL CONSIDERATIONS

3.1 Introduction

The purpose of research design, as stated by Creswell & Poth (2018), is to compel researchers to make multi-layered and interrelated decisions. The question that the researcher wants to answer guides the decisions. In deciding which research design to use, the researcher considers several factors. These include the epistemology informing the research, the strategy of inquiry that will be employed and decisions regarding methods of data collection and analysis. Johnson & Christensen (2012) postulate that educational researchers base their choice of research approach on the research questions, the objective of the research, time and cost constraints, the possibility of the manipulation of an independent variable and the availability of data and available populations.

In this chapter I will outline the decisions that informed the strategies of inquiry, methods of data collection and analysis in my research design.

3.2 Research approach

This study seeks to explore how pre-service mathematics teachers construct alternative models and further to understand how it reflects on their experiences in mathematical modelling. In this study, I employed a qualitative research design. This research is not suited to a quantitative approach as it is not concerned with measurement and quantification. Instead, this research is concerned with how pre-service students construct models while engaging in modelling tasks.

According to Johnson & Christensen, 2012, qualitative research is generally used to describe local phenomena and sometimes construct theories or generate hypotheses. A qualitative approach occurs naturally and researchers use a broader lens to investigate human behaviour in full detail. Qualitative research views the researcher as an instrument of data collection. Qualitative research seeks to ascertain a phenomenon as opposed to measuring it, generally through “what”, “how” and “why” questions (Green & Thorogood, 2014). Furthermore, Elliot et al (2009), state that the qualitative researcher “understands and represents the experiences and actions of people as they encounter, engage and live through situations.” These statements

are in unison with the current research which is to understand the perspectives of pre-service students on the construction of alternative models.

Willig (2013) states that qualitative research is by nature interpretative. Similarly, McLeod (2011) accentuates that qualitative research is always a hermeneutic enterprise. As such, when interpretations of data are made there are always further competing interpretations that can be made. Hence, the “truth claims” that one can make are lessened (McLeod, 2011). As a result, qualitative research is influenced by the personality, preconceptions, interests, expectations and assumptions of the researcher. Elliot et al (2009), suggest that qualitative researchers aim to “bracket” their own values to understand and represent participants’ experiences as accurately as possible. In accordance with Morse (2001), consistency maintained in the methods and approaches used by researchers can result in the production of better quality work. Denzin & Lincoln (2011) stress that qualitative research is a set of interpretative and material practices that makes the world visible. In addition, these practices turn the world into a series of representations, considering conversations, interviews, photographs, memos, recordings and field notes.

3.2.1 Reflexivity

As mentioned before, the values and beliefs of the researcher, whether conscious and unconscious, can have an impact on when qualitative research is conducted. According to (Willig, 2013), reflexivity calls for the researchers to be mindful of their own contribution to interpretation throughout the research process and to assert that they cannot be “outside of” the subject matter. Being a reflexive researcher prompted me to ensure that my perspectives were clear from the onset. Regular contact with my supervisor and supervision gave rise to continuous reflection throughout the research process and helped me to deepen my self-awareness.

3.2.2 Thematic analysis

For the analysis procedure a thematic analysis was followed. Thematic analysis is a qualitative method of data analysis to identify, analyse and report themes within a data set (Attride-Stirling, 2001; Braun & Clarke, 2006). According to Boyatzis (1998), thematic analysis is extensively used as a method or as a tool demarcating themes across different methods. Apart from describing and organising the data set in detail, thematic analysis also goes further and interprets various aspects of the research topic. Joffe (2012) posits that thematic analysis is a

research approach suitable to illustrate the specific nature of a group's perception of the phenomenon being researched, which in this instance refers to how pre-service mathematics teachers construct alternative models.

Within thematic analysis the search for patterns is guided by either an inductive approach or a theoretical approach. The latter is often referred to as the deductive approach. This approach is influenced by the researcher's theoretical ideas drawn from existing literature. Braun & Clarke (2006) observe that the research question is eminent in themes emerging from the data. As a result, the focus is often on part of the data rather than on the data in its entirety. This is in contrast with the inductive approach where the themes are generated exclusively from the data and the researcher's influence by way of his own theoretical interest in the subject is avoided. For the sake of this study, an inductive approach was chosen for its potential to uncover an assortment of themes.

Flexibility is one of the benefits of thematic analysis. Robson (2011) states that thematic analysis presents opportunities to a variety of theoretical frameworks, whilst Braun & Clarke (2006) claim it is not tied to a specific epistemological position. However, the theoretical framework, aims and research methods must fit appropriately and the theoretical assumptions underlying the analysis must be clearly stated (Attride-Stirling, 2001; Braun & Clarke, 2006). Willig (2013) stresses the importance of "digging deeper" in qualitative research. Braun & Clarke (2014) concur that thematic analysis reflects reality and unpicks the top layer of this reality by interpreting different aspects of the data. They further differentiate between "semantic" themes and "latent themes" where the former focus on the "explicit meaning of the data" and the latter "examine the underlying ideas, assumptions, conceptualisations and ideologies" that lie behind what is said.

Another aspect to consider when dealing with data analysis is the realist or constructionist paradigm adopted by the researcher. The former is also referred to as the essentialist view. In the realist/constructionist approach, language reflects meaning as well as experience and leads the researcher to theories regarding experience and the motivations of the respondent. Conversely, Burr (2003), asserts that the realist or constructionist paradigm denies the existence of an objective reality and maintains that social reality is fabricated through historical and cultural contexts. Additionally, this paradigm does not consider individual motivations. This research study will be driven by thematic analysis at a latent level guided by an inductive approach and epistemologically grounded on the realist paradigm.

This researcher believes that thematic analysis is the approach best suited to understand how students construct alternative models and it also give insights into their experiences in mathematical modelling. An inductive approach will be followed for the study because of the variety of themes it uncovers.

3.2.3 Analysis process

The analysis framework adopted for this study was thematic analysis. Thematic analysis is comprised of 6 stages. Before explaining the six-phase framework, it is important to note the reasons for selecting thematic analysis for this current research. This will be done by a brief discussion of the advantages of the analytical method. As indicated above, thematic analysis is highly flexible. Braun & Clarke (2006) explain that thematic analysis has the capacity to summarise the fundamental traits of a substantial size of data. Additionally, thematic analysis has the potential to facilitate comparison by revealing similarities and disparities within the body of data.

Braun & Clarke (2006) developed a six- phase framework to conduct a robust thematic analysis. These phases are listed in Table 1 below.

Phase	Description of the process
1. Familiarising yourself with the data	Data transcription, reading and re-reading transcribed data, jotting down initial ideas
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme
4. Reviewing themes	Checking the themes work in relation to the coded extracts (level 1) and the entire data set (level 2), generating a ‘thematic map’ of the analysis

5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis

Table 1: Phases of thematic analysis
Source: Braun & Clarke (2006), p. 35

Having looked at the six stages of thematic analysis, a brief account of the practical implementation of the present qualitative study will be explained. The researcher followed the different phases of the data analysis as described above.

Phase 1

Data from conversations on video and audio recordings were transcribed. Transcriptions were checked against the original video and audio recordings and any mistakes were corrected. Braun & Clarke (2006), propose reading the transcripts through several times in an “active way”, searching for meanings and patterns. During this time-consuming process, I familiarised myself with the data and points of interest were marked. This stage was instrumental in my understanding of the data. A mind map of the initial themes that emerged from the data process can be seen in Appendix C.

Phase 2

Furthermore, initial codes were constructed. This process was conducted using a qualitative data analytic software program, called Atlas ti, version 8. The transcripts were transported to Atlas ti and were read line by line. I coded the data using different colours for each code. Meaningful chunks were highlighted and given code names. As I read and re-read the data, new codes were generated and sometimes existing codes were modified. Guided by Braun &

Clarke's (2006) recommendations, many patterns were identified, some of the data was highlighted with the code and extracts were coded as many times as were relevant.

Phase 3

All codes of the three sets of data were classified according to the similarity of their respective topics and sorted into potential underlying themes. This comprised searching for patterns across the data and combining codes by looking at their relationship. Sticky notes were used to aid this process each code being written on a sticky note and then organised into different themes. This included codes which were not as relevant to the exploration of how pre-service mathematics teachers construct alternative models. During the reviewing phase, some of the themes were grouped together to form a broader category. Furthermore, the codes were classified according to the similarity of the topic. I also noticed that the themes overlapped and varied in size. During this process, I also rearranged certain codes and their headings.

Phase 4

The key aspect of this phase is to refine the themes by reviewing them at two levels. Level one entails reading all the extracts combined for each theme to ascertain whether they formed a consistent pattern. As a result, more than 20 themes were merged and other themes were grouped into separate themes. It is apparent that level two required re-reading the complete data-set to draw the inferences based on the themes in the context of the data-set. This involved a repetitive thinking process moving to-and-fro as needed, integrating and interweaving different data sources. The "code manager" function in Atlas ti was also used to check the spread of themes across the activities.

Phase 5

Braun & Clarke (2006) explain that this step is to determine the essence of each theme and to organise the theme into a logical and consistent account. In addition, the names of each theme were reconsidered, attempting to be concise and precise. Together, the themes and their relation to each other were taken into consideration to determine the "story" informed by the data.

Phase 6

This step narrates stories, which the product of prolonged data immersion, deep-thinking and reflection (Braun & Clarke, 2019). Excerpts were chosen to encapsulate each theme. It is apparent that with a set of established themes, the thematic analysis of the data moved to an account where the results were recorded in the thesis.

3.3 Research instrumentation

The research instrument was comprised of three tasks of real-world mathematical problems. The three real-world mathematical problems selected for the pre-service mathematics teachers were regarded as appropriate for data collection as all three activities were embedded in real-world contexts and the solutions of all the problems offered the opportunity to construct alternative mathematical models. All the mathematical problems could be solved through different strategies and approaches.

The participants were free to divide themselves into groups. Before the commencement of any group discussions, the rules and procedures were explained to the participants, i.e. only one person to be allowed to speak at a time, the election of a group leader, a scribe and reporter etc. Discussions were restricted to the group-setting as no one was allowed to engage in discussions outside the group. Further to it, participants were tasked to record all ideas that came up in the construction of an alternative mathematical model. No problem-solving strategies were recommended in order to allow the participants to develop their own approaches to model the solutions to the problems.

The participants consented to the recording of the discussions in the groups and the feedback in the plenary (see Appendix B). The audio-recordings of the discussions were transcribed afterwards. In this way the researcher could listen to the tapes on numerous occasions to code, summarise, note comments of interest and to identify potential themes.

3.4 Sampling

Purposive or judgemental sampling was utilised for the study, as the primary consideration was the judgement of the researcher as to who could provide the best information to achieve the objectives of the study. The researcher thus opted for participants who in her opinion possessed the required information and who were willing to share it.

Permission was obtained to conduct the study at the University of the Western Cape. Participation in the study was voluntary. In total, twenty fourth-year pre-service mathematics teachers from the Faculty of Education of the University of the Western Cape participated in the completion of the mathematical modelling activities on which the analysis is based.

3.5 Ensuring validity and reliability

The substance of the qualitative output is guided by the proof of reliability and validity. Boudah (2011) defined reliability as the degree to which a study can be repeated with the same results. In addition, Brink (1993) stated that reliability refers to the extent to which a method of research can deliver similar results during various periods of testing. Noble & Smith (2015, p.34) contrast reliability and validity in research. They point out that the concept “reliability” refers to the consistency within the analytical procedures whereas “validity” describes the integrity and application of the methods undertaken and the accuracy with which the data of the study is reflected. Noble & Smith (2015) argue that to increase the “trustworthiness” of research-findings involves the incorporation of methodological strategies. Boudah (2011) concurs with their statement and adds that researchers who use the paradigm of qualitative methods should share the idea of trustworthiness. Stemler (2001) maintained that without the notion of reliability as a criterion, the study is no good. The concept of “reliability” is thus central to the idea of quality research.

According to Boudah (2011) validity is the degree to which conclusions drawn from the findings come from the study itself and not from chance or error. In addition, Blumberg et al. (2005) states that validity refers to the extent to which a test measures what we wish to measure. In qualitative research validity is comprised of the procedures used to check the accuracy of the findings (Creswell,2013). For Patton (2002), in qualitative research, validity and reliability are concerned with the analyses of the results and the judgment of the quality of the study. Lincoln & Guba (1985) state the researcher must lead the audience into believing the findings of the research.

In ensuring reliability and validity throughout the research project, I was guided by the criteria adopted by Yardley (2000):

- Sensitivity to context: includes the context of the social setting in which the research is conducted as well as relevant theoretical positions and ethical issues.

- Commitment and rigour: refers to engagement with the participants, having the necessary skills and thorough data collection and analysis.
- Transparency and coherence: involves clearly specified research methods, well-articulated arguments and a reflexive stance.
- Impact and importance: includes the significance of theory, the community in which the research is conducted and the recognition for researchers that knowledge cannot be objective.

In this research study, the codes were validated for theme consistencies by rigorous discussions with my supervisor. Additionally, extracts from original transcripts were given to three knowledgeable researchers to examine if they agreed or disagreed with the codes which the researcher had identified. Creswell (2009) refers to the aforementioned as inter-coder agreement. Subsequently, each of the three validators reviewed the transcript extracts of the tasks to examine if there was a need for additions or amendments: in other words for consistency of the themes. Upon review of the validation process, all three validators confirmed the consistency of most of the themes identified by the researcher (see Appendix T).

The preliminary coding of each of the tasks by the validators was time-consuming, but necessary to safeguard code trustworthiness and quality during the early stages of the data analysis.

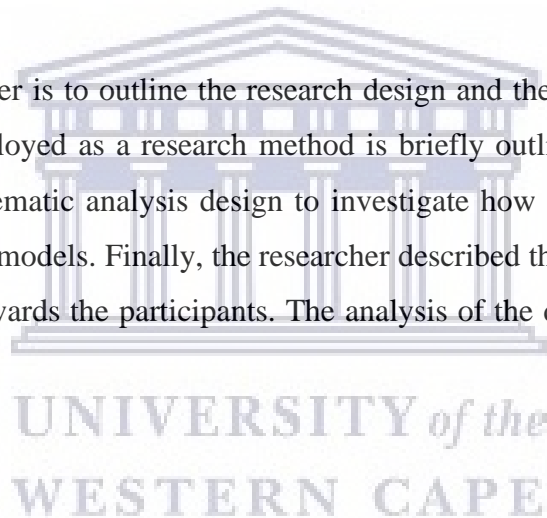
3.6 Ethical considerations

Zegwaard, Campbell & Pretti (2017) are of the view that ethical considerations have escalated following society's expectation of accountability. Ethical considerations are necessary to protect participants from any harm. Permission and approval for the current research were sought from the University of the Western Cape. Ethical clearance was obtained from the University of the Western Cape. Student participation was voluntary and respondents were fully informed about the nature and purpose of the study (see Appendix A). The data was anonymised and pseudonyms were assigned to the participants. Students gave their written consent to participate in this research and a copy of the consent form can be found in Appendix B. Participants were aware that they had the right to discontinue participation at any time during the research study. The respondents were encouraged to ask any questions they might have about the research study.

McMillan & Schumacher (2010) propose that data must be kept anonymous to prevent participants from being identified. Very importantly, extracts from the participants' mathematical work included in the research were not labelled and so could not reveal information about the respondents. Another key element of conducting ethical research involves confidentiality. McMillan & Schumacher (2010) express the opinion that confidentiality refers to the retrieval of data. Another essential point is that the identity of participants remains confidential and should only be available to the researcher. Transcripts were stored in a password-protected folder on the researcher's laptop. Adler & Lerman (2003, p.29) assert that the researcher should "take sufficient care of those being researched". Thus, once the research study has been completed, the data will be securely stored for 5 years with only the researcher having access to it.

3.7 Conclusion

The purpose of this chapter is to outline the research design and the research approach. The qualitative approach employed as a research method is briefly outlined. To summarise, the researcher exploited a thematic analysis design to investigate how pre-service mathematics teachers build alternative models. Finally, the researcher described the ethical concerns in the professional approach towards the participants. The analysis of the data will be discussed in the next chapter.



CHAPTER 4

DATA ANALYSIS OF TASKS

In this chapter, I offer a separate analysis of each task undertaken by the pre-service mathematics teachers, namely, the Johannesburg Stock Exchange (JSE) Task, the Rio Summer Olympics Task and Provincial Soccer Rankings Task. These analyses are followed by a detailed description of each theme identified. In conclusion, the chapter highlights the skills, knowledge, abilities and competencies of pre-service mathematics teachers displayed in the development of the construction of alternative mathematical models.

4.1 DATA ANALYSIS OF THE JOHANNESBURG STOCK EXCHANGE (JSE) TASK

4.1.1 Introduction

This section analyses the results of the Johannesburg Stock Exchange (JSE) task that the pre-service mathematics teachers completed. The collected data was transcribed and then analysed and themes were generated. The data used in this section deals with the students' discussion of a socio-mathematical issue. A socio-mathematical issue is one where mathematical models are used in arguments about a social issue. The students were presented with a newspaper article (Appendix D) dealing with black ownership through shareholding in the Top 100 Companies listed on the JSE. Briefly, the article focused on two different economic empowerment models used in South Africa to promote black ownership, namely the Alternative Prosperity (AP) group and the National Empowerment Fund (NEF). The two models came to different conclusions. In the article referred to above, the methods each model used to determine the number of Black South Africans holding shares on the Johannesburg Stock Exchange (JSE) are described.

The overarching purpose of this research study was to outline a socio-critical perspective of mathematical modelling in mathematics education. The task that the pre-service teachers had to complete was done in support of the objective. For Cotton (2013) mathematical modelling is based on the premise that mathematics can and should play a role in addressing difficulties faced in society, including growing inequality and unsustainable economic growth. Skovsmose (2011) posits that critical mathematics education should include reflections

‘through’, ‘with’ and ‘on’ mathematics. He maintains that students should reflect ‘through’ mathematics by engaging in meaningful mathematical inquiries in which they pose their own questions and make their own decisions while interacting and communicating with other students. Furthermore, they should reflect ‘with’ mathematics by using it to develop their understanding of a range of social, cultural and economic issues.

The JSE task deals with inequality and black shareholding ownership in South Africa. The participants were divided into groups, with an elected group leader and were asked to record all ideas and discussions that transpired. The working session lasted for 45 minutes. During the plenary session the group leaders reported back on the discussions held.

4.1.2 Overview of themes

This sub-section provides a narrative of the themes I constructed from the analysis of the data. The themes were grouped into four main sections, namely: Economic Empowerment; The Authority of Research; Trustworthiness of Information and Shares Assignment Criteria.

Figure 4.1 below provides a brief description of the themes and codes, followed by a detailed discussion of both topics.

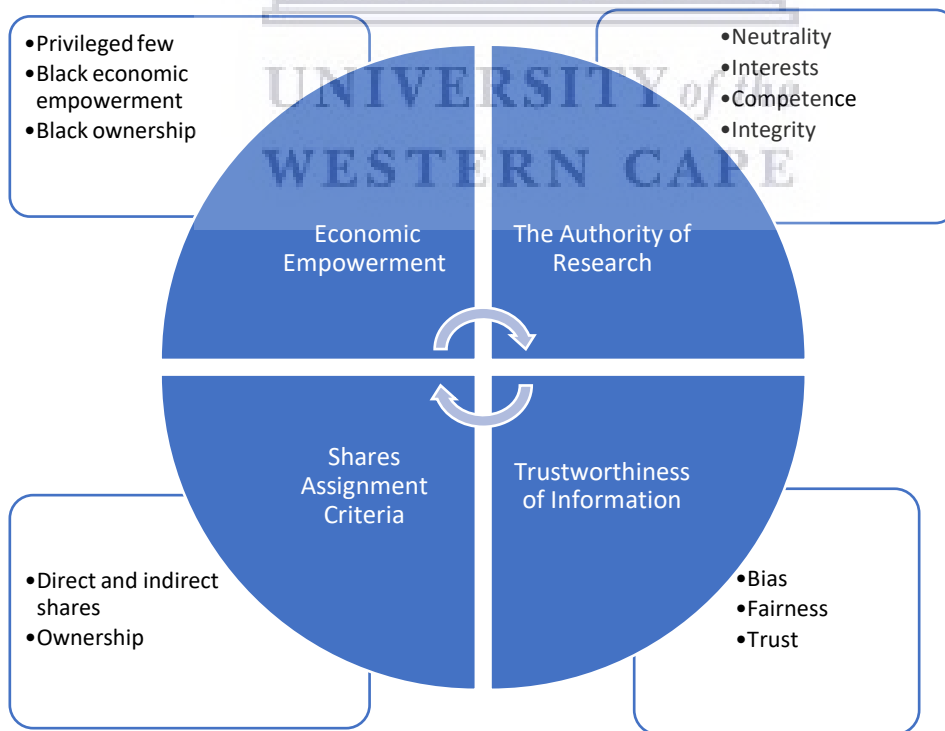


Figure 4.1: Thematic Map of JSE themes and codes

4.1.3 Economic empowerment

The theme, Economic Empowerment, emerged from the data when pre-service mathematics teachers discussed a newspaper article they were given to read. As I read and re-read the transcribed data, it became clear that the article had had a strong influence on the emerging discussion. The students referred to aspects such as “privileged few”, “Black Economic Empowerment (BEE)”, “Black ownership” and “King III Report”. The King Committee on Corporate Governance issued four reports namely, King I (1994); King II (2002), King III (2009) and King IV (2019). The King IV Report on Corporate Governance is a booklet of guidelines for the governance structures and operations of companies in South Africa. The intention of the King IV report is to broaden acceptance of corporate governance by simplifying and defining governance objectives. Compliance with the King Reports is a requirement for companies listed on the Johannesburg Stock Exchange (JSE) (Companies Act, 2008).

Utterances such as the one that follows were used as codes and grouped under the theme economic empowerment. The excerpt below illustrates the data segment that was coded “privileged few.” During the report-back by the reporter from Group 1 (male) the following, inter alia, were said:

“So, with the National Empowerment Fund (NEF), we found it highlights only a privileged few shareholder. So, it doesn’t take everyone into account. Obviously, shares must be directly held by black individuals. And those are the only ones that they referred to in their results.”

The reference to “privileged few” is drawn from current discourse on distribution of wealth in the country which is linked to economic empowerment.

During the deliberations in Group 2, it became clear that the students had an understanding and knowledge of the current South African political context. The discussion revolved around how only a narrow stratum of previously disadvantaged groups benefitted from Black Economic Empowerment. The information obtained from the official documents of the Department of Trade and Industry (DTI) describes Black Economic Empowerment as a selective programme launched by the South African Government to redress the inequalities of the past by giving formerly disadvantaged groups (Black South African citizens) economic privileges that are not available to White South African citizens (DTI, 2003).

Another objective of economic empowerment is to empower rural and local communities to succeed in economic activities by providing them with land, infrastructure, ownership and skills.

At this point the researcher intervened in the report-back by explaining that Black South Africans includes Coloured, Africans, Indians and Chinese. The report-back by the reporter of Group 2 (female) proceeded as follows:

“Our group chose the Alternative Prosperity group. And the reason we chose that one was because it’s an independent research headed by Trevor Chandler of the Alternative Prosperity and we also said that they are consistent with the BEE and King three codes. This group also includes annual reports and financial statements which means that they have a variety of information sources, which include the share registers of JSE listed companies, BEE certificates of these companies and then under listed South African subsidiaries, annual reports and financial statements.”

The low level of economic interest by black South Africans is linked to the discrimination of the past. Furthermore, the low level of direct participation on the Johannesburg Stock Exchange (JSE) by all South Africans is also linked to low financial literacy and related savings (Nicky Newton-King, 2014).

During the report-back by the reporter of Group 3 (male) black ownership on the Johannesburg Stock Exchange (JSE) was referred to as follows:

M1Gr3: “My group supports the Alternative Prosperity group. So, the reason why is because this article ultimately deals with like investments. There are two sets of research stating to where the funding and empowerment must go. So, they show the need for the research to happen, started doing the research. Presented their results but now the results actually show a positive increase in the amount of people – the amount of black ownership in the business sector and the companies listed on the JSE.”

The National Empowerment Fund (NEF) views the legitimate and effective method of measuring black ownership and control on the Johannesburg Stock Exchange (JSE) as the assessment of direct ownership and control. It is a further requirement that this ownership or equity should vest directly with black companies or individuals, broad-based groups or community trusts, as well as employee share ownership schemes.

4.1.4 The authority of research

This theme encapsulates functionality within the authority of research between the Alternative Prosperity and National Empowerment Fund. Most of the students who referred to the

Alternative Prosperity group, used an unbiased source in relation to the National Empowerment Fund. However, they suspect the latter as having a motive for influencing the way people see the findings of black ownership on the Johannesburg Stock Exchange. For instance, for some students, this authority created a situation where students were uncertain about the research done by the National Empowerment Fund (NEF). As I read through the data, four different kinds of codes and valued criteria were found. These highlighted the following concepts: “neutrality”; “interests”, “integrity” and “competence”.

The concept “analysis of neutrality” was used to describe students’ thoughts about analysing authorities. The students used the analysis for neutrality by evaluating whether the source perhaps had conflicting interests. In the extract below, a member of Group 3 (female) referred to the seemingly independent research headed by Trevor Chandler of the Alternative Prosperity (AP) who did the research for the Johannesburg Stock Exchange (JSE).

F1Gr2: “I have something we can discuss. So we know this is independent research that was done, so independent research according to me is based on like, you must be neutral, like it’s your being because it’s an independent thing, you come in and you do basic research So, the person’s name is Trevor Chandler, now he created Alternative Prosperity.... this is his company or the main thing of the JSE.”

For another Group, the situation was a little more complicated. Even though, they supported the Alternative Prosperity group, initially, they were concerned that Trevor Chandler was commissioned by the Johannesburg Stock Exchange. This discussion proceeded as follows:

M1Gr1: “Yes, but I am seeing this Alternative Prosperity, this company that Trent Chandler is doing his research for. He is being funded by the JSE.”

F2Gr1: “You mean, commissioned by the JSE.”

M1Gr1: “And the JSE is where these companies are being represented on.”

The analysis for neutrality might be viewed as an attempt to establish who is implicated by their own interests. The excerpt above indicates that the students thought neutrality could be difficult for researchers. An observation of the student’s discussions of neutrality, suggest that it seems fair to say that often they do not really ‘analyse for neutrality’, but only alluded to the fact that they would trust those researchers who were neutral.

A key aspect of “integrity” emerged, when students questioned the fact that both the Alternative Prosperity (AP) group and the National Empowerment Fund (NEF) considered the

same facts when doing their research, and yet they arrived at two different conclusions. The Group 1 discussion proceeded as follows:

F2Gr1: “Okay so are you raising that both the Alternative Prosperity and National Empowerment Fund, when they were doing their research, where they look at the same facts or at the same records?”

M1Gr1: “They were using different methods though.”

M2Gr1: “Different methods to do the research but they’re representing figures about the same thing”.

Another aspect, referred to as “competence”, was highlighted during the deliberations of the students in Group 1 in the evaluation of the authority of research. For instance, some of the students responded as follow: “I agree with the Alternative Prosperity (AP),” “they have a more holistic approach,” “the AP is consistent with the BEE codes” and “AP linked to independent research.” The inferences that can be drawn from the responses above suggest that the Alternative Prosperity (AP) was considered more competent.

This theme is important as it identifies the integrity of knowledge that emerges from research. It can be deduced from the discussion of this theme that students took into consideration an evaluation of the authority of the research. They viewed it as key to the credibility of the two different models, namely the National Employment Fund and the Alternative Prosperity group, each with different perspectives based on the aspects which are included in their models.

4.1.5 Trustworthiness of information

The aim of this theme was to explore the insights into pre-service mathematics teachers’ ways of deciding upon the “trustworthiness of information” when engaged in a newspaper article dealing with two different models for the same phenomenon. The concept “trustworthiness,” denotes the extent to which information was deemed sufficiently reliable for inclusion in the pre-service mathematics teachers’ decision-making.

A scoping of the literature of some type of studies on students’ evaluations of the trustworthiness of information on controversial issues was undertaken. In these studies, credibility deals with the focus of the research and refers to the confidence in how well the data address the intended focus (Polit & Beck, 2012). However, the aim of this study was to focus predominantly on students’ ways of dealing with one specific issue: the different conclusions reached as a result of the use of two different models. Further discussions of the bias issue ensued when attention was drawn to the fact that the National Empowerment Fund

(NEF) is not independent. The South African Government has tasked the NEF to facilitate economic equality and transformation in South Africa. For example, from group 1 (female) states:

F1Gr1: “But I feel like the NEF, it’s kind of like bias.”

F2Gr1: “Yes, it’s going to bias.”

F1Gr1: “The Alternative Prosperity bears the hallmark of reliable interrogation.”

F2Gr1: “I feel the NEF is bias because maybe it is not going to expose the bad side of all the companies.”

In addition, this group stated in more general terms that it was difficult to establish what information to trust and which sources to believe. A few students also mentioned the researcher’s information on the newspaper article was problematic as the study was done by the Black Economic Empowerment (BEE) advisory group, Alternative Prosperity (AP) for the Johannesburg Stock Exchange (JSE). In the extract below, members of Group 1 referred to Black Ownership on the Johannesburg Stock Exchange (JSE) which stood at 3 per cent and commented on the trustworthiness of the JSE:

M1Gr1: “If you think about it, the National Empowerment Fund is concerned with empowering you know, providing funding.”

F2Gr1: “For black owned companies.”

M1Gr1: “Yes, actually they say that black ownership on the JSE stood at only 3%, then there is most likely more money required, so the National Empowerment Fund would be prone to figures which state that there are low percentages.”

But the thing is the JSE has no reason to lie.”

The group also raised concerns about fairness when attention was drawn to which of the two models, namely the Alternative Prosperity (AP) and the National Empowerment Fund (NEF), consider people of ALL the different races in South Africa. This discussion proceeded as follows:

F2Gr3: “So what is the question again? Which one of the two models we would support? So, we would support the Alternative Prosperity.”

F3Gr3: “Yes.”

M1Gr3: “The AP just seems fair... like it takes a bigger amount of people into consideration.”

This theme reflects the interpretations of pre-service mathematics teachers of information about two black empowerment groups and their relative trustworthiness.

4.1.6 Shares assignment criteria

The thematic analysis yielded interesting insights into the views of some pre-service teachers across the groups. This led to the identification of a common theme whereby all the participants in the groups believed that “share assignment criteria” are considered in the breakdown of black ownership in the Top 100 Companies, listed on the Johannesburg Stock Exchange (JSE).

The theme “shares assignment criteria” relates to the students’ accuracy in their representations of a real-world problem mathematically and their selection of applicable content knowledge.

Students referred to black shareholders in the data and all the groups agreed that the number of black shareholders in JSE-listed companies is overtaking the number of white shareholders, reflective of the BEE objective. It is evident that the students in this study seemed to emphasize the growth of black shareholding on the Johannesburg Stock Exchange (JSE). Students in both Group 2 and 3 summed this up when they said:

F3Gr2: “And here they said the findings, they found that the black people are holding more shares in the JSE because they use their pension money. Now they want to know like usually, I wouldn’t – I don’t know, I’m speaking now in general like the white people would use, they will do part of the JSE companies and they do it throughout the years but whereas the black people are like on pension and then they invest in the JSE. And that is why.”

F1Gr3: “In the Alternative Prosperity, the AP, I think I heard them say the number of black South Africans holding shares on the JSE has overtaken the number of whites.”

The reference to “direct and indirect shares” below is drawn from current rhetoric on how the low level of economic interest by black South Africans is linked to the shares assignment criteria.

During the deliberations in Group 2, the students demonstrated insight into how South Africans are often tentative about investing directly on the Johannesburg Stock Exchange (JSE). The discussion revolved around how the financial services industry is working to improve financial literacy by running directed capital educational programs in schools and tertiary institutions as

well as to the general public. All the groups identified relevant information from the newspaper article which supported their assumptions. Below are some of their views:

F3Gr2: “Some of them mentioned, the only difference, between direct and indirect shares is of procedural, so the methodologies, they use are just different. The one sticks to strictly black people can invest and the other one is broader... multicultural. I mean any person can invest.”

F1Gr2: “Well it says here that the NEF states - the shares must be held directly by black individuals.”

F3Gr2: “But then those who are investing through pension funds or whatever else ...they’re indirectly owning shares.”

4.2 DATA ANALYSIS OF THE RIO SUMMER OLYMPICS TASK

4.2.1 Introduction

This section examines and analyses the results of the strategies pre-service mathematics teachers followed in the development of alternative ranking models. Rankings are widely reported on in the media and are excellent examples of mathematical models. For example, the Human Development Index (HDI) is an illustration of a ranking system used by the United Nations to assess the level of socio-economic development in countries. According to Prinsloo (2018), the Human Development Index (HDI) is a composite of three basic components: longevity, economic prosperity and schooling. Furthermore, these factors include the following variables:

- Life expectancy at birth
- Per capita income, and
- Level of education based on adult literacy rate and the average number of years of schooling of adults.

Other familiar examples of ranking systems that mathematical models used to illustrate real-world phenomena are Body Mass Index (BMI), Big Mac Index etc.

The Rio Summer Olympics was the second task to assess the competencies of pre-service mathematics teachers to develop the construction of alternative mathematical models. They were provided with data of the official medal awards for the Rio Summer Olympics. The pre-service teachers were instructed to construct an alternate model for ranking countries participating in the Rio Summer Olympic Games. The activity is given in Appendix E. The

ranking system used for countries is an issue which is viewed as controversial and has been widely discussed in the popular media. Wilberger (2012) alluded to a possible flaw in the existing ranking system in that it gives so much prominence to countries who win gold medals and relegates the significance of silver and bronze medals.

After studying and discussing the contents of the table in their respective groups, the students were presented with an article entitled “Class letter to Commonwealth Games Committee” dated Monday, 9th June, 2003. This article questioned the validity of ranking countries’ performance by the number of gold medals won. Group discussions followed the reading of the article. These discussions lasted for about 45 minutes. A detailed analysis of the discussions held will be provided at a later stage. The following themes emerged.

4.2.2 Themes identified

The following sub-section will deal with the themes that were identified, described and analysed, namely:

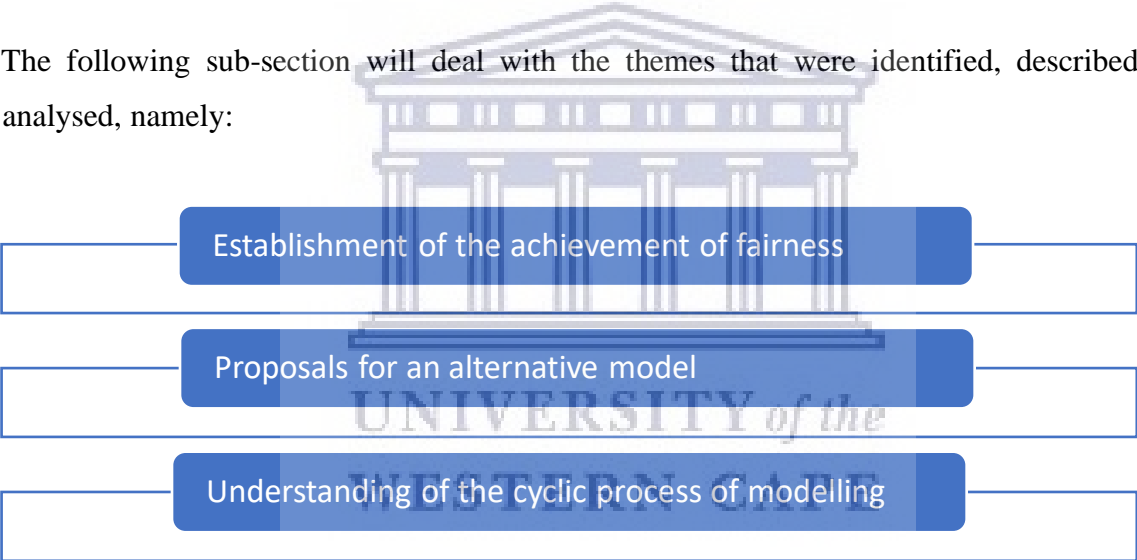


Figure 4.2.2: Thematic illustration of themes

4.2.3 Establishment of the achievement of fairness

From the onset the pre-service teachers who participated in the activity, reiterated that their choice of an alternative model was caused by the unfairness of the given model. The group strongly argued that the 2016 Summer Olympic Games Ranking System was based on the number of gold medals won as opposed to the total number of medals. Wilberger (2012) posits that the existing ranking system does not give any credit for winning minor medals other than helping to order those countries who won the same number of gold medals. In the event where two or more countries obtained an equal amount of gold medals, the next step is to consider the number of silver medals obtained and thereafter the number of bronze medals. In an attempt

to modify the model, Group 2 presented an alternative ranking system using weighted scores as follows: five points for each gold medal, three points for a silver medal and 1 point for a bronze medal.

During the report-back by the reporter (F3Gr1) said:

“The reason why we decided on a points system because obviously we don’t know what weight gold carry in this given ranking system, and we feel the current ranking system is not fair for example. when you look at Denmark, their ranking position is twenty-eight in the given ranking system, but they came home with fifteen medals. So, how can you rank a country that came home with more medals at position twenty-eight and a country like Switzerland who’s ranking position is at twenty-four, but they went home with seven medals? For argument’s sake, Argentina went home with four medals and they were ranked higher than Denmark. How is that possible? So, in order to make it like fair we then decided to work with the points system and Denmark came first and Argentina came ninth.”

For the students, a fairer ranking system seems warranted; something that takes into consideration the total number of medals won. It is interesting to note that in the quest for fairness, Group 3 also developed an alternative ranking model based on weighted scoring. The only difference was in the ratings. Three points were awarded for a gold medal, two points for a silver medal and one point for a bronze medal. This discussion proceeded as follows:

F1Gr3: “I think the ranking system should be how many medals are won in total and not how many gold medals the country won.”

M2Gr3: “And I think there should be weighting to it.”

F1Gr3: “No, that’s not what I was saying. Like they should work according to a point system. So, say for example a gold medal will carry”

M1Gr3: “3 points.”

F2Gr3: “Yes, gold will carry 3 points. A silver will be 2 points.”

M1Gr3: “And a bronze will be 1 point. So, it’s fair in a sense because you’re ranking first, second, or third”.

An example of the Group 3 Alternative System is given in Figure 4.2.3, below.

Alternative Ranking System.
(Points System)

Gold = 3 points
Silver = 2 points
Bronze = 1 point.

→ If countries have the same number of points, we will look at the total number of medals.

RANK	COUNTRY	POINTS
24.	Denmark	25
25.	Sweden	21
26.	Ukraine*	20
27.	South Africa	20
28.	Serbia	16
29.	Iran**	15
30.	Switzerland	15
31.	Greece	13
32.	Argentina	11

* Ukraine ranked above South Africa because they have a greater total number of medals.
** Iran ranked above Switzerland because of greater total number of medals.

Figure 4.2.3: – Participants Alternative Summer Olympics Ranking System

It is evident that all the students in this study had the same idea in terms of giving different weight to the different categories of medals. Their respective alternative ranking models are a compromise system, which incorporates both gold and total medal counts. The most credit is given to gold medals. However, some credit is still given to the silver medals and bronze medals won. The students maintained that their ranking system is fair as it takes into consideration all the medals won by giving weights to the different categories of medals.

4.2.4 Proposals for an alternative model

After looking at and discussing the contents of the table of the Summer Olympic ranking system, attention was drawn to the design of an alternative ranking model. Reference was made to the current ranking system and the students realised that some mechanism had to be included in their model to take cognisance of different medals. This current system is viewed as problematic by the students as revealed in the excerpt below:

M3Gr1: “This Olympic Ranking Table is pointing out that there are countries who got a lot of silver medals right, but then a country who got far less silver medals than them but only got like one more gold medal. They are ranked higher on this given ranking list. This is a problem.”

F1Gr1: “Can we look at our model?”

M2Gr1: “I think a weighted ranking model is more reasonable and will allow contributions from all athletes.”

F1Gr1: “Our model must be an improvement of the given model. It must give the most credit for gold medals and some credit for silver and bronze medals.”

Different levels of conjecturing were observed during the development of weighted scores. During the iterations of their model, each group indicated the total number of points to be allocated for each category. For example, Group 3 provided the following explanation for their alternative model:

M1Gr3: “So by looking at South Africa and Ukraine, I see according to our model, they have the same points, on 20. South Africa though, based on the medals – the better the colour medal the more weighting it has. When looking at the given table, they both have two gold medals so then they’ll be equal. Then by looking at South Africa, they have one more silver than Ukraine.”

F2Gr3: “And Ukraine has two more bronze than South Africa.”

M1Gr3: “So, then Ukraine get ranked above South Africa because they have a greater total number of medals. But both will be above Switzerland in our alternative table.”

This redefinition of the problem led the students to the generation of a new model for ranking different countries performances at the Olympic Games. Only two alternative models were developed. The one group of students generated weighted scores by awarding five points for each gold medal, three points for silver and one point for a bronze medal. The other two groups awarded three points for a gold medal, two points for a silver medal and one point for a bronze medal. All the groups had the same idea of allocating weights to the different categories of medals.

Despite experimenting with different weightings for each type of medal, all the groups discovered that Denmark ranked first and Argentina ranked ninth. This result indicated that even though some of the weighted ranking systems may vary slightly, it can make a significant difference in the order of some of the tables. It also illustrated that different transformations of medals into points are possible.

4.2.5 Understanding of the cyclic process of modelling

During the initial stages of this activity references were made to constructs of the modelling cycle. In the extract below a member of the group requested clarification on the ranking of the different countries.

F1Gr3: “Explain to me how you are going to rank the countries because we are going like completely against this ranking system.”

M2Gr3: “Remember our weighted total is $3G+2S+1B$.”

F2Gr3: “Yes, we have done all the calculations and our system looks different.”

M1Gr3: “We are basically going to rearrange the countries.”

M2Gr3: “I said total number and then from there then it is the rank, then colour medal after that. If you work out a mathematical equation for this there must be a way where we are going to have the same points, same number of medals but different make up of medals because we have done it.”

In the above excerpt the group declared their model, $3G + 2S + 1B$, (see M2Gr3) and in addition to it, they completed the “mathematical” part (F2Gr3).

Integral to the students’ mathematical work done during the modelling process, is that they demonstrated their abilities to simplify, filter and idealise the information stipulated by the activity. According to Stillman (2012), this mathematical work takes place during the stage of “formulating the mathematical problem.” In the extract below a member of the group highlighted a possible flaw in the current ranking system. The discussion proceeded as follows:

M3Gr1: “But do you feel that these rankings are accurate? Do you think they are accurate if you base them on the gold medals only?”

F1Gr1: “No, I don’t think they are.”

M3Gr1: “So then what do you think is being like ignored in this table?”

F1Gr1: “I think, okay. They can generate a score for each medal. They can award for example, three points for a gold medal, two points for bronze and one point for silver.”

4.3 DATA ANALYSIS OF THE PROVINCIAL SOCCER LEAGUE TASK

4.3.1 Introduction

This section describes the pre-service mathematics teachers’ response to the soccer league table task. Impressions of the task and reflections on their experience are followed by a discussion of their approach to the construction of an inter-provincial soccer league, considering the socio-economic development of each province involved in the soccer competition.

Initially, the students were presented with a soccer league table that listed the nine provinces (ranked according to the matches won, drawn and lost) for a Provincial Soccer League (see

Appendix F). The table contained information in accordance with the traditional soccer league table. In addition, the students were provided with the results of a survey conducted by Statistics South Africa, which provides the mid-year population estimates per province, the life expectancy per province as well as the national and provincial Gross Domestic Product (GDP) per person (listed as Appendix G). Group discussions followed after the students reviewed and discussed the contents of the activity. This discussion lasted for 45 minutes. A detailed analysis of the discussions held will be provided at a later stage.

The next sub-section deals with the themes identified upon the analysis of the data.

4.3.2 Themes identified

The following sub-section deals with the codes and themes that were identified by way of the analysis. Figure 4.3.2 below, provides a brief description of the themes and codes followed by a detailed discussion of the themes as well as the codes.

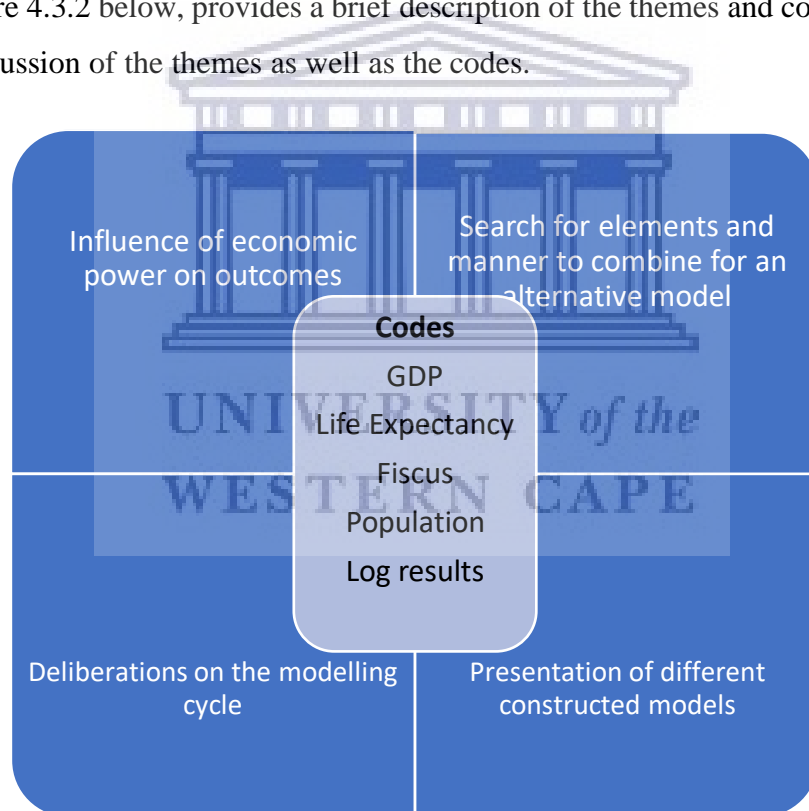


Figure 4.3.2: Thematic map of Soccer Ranking Themes and Codes

4.3.3 Influence of economic power on outcomes

The aim of this theme was to explore the insights into pre-service mathematics teachers’ ways of deciding upon the “influence of economic power on outcomes” when engaged in

constructing an inter-provincial soccer league table. The socio-economic conditions of each province involved in the soccer competition were considered. The transcripts were read and re-read to facilitate an understanding of how the themes fitted together. Within the discussions, aspects such as “Gross Domestic Product (GDP)”, “Life Expectancy” and “Fiscus” were referred to.

The discussion of this theme describes some students’ articulation of a need to evaluate the different information and the opinions they offered. The quotations below are examples of the kind of statements made by students in the groups to indicate the influence of economic power.

M3Gr3: “I suppose it has got to do with opportunity, so how much weight do we give to opportunity because obviously you get soccer maybe you look at whether it’s athletics or rugby or cricket or golf. But generally those provinces that have a higher GDP, are going to be playing those sports because you need money in order to, you know, succeed at it because you need equipment and if you can’t afford it, chances are you are not going to go anywhere with it. Soccer is a bit different... I think you also need talent.”

F1Gr3: “Compared to someone that is, look I can’t just say it like that but what I am saying is like someone who is academically smart, comes from usually better home, like where they are exposed to certain things.”

F2Gr3: “Just open to more opportunities.”

F1Gr3: “But whereas a sport is a talent, you can play it anywhere.”

In the above quotations the students refer to the discrepancies between the rich and the poor (see F1Gr2 and F2Gr3). The cities are spaces of socio-economic divisions and inequalities. Most students who evaluated the information have done that to a greater or lesser extent. In my view, the most interesting aspect is that these students stated this explicitly. This indicates that the students are conscious that one might – or must – think for oneself. Furthermore, the students also focused on the importance of listening to the other participants before making a final decision:

F2Gr1: “So, do you think we can compare a soccer player in the.....”

F1Gr1: “Western Cape.”

M3Gr1: “So now, comparing a soccer player in the Western Cape ... comparing maybe a Gauteng player and an Eastern Cape player.”

F1Gr1: “Or a Northern Cape player.”

M2Gr1: “It said here, like you can still consider the amount of games won and lost. Do you know what I’m saying? Do you think we must somehow multiply it by a factor that includes the Fiscus?”

M3Gr1: "We must include the GDP and the life expectancy as well."

These and similar statements about the importance of listening to different students also imply that the opinions from different students must be compared and autonomously evaluated by the students themselves.

4.3.4 Search for elements and a manner to combine them for an alternative model

This theme deals with the elements the participants considered including in a possible alternative mathematical model for a soccer league table. The themes overlap and in all the themes aspects such as "Population", "Gross Domestic Product (GDP)" and "Life Expectancy" were referred to. Of note, whilst the students were busy with the activity was their continuous checking of the correctness of their calculations. Their calculations incrementally improved. The discussion proceeded as follows.

F2Gr2: "It's the soccer. It's the team over the population - it needs to be that ratio."

F1Gr2: "Remember, that needs to be the ratio. The team over the population."

F3Gr2: "But how?"

F1Gr2: "Because, not the whole population partakes in the thing."

F1Gr2: "So, something needs to go over the population, right? So, it's obviously..."

F2Gr2: "How can we add the totals there as well? Because we are adjusting the total now."

F1Gr2: "What do you mean? What total?"

F2Gr2: "These totals here (total on soccer league table)."

F1Gr2: "No, we're not changing that total. That's just how many points they got while they played soccer."

F2Gr2: "We need to change it."

F1Gr2: "It's going to change after we do the calculation basically."

The use of the population in the calculations warranted the inclusion of references to the socio-economic development of each province. During the deliberations, it is interesting to note how F1Gr3 took the initiative to explain why the population forms an integral part of the socio-development criteria. Furthermore, F1Gr3 explains why it is appropriate to include the Gross Domestic Product (GDP) in the group's deliberations. The quotations below provide examples of the kind of statements made to justify the inclusion of the GDP as a socio-economic factor:

F1Gr3: "We just all need to keep the population. We know where the population is."

F1Gr3: "There. The population must be there. But then it needs to be the population times the GDP."

F3Gr3: "Isn't it the life expectancy?"

F1Gr3: "It needs to be the population times the GDP."

F3Gr3: “Why times?”

F1Gr3: “Because the population is the total and the GDP is per person, so it needs to be the total times the population.”

F3Gr3: “This is per person? Is that what you’re saying?”

F3Gr3: “Ja.”

F2Gr3: “So, this must be multiplied with the ...”

F1Gr3: “The mid-year population.”

The purpose of establishing the correctness of the presented data was important as they worked towards a mathematical model to determine a new soccer ranking system.

4.3.5 Deliberations on the mathematical modelling cycle

The theme “Search for elements and a manner to combine them for an alternative model,” laid the basis for the development of a mathematical model. In pursuit of the intention to improve the current ranking system, the students first simplified the problem. For example, the students compared the log results to the mid-year population results. In the quotation below, a member of the group (M1Gr3) contemplated how the log results and the mid-year population of each province relate to each other.

F3Gr3: “We need to design a new ranking system.”

F2 Gr3: “What are you looking at?”

M1Gr3: “I want to look at the results on the log, so Gauteng had the most people and the most points. Mpumalanga is an outlier, meaning second on the log but sixth in population. Western Cape is third on log and third in population. KZN is second in population and fourth on log, so it is not far away. Free State is second last in population but fifth on log.”

F3Gr3: “So, we’re saying that there is an impact?”

During the deliberations below, the group explored the possibility of excluding Mpumalanga from the calculations. The discussion proceeded as follows:

M1Gr3: “So, Mpumalanga basically must be pushed out but how do we do it?”

F3Gr3: “We can find a formula to exclude Mpumalanga.”

M1Gr3: “So, these need to be put together in order to create a percentage that it is to going to apply by? So, what do we multiply population with? I suppose we can find out the total population of the country, find out the percentage of the population in each or the ratio of each, each province has, multiply that by the GDP and then find the square root.”

The respective calculations of the log results and the mid-year population provided a mathematical solution. Beside solving and formulating the mathematical work, the students tried to make sense of the results. Therefore, the students proceeded through multiple cycles of working mathematically, constructing and revising their model.

4.3.6 Presentation of different constructed models

In discussing the contents of an inter-provincial soccer league table, the students deliberated on ways to improve the current ranking system. The students were convinced that some process had to be incorporated in their model to include the socio-economic indicators. In their quest to alter the model, Group 3 presented an alternative ranking system using the socio-economic factors inclusive of the provincial population and GDP. During the report-back, the reporter (M1Gr3) continued as follows:

M1Gr3: “We tried to economise for the sake of allowing for the mistakes if they were there. This part about the teaching strategy but, what we came up with ultimately is sort of a dual point system. So, we used the current log points and we put it through an equation so, our equation was their log points and that was over what we called the PGDPI. So, we used the populace, multiplied by the GDP – or the ratio of the populace, times GDP and then multiplied that by a hundred to get a new point’s ... ja, sort of a weighted point system. And so, how that works is, once we got that – so for Gauteng, they had their thirty-three log points and then got added another one point six five points on the weighted system which gave them – we added those two points together and gave you a total points of 34.65 log points – or total points, and then ranked them according to those total points.”

In the excerpt below, Group 3 developed an alternative ranking model using a ‘rate’ factor and then multiplied the ‘old points’ by it. There is thus no focus on the ‘dimensions’.

An example of the Group 3 Alternative System is given in Figure 4.3.6, below.

Mathematical Modelling

SAFA New Ranking System:
Proposed formula: $\left[\frac{\text{Ratio of population}}{\text{Ratio of GDP}} \right]$
 $\frac{\text{Total Points}}{\text{GDP} \times 100} = \text{New number of points}$ (GDP) ↑

PROVINCES	LOG POINTS	TOTAL POINTS	RANK
Gau = $\frac{33}{20.06} = 1.65$	33	34.65	2
MP = $\frac{32}{9.34} = 3.43$	32	35.43	1
WC = $\frac{30}{12.6} = 2.38$	30	32.38	3
KZN = $\frac{28}{13.61} = 2.06$	28	30.06	5
FS = $\frac{27}{7.61} = 3.55$	27	30.55	4
NW = $\frac{26}{8.68} = 3.00$	26	29.00	6
LIM = $\frac{24}{7.19} = 2.61$	24	26.61	7
NC = $\frac{22}{4.71} = 4.48$	22	26.48	8
EC = $\frac{21}{9.39} = 2.24$	21	23.24	9

Figure 4.3.6: Participants Alternative Soccer Ranking System

Following the discussion of the contents of the table, Group 2 decided to modify the soccer league table by including the socio-economic factors such as the “life expectancy”, “GDP” and “population”. The presenting group explained their model as follows:

F3Gr2: “Okay so, what we did – we took the life expectancy and the Gross Domestic Profit of South Africa and we multiplied those two together and then we divided by the population of each province. Then we multiplied that by the total score. So, we also kept the points the same as in the SAFA table. Then, we worked it out for each province. Eventually what we realise is then, obviously we are going to come to a constant for the life expectancy times the Gross Domestic Profit divided by the population of the province. So then, we used that (life expectancy times GDP divide by the population of the province) and we substituted everything into the formula and, this is how it was ranked originally from the soccer league table and then, when we did our calculations and it was a lot different. So, Gauteng was first in the SAFA table and Gauteng was last in our table and then, North West was sixth in the SAFA table and then they were fourth in our adjusted table. And, we called ours the socio-economic index.”

After experimenting with various socio-economic indicators, Group 1 found that using the “GDP” and “population” variables would resolve their problem. The group then looked very carefully at the data of each of the nine provinces again and decided to divide the GDP by the population and multiplied it by the total score. Group 1 provided the following explanation for their alternative model:

M3Gr1: “So, looking at those rankings and we were requested to just adjust what the score is. We took the table and we adjusted them. So, we took the totals that they have, according to the way it was set up. They said that they got like three points for a win, one point for a drawn match and we add the loss and then we divide by two. Then we basically made a formula that adjusted the

total score which we took the GDP of each province and divided it by the population of the province because, we went with the assumption that, if your – if they determining a specific GDP for a province then you need to compare it to itself in terms of population. Then we did that (divided the GDP by population size), multiplied by the total score and then we got our adjusted total. And now, even though they have these totals, they do represent the amount of games were won and drawn and lost, according to the old system, but they're given a new ranking that's adjusted according to their GDP and their population size.”

This redesign of the model gave rise to a new model for ranking different provinces' performances in the soccer league. Three alternative models were developed and socio-economic factors such as “population”, “life expectancy” and “GDP” was mentioned in various forms in their respective groups. All the groups had the same idea of allocating weights to the log points of the different provinces.

4.4 Conclusion

The data analysis of the qualitative data collected was presented in this chapter. The data analysis demonstrated the different ways in which pre-service mathematics teachers attempted to construct alternative models. The data analysis of the three tasks rendered eleven themes.

In the data analysis of the JSE task, an account was presented of the results that emerged from the group discussions held with pre-service mathematics teachers based on a newspaper article dealing with two different models for the same social phenomenon. Through the method of thematic content analysis, themes were illuminated ranging from economic empowerment; the authority of research; trustworthiness of information and shares assignment criteria. The data collected from the students showed a bias towards the Alternative Prosperity model (AP), which has a greater focus on the involvement of more black people in the listed companies. The National Empowerment Fund (NEF) on the contrary aims to promote the distribution of shares that are only open to black people. In this task, the students had the opportunity to discuss how different criteria generate different mathematical results. Thus, the students discussed how different interests produce different mathematical models. Furthermore, it was an opportunity to engage with the seemingly non-neutral nature of mathematical descriptions of real-world situations.

The data analysis of the Summer Olympic Ranking presented the results that emerged when pre-service mathematics teachers engaged in conversations about the construction of an alternate ranking model. The analysis rendered themes ranging from establishing of the

achievement of fairness; proposals for an alternative model to understanding the cyclic process of modelling. The student's creations revealed informal knowledge of variation and the ranking of scores. In this task, the students were required to produce a mathematical model for issues that they found meaningful and worthy to invest their time in. Therefore, they proceeded through the mathematical modelling cycle of developing and evaluating their models. This process of proceeding through the mathematical modelling cycle encouraged much discourse between the students in their respective groups.

Discussions around the mathematical modelling cycle together with the construction of an alternate ranking model are set forth in the Provincial Soccer League section. The data analysis produced four themes namely, "Influence of economic power on outcomes," "Search for elements and manner to combine them for an alternative model," "*Deliberations in the modelling cycle*" and "Presentation of different constructed models." Throughout the data analysis, concepts such as "GDP," "Life Expectancy," "Population" and "Fiscus" emerged as recurring themes as well as their effect on the socio-economic status of a province.

The activities which the students were involved with include: mathematical ideas, interpretation of key features of tables, the making of generalisations, defining variables and interpretation of solutions in a realistic context.



CHAPTER 5

DISCUSSION, LIMITATIONS, SUGGESTIONS FOR FUTURE RESEARCH AND CONCLUSION

5.1 Introduction

The aim of this qualitative study was to explore how pre-service mathematics teachers construct alternative mathematical models. This chapter discusses the main findings and describes the conclusions of the research study. Furthermore, limitations of the study and suggestions for future research into the development of alternative mathematical models are reflected upon. Finally, this chapter concludes the research study.

5.2 Discussions

In this chapter, I will discuss the findings relative to the guiding research questions:

1. How do pre-service mathematics teachers approach mathematical modelling when faced with tasks designed from a socio-critical perspective?
2. How do pre-service mathematics teachers construct alternative models while engaged in mathematical modelling?

5.2.1 Research Question 1

How do pre-service mathematics teachers approach mathematical modelling when facing tasks designed from a socio-critical perspective?

In the research study undertaken by Blomhøj et al. (2003), task design is important in developing mathematical modelling capacity in students. However, whilst elevating the importance of task design, the results of this research study revealed the importance of discussions in which components of mathematical modelling are addressed by pre-service mathematics teachers. The mathematical modelling capacity was promoted through the interaction with the tasks with which students engaged. I allowed the pre-service teachers to consider answering the tasks using their own approaches, instead of guiding the students to make use of specific mathematical techniques to find a solution. Furthermore, the mathematization process was supported by drawing on the pre-service students' own

considerations. This procedure validated the pre-service teachers' ideas personally and mathematically. In addition, the pre-service students accomplished this by making sense of the real-world situation.

Investigating the development of the mathematical modelling capacity of the pre-service mathematics teachers, this research study discovered six elements referenced by the pre-service teachers while they were doing the mathematical modelling tasks as described by Blomhøj & Jensen (2003). These elements included (1) task formulation; (2) systematization; (3) mathematization; (4) mathematical analysis; (5) interpretation and evaluation of results; (6) evaluation of the validity of the model. Through these elements, the pre-service teachers became conversant with the mathematical modelling process. Additionally, the pre-service students accentuated the different phases of the modelling process while completing the tasks. The different elements of the modelling process were targeted through group discussions.

Niss, 1989; Blomhøj, 1993; Gregersen & Jensen, 1998, later supported by Blomhøj & Jensen (2003), describe the creation of a mathematical model comprised of six sub-processes (see chapter 2.3). All three tasks set in this research project require the pre-service mathematics teachers to work with all these mathematical modelling sub-processes. The first task caused uncertainty and Blomhøj & Jensen (2003) advanced this as the crux of the challenges that students encounter when facing this type of task. Despite this task being perplexing because of "too many roads to take" (Blomhøj & Jensen, 2003), it was also thought-provoking. Since the pre-service mathematics teachers were faced with real-world problems during the tasks, action-learning came into play. Schoenfeld (1987) proposed a theory that learning is a facet of cognitive science. According to this proposition, mathematising and analysing mathematical models are cognitively demanding for students.

According to Keiran & Dreyfus (1998), the global meta-cognitive skills in the learning of mathematics are modelling, reasoning, critical thinking and problem solving. These meta-cognitive skills are also promoted in the South African school curriculum. Such skills support the learning of mathematics and are fundamental in mathematical thinking. The emphasis on real-world contexts targets these meta-level skills as the pre-service mathematics teachers are tasked with tracing socio-economic factors important to analysing the modelling tasks. Focusing on the unpacking of socio-economic factors influenced the pre-service teachers to consider factors central to that system. Although Haines & Crouch (2013) asserted that novice modellers find it difficult to remove irrelevant contextual factors, pre-service teachers should

be encouraged to discover and contemplate the significance of the different factors in the resulting solution.

5.2.2 Research Question 2

How pre-service mathematics teachers construct alternative models while engaged in mathematical modelling activities.

For many years, problem-solving has been an integral part of the South African school mathematics curriculum and mathematical modelling only become more prominent during the latter part of 2011. Consequently, teachers have been required to participate in the teaching and learning of mathematical modelling. According to Schoenfeld (2014, p.407) five elements connect the mathematics classroom to a modelling context, viz. (1) “mathematics,” (2) “agency, authority and identity,” (3) “cognitive demand,” (4) “uses of assessment” and (5) “access to mathematical content.” These elements are also meant to prepare teachers for a composite world that will enable them to act decisively in a real-world context.

The results of this research study revealed that the pre-service mathematics teachers’ alternative mathematical model constructions started with an unequivocal problem setting. Subsequently, the pre-service mathematics teachers developed alternative mathematical models that encompassed the relevant real-world situations. Through teamwork, students were able to indicate relationships, limitations and variables which allowed them to revise and form alternative mathematical models. Discussions occurred freely within the respective groups. Pre-service mathematics teachers were instructed to keep a written record of all questions asked within the groups as well as questions asked during the plenary session. By reporting back during the plenary session as well as providing an opportunity to ask and answer questions, the pre-service mathematics teachers expanded and refined their understanding. They discovered alternative ways to communicate their ideas as to how to construct alternative mathematical models. Hesse et al. (2015) state that group work encourages students to share responsibility, value each group member, work effectively with other students and exercise flexibility. It is apparent that the results of this research study revealed that each group of the pre-service mathematics teachers looked at their alternative models from a distinct viewpoint.

The results of this research study further revealed that the pre-service mathematics teachers tried to make sense of the meaning of the real-world problem through the process of comprehension; in other words the ability to understand something. In addition, the pre-service

mathematics teachers put forward conjecture after conjecture, and this clearly suggests they are able to construct alternative mathematical models.

5.3 Limitations of the study

Simon & Goes (2013) suggested that limitations should refer to those matters which are beyond the researcher's control and simultaneously limit the breadth of the study. In addition, Wiersma (2000, p.211) posited that limitations in qualitative research refer to the size of the sample, the data collection method and validity and reliability of the research study. The current study confirmed a few limitations considering the afore-mentioned aspects. The sample size was relatively small since it included only pre-service mathematics teachers from a specific university as stated in chapter three. The researcher did not consider investigating all universities in South Africa who cater for pre-service teachers that study mathematics as a core subject.

Guy & Airasian (1996) suggest that in qualitative studies, generalisations are sometimes non-existent or minimal since participant selection is sometimes small and overly-focused. Considering the small sample size, the results of this research study are not applicable to a larger community. The results of these findings are restricted to the current study. At the same time, the results of this research study provided extensive insights into pre-service mathematics teachers' development of alternative mathematical models and how such mathematical models are linked to their practice.

The three task-based activities administered to the pre-service mathematics teachers were presented in the form of a description. Pre-service mathematics teachers who are English Second Language speakers may have experienced difficulties comprehending the questions. This might have posed a challenge to these students in terms of grasping adequately the tasks which were presented.

The analytical process of the data analysis consumed a substantial amount of energy and time, in particular the development of a coding system. It may be useful to have a set of elements to examine prior to doing observations. This may include general elements of mathematical modelling, namely, elements that require thinking about the real world.

5.4 Suggestions for future research

The research findings of this study and other research studies done in South Africa confirm the need for the inclusion of mathematical modelling in the development of pre-service mathematics teacher education. Over the last few years, appropriate research-based mathematical modelling tasks for educational use have been produced. However, not many research studies within pre-service teacher education target extra-mathematical or interdisciplinary knowledge requirements purposefully for the effective teaching of mathematical modelling. Tan & Ang (2013) found that pre-service teachers distinguished mathematical modelling from the real-world (car stopping distances), activated their real-world knowledge and endeavoured to include such considerations in their mathematical modelling within the real-world context (Widjaja, 2013). This researcher suggests that future studies be conducted with the primary focus on extra-mathematical or interdisciplinary knowledge for the effective teaching of mathematical modelling to pre-service mathematics teachers.

Barbosa (2003) reflected on the role of mathematics in society, drawing on research studies about the socio-cultural scope of mathematics (Atweh et al, 2001; D'Ambrósio, 1999). Similar arguments are supported by many researchers. (Borba & Skovsmose, 1997; Keitel, 1993; Skovsmose, 1994), for example, focus on the critical nature of mathematical models in society.

These researchers identified tools that the mathematical modelling paradigm possesses which are usually obscured from the public. Therefore, it is imperative that students are given an opportunity to deliberate on the role of mathematical models as a means of decision-making in society. It is my recommendation that teacher preparation programmes give prominence to mathematical modelling “as content” as through this platform, pre-service mathematics teachers will be exposed to social issues.

This researcher incorporated mathematical ideas which the pre-service mathematics teachers were accustomed to in order to encourage the pre-service students to think about real-world problems. This approach is recommended by Lesh et al. (2000) who speak of co-ordinating mathematical modelling tasks with concepts that pre-service teachers are familiar with. Notwithstanding the above, Dym (2004) posited that one aspect of mathematical modelling is that tasks may require the advancement of new mathematics. It is recommended that pre-service mathematics teachers be provided with a better insight and understanding of how to

support the development of mathematical modelling. Of significance would be the inclusion of a formal prescribed course on the development of alternative mathematical models in the mathematics education curriculum for pre-service teachers.

5.5 Concluding remarks

This research study was concerned with how pre-service mathematics teachers construct alternative mathematical models and to further understand how this reflects on their experiences of mathematical modelling. Bauersfeld (1993), later supported by Stillman, Kaiser, Blum & Brown, (2013, p.9) acknowledges that mathematical modelling has been integrated into the mathematics school curriculum of various countries and that mathematics learners and teachers are expected to employ a “culture of mathematising as a practice.” Moreover, the South African Curriculum and Assessment Policy Statement (CAPS, 2011) for mathematics in the Further Education and Training (FET) phase accentuates mathematical modelling. In support of this, the second aim of the Curriculum and Assessment Policy Statement (CAPS, 2011, p. 8) states that mathematical modelling is the cornerstone of the mathematics school curricula and that real-world problems should be embedded in all disciplines of mathematics where possible. Of note is where appropriate contextual problems pertaining to socio-economic factors should be included. Julie (2002) sees this aim as a continuum of educational needs in which mathematical modelling allows students to experience the relevance of mathematics as a subject.

The research findings of this study revealed that the pre-service mathematics teachers use different techniques to translate real-world problems into mathematical problems. These techniques consisted of skills like constructing tables or using algebraic method. One can deduce that the participants were aware that alternative strategies were available or existed to solve a particular mathematical modelling problem. Therefore, it is my contention that the pre-service mathematics teachers have the capability to construct alternative mathematical models when faced with real-world problems. This study brought to the fore the need for pre-service mathematics teachers to acquire mathematical modelling knowledge and skills during the development of pre-service mathematics teacher education. Furthermore, I am of the opinion that pre-service mathematics teachers should be exposed to mathematical modelling during teacher education programmes. Both Ikeda (2013) and Ng (2013) are adamant that pre-service mathematics teachers are not ready to teach mathematical modelling. Their argument is based on the lack of competence demonstrated by pre-service mathematics teachers in the teaching

of mathematical modelling. They should be formally exposed to mathematical modelling tasks during pre-service teacher education programmes. The understanding of mathematical modelling is said to occur when a conducive climate towards mathematical modelling in the mathematics classroom is cultivated.

Mathematical modelling is essential for the 4th industrial revolution as the world is navigating towards a future where digitalisation will be prevalent. Since machines or computers will perform the basic mathematical calculations a greater emphasis will be necessitated on the other steps required to be followed in performing mathematics in the real world. Wolfram (2010) identified the following steps or constructs in performing mathematics in the real-world, viz:

- identify where mathematics is relevant;
- apply mathematical problem solving;
- translate and assess the outcome; and
- convert real-world problems into mathematical problems.

These steps or constructs above resonate with this researcher's experience of and exposure to mathematical modelling. The second step or construct as mentioned above, is executed through computers. The constructs (1) identification of the relevance of mathematics, (2) the translation and assessment of the outcome and (3) conversion of real-world problems into mathematical problems form the bedrock of mathematical modelling, applications and understanding.

With reference to previous literature, this research study supports findings which confirm the need for the inclusion of mathematical modelling in teacher preparation programs. It also reiterates previous suggestions that undergraduate teacher-education must provide opportunities for both learning and doing mathematical modelling whilst engaging with the realities of teaching mathematical modelling at school level. I believe that it is essential that the development of the capacity of pre-service mathematics teachers find expression in teacher-education programs. Furthermore, the use of mathematics applications and mathematical modelling forms a fundamental part of the teaching strategies to solve real-world problems whilst reflecting on the role of mathematics in society.

The limitations of this study include the small sample size of participants, the challenges posed by interpretation and the lack of generalisability of the research findings. Finally, suggestions for future research include researching the inclusion of mathematical modelling "as content"

in the pre-service teacher preparation program, a formal prescribed course on the development of alternative mathematical models in the pre-service mathematics curriculum and a further exploration of the nature of extra-mathematical or interdisciplinary knowledge for the effective teaching of mathematical modelling to pre-service mathematics teachers.



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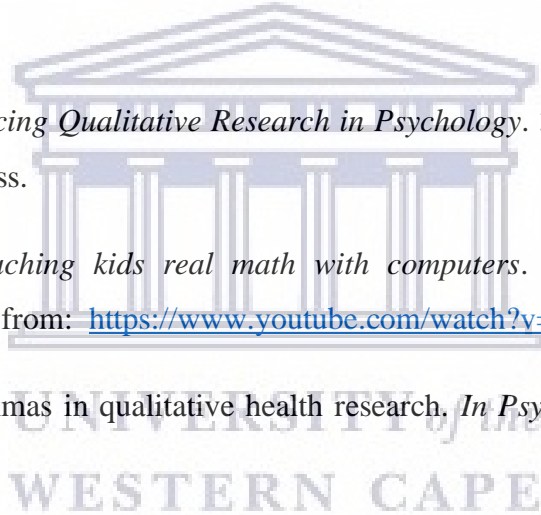
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APPENDICES

APPENDIX A

Ethics Statement

Before undertaking this study various sources have been consulted in order to ensure that this study meets acceptable ethical guidelines. The researcher also undertakes to abide by the Code of Research Ethics of the Human Sciences Research Council and of the American Psychologist Association.

The researcher undertakes to treat as confidential all information obtained from the University of the Western Cape and elsewhere and that all such information will be kept in a locked cabinet.

The ethical principles that this research will strive to adhere to include the following: Autonomy, beneficence, nonmaleficence, justice and confidentiality. Autonomy refers to the right of every individual to self-determination or the freedom of the individual to decide and/or act for him or herself. The principle of beneficence refers to the idea of doing good in the process of conducting the research; Nonmaleficence is the idea that research should not harm participants; Justice is the requirement that all research participants be treated with impartiality and conscientiousness and that there is an equitable allocation of resources, opportunities, benefits, and burdens for all participants (Adu-Gyamfi and Okech, 2010).

It is important that research participants are informed of the nature, duration and purpose of the research and also the methodology that will be followed. The consent of participants should be voluntary and they should have the right to withdraw their participation at any stage. Participants should also be aware that all information obtained in the course of the research will be treated as confidential and that the right to privacy of participants will be respected.

Operationalization of Ethical Principles

The right to full disclosure about the research

In order to give research participants a clear understanding of the study the researcher will explain the general purpose and process of the study as well as a description of what each participant will be expected to do and the conditions that they will be exposed to. All participants will be fully briefed about the research procedure and how findings of the research will be disseminated.

The right to privacy

Research participants have the right to refuse to be interviewed. They also have the right to refuse any mention of them in the study. Research participants will also be informed that they may terminate their participation in the study at any time and that any data obtained will be held confidential. They will also be informed that all data collected will be accessible to the study supervisor as well.

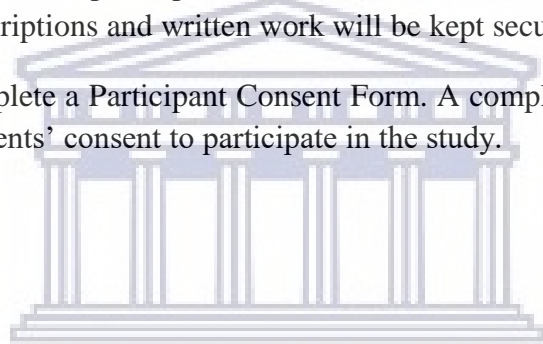
The right to anonymity

The participants have the right to remain anonymous. The researcher will ensure that all participants remain anonymous in the recording of data as well as dissemination of findings of the study. The researcher will make certain that each participant remain anonymous during the transcribing of interviews.

The right to confidentiality

The information gathered from participants will remain confidential. Furthermore, all data such as recordings, transcriptions and written work will be kept secure in a locked cabinet.

All participants will complete a Participant Consent Form. A completed Consent form will be viewed as the respondents' consent to participate in the study.



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APPENDIX B

Participant consent form

VERIFICATION OF ADULT INFORMED CONSENT FOR OWN PARTICIPATION

I,.....

(Please print full name and surname)

voluntarily give my consent to serve as a participant in the study entitled:

Pre-service mathematics teachers' engagement with the evaluation and construction of alternative mathematical models for the same phenomena

I have received a satisfactory explanation of the general purpose and process of this study, as well as a description of what I will be asked to do and the conditions that I will be exposed to.

It is my understanding that my participation in this study is voluntary and I will receive no remuneration for my participation.

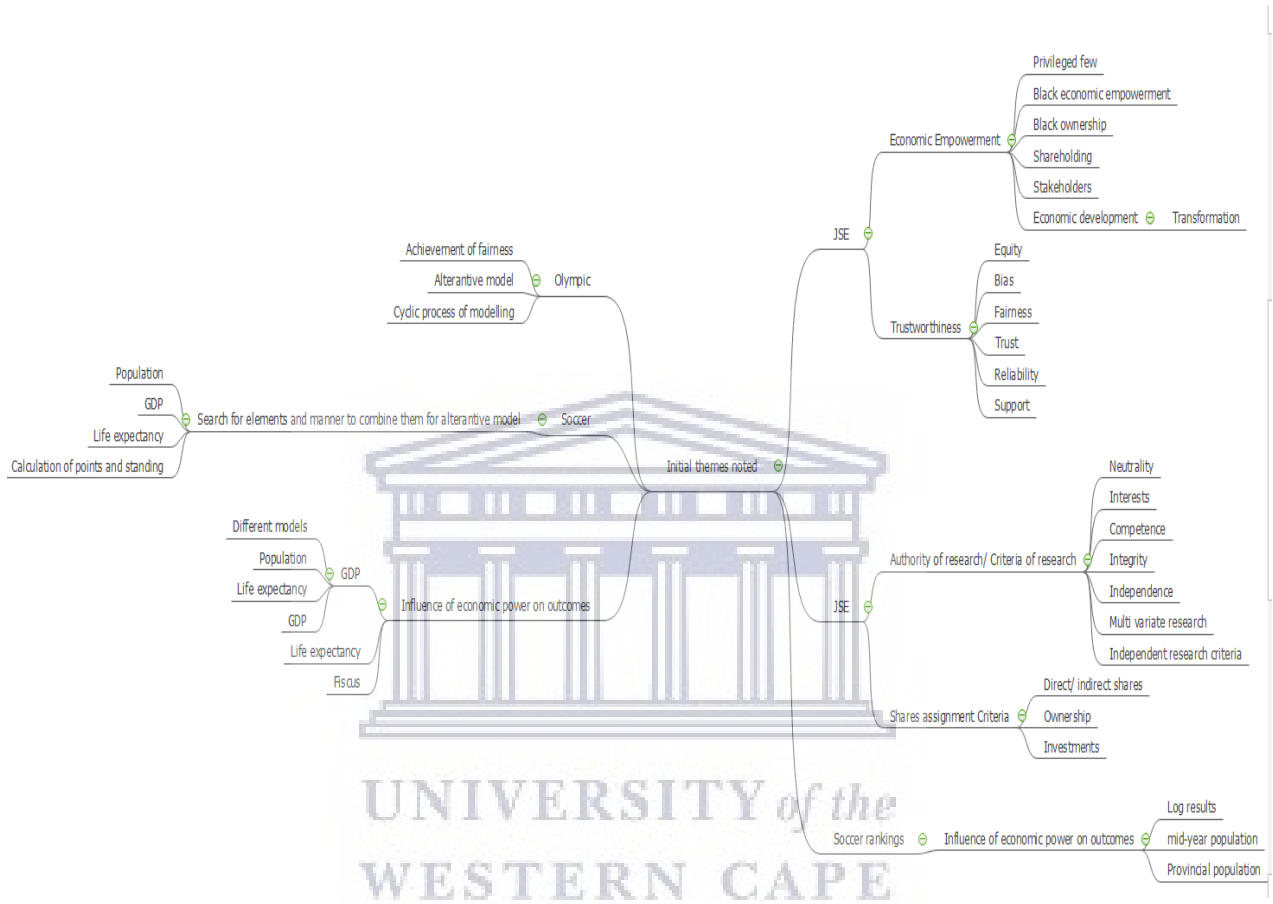
It is further my understanding that I may terminate my participation in this study at any time and that any data obtained will be held confidential. I am aware that the researcher has to report to his supervisor and that all data collected will be accessible to the supervisor as well.

Signature of participant.....

Date.....

APPENDIX C

Mind map



Newspaper clipping about Johannesburg Stock Exchange (JSE)

12 | BusinessTimes

MAY 31 2015 | Sunday Times

OPINION

How many top 100 companies are black?

Scrap looms over proportion of shares in JSE-listed companies that black South Africans really own

IT'S pointless for the JSE to keep pussyfooting around with two sets of "research" — only one of which deserves the appellation — on the number of black South Africans invested in the local bourse.

There's the independent research headed by Trevor Chandler of Alternative Prosperity, which bears the hallmarks of reliable interrogation, and something else by the National Empowerment Fund, which doesn't. Both cannot be correct in their conclusions because the differences between them are vast.

Either black South Africans, according to Alternative Prosperity, own at least 25% of the JSE's top 100 listed companies; probably closer to 30% once analysis is completed on outstanding share registers, and perhaps more like 40% of available shares after foreign investors are excluded. Or, according to the NEF, they own 5%.

The debate defies an academic nit-pick through diverse methodologies equally robust. The stakes, in endorsing one side or the other, are high and immediate.

With the government flip-flopping on what it wants BEE to mean, it gets to the root of BEE's future shape, with profound impacts on corporate governance.

For mandated investments, specifically pension funds that have millions of members, the outcome can also determine whether their shareholdings are at risk of further dilution.

For the first time, according to Alternative Prosperity, the number of black South Africans holding shares on the JSE had overtaken the number of white. This was more because of their holdings in mandated investments, inclusive of pension funds in the

public sector, than through BEE structures.

Shareholders were determined by economic interest, that is, the right to receive dividends, irrespective of how.

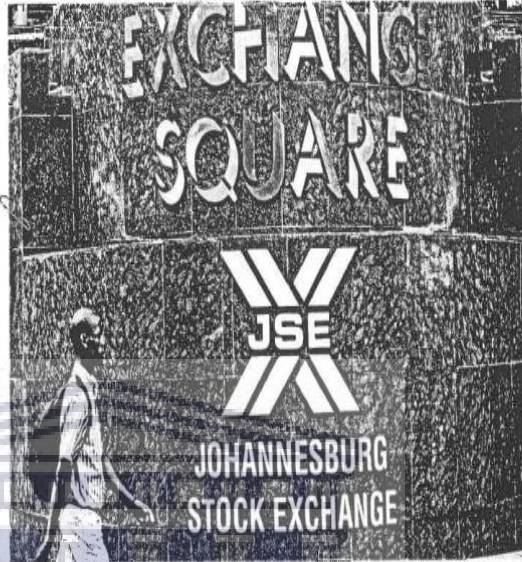
The Alternative Prosperity research had been commissioned by the JSE. It set out to measure, conclusively and credibly, the extent of transformation in shareholdings. In proudly announcing the findings, JSE CEO Nicky Newton King could scarcely have anticipated the government's response. Within days, President Jacob Zuma contradicted them by producing and endorsing the NEF conclusions.

The guardians of political correctness must not be fooled. A person is or isn't a shareholder.

The determinants of fact, not interpretation, are whether that person is entitled directly or indirectly to vote at shareholder meetings of the investee company and to receive dividends from it. Irrelevant is the vehicle through which shares are held.

The only differences between direct and indirect shareholders are procedural.

So either the economic interest of black people through mandated investments should be included (as per Alternative Prosperity), or they shouldn't (as per the NEF). Only one of them can be right.



DO THE MATH: For the first time, according to Alternative Prosperity's research, the number of black South Africans holding shares on the JSE had overtaken the number of white shareholders. Picture: REUTERS

Read the attached article and discuss in your groups:

Which of the two methods for determining the "number of Black South Africans holding shares on the JSE" would your group support?

Choose a spokesperson to present, with reasons, your choice.

Allen Greenble

Description	CALCULATING BEE ON THE JSE				HOW TO RECONCILE THE DIFFERENCE
	AP study finding based on JSE*	NEF study finding, not to be based on JSE*	AP finding, based on local operators	NEF finding, not to be based on local operators	
Conclusions reached on direct BEE	10%	6%	17%	10%	NEF study excluded: • BEE desks of subsidiaries of listed firms • Similar blocks of BEE shareholdings on local registers
Conclusions reached on indirect BEE**	13%	not applicable	22%	not applicable	NEF did not study indirect ownership

*This figure is based on the shareholder weighted index (SWI). **BEE legislation specifically allows for either the inclusion of mandated investments in BEE calculations or its exclusion from both the numerator and the denominator of the calculation.

Source: NEP-QA/WATW

The Alternative Prosperity approach is consistent with realities of modern-day share ownership, emphasised in King 3, which urges the active exercise of voting rights. It is also consistent with the BEE codes and the retirement-fund activism policies of the ANC in Gauteng.

By contrast, the NEF is saying in effect, that the shares must be held directly by black individuals or a vehicle belonging to those individuals. Otherwise they aren't recognised. Such an approach ignores the way in which most shares are

held and floods even Companies Act principles.

The contradictions between Alternative Prosperity and the NEF extend beyond mandated investments.

For a start, there's no way that the NEF can be considered independent. It's a creature of government, ultimately responsible to Zuma. And whatever the other areas of NEP distinction, research of this nature is not among them.

It smacks of amateurism. Apparently using as its base document the publication *Who Owns Whom*, which records only

larger shareholders with influence in listed companies, the NEF hasn't attempted to incorporate the legislated BEE criteria.

That it hasn't taken into account the global share registers of major JSE-listed corporates, such as SABMiller and Richemont, is another obvious omission.

Moreover, it has selectively interpreted different forms of BEE. At the same time, it has ignored the JSE-listed companies most highly valued by market capitalisation that operate variously around the world and

are additionally listed on other exchanges. Overall, the NEF highlights the privileged few rather than all black South Africans who are intended beneficiaries of transformation policies.

Alternative Prosperity, on the other hand, is known to have used a variety of information sources, including share registers of JSE-listed companies, BEE certificates of these companies or their listed South African subsidiaries, annual reports and financial statements, and data directly obtained from mandated investors. The different outcomes can be illustrated within a matrix related to the JSE's shareholder-weighted index.

There might well be imperfections in the Alternative Prosperity research. Given the firm's reputation, however, they are unlikely to be as blatant or serious. The best way to find out will be for Alternative Prosperity and the NEF, as proxies for the JSE and Zuma, to engage face-to-face in open debate.

Let's see whether they're up to it. If the one is and the other isn't, it will be case proven.

• Allen Greenble is editorial director of *Today's Trustee* (www.trustee.co.za), a quarterly magazine mainly for trustees of retirement funds.

APPENDIX E


Summer Olympic Ranking

Ranking of countries participating in the Summer Olympics (Data: Rankings of the 2016 Olympics)

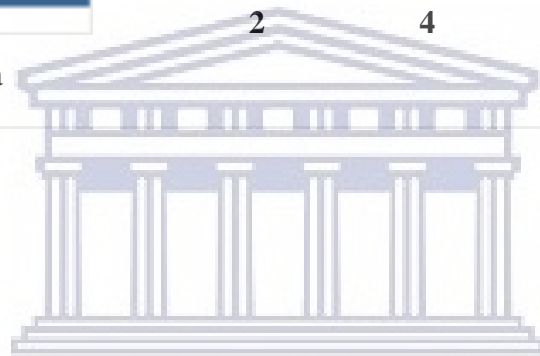
Currently the media rank countries participating in the Summer Olympics according to the number of gold medals won. When there are ties the number of silver medals come into contention and thereafter the number of bronze medals. (The International Olympic Committee—IOC—does not endorse the ranking system.)

Design an alternative ranking system for the Summer Olympic Games and rank the countries below according to your system.

Countries ranked 24 to 31 for 2016 Rio Olympics

Ranking Position	Country	Gold medals	Silver medals	Bronze medals	Total Medals
24	 Switzerland	3	2	2	7
25	 Iran	3	1	4	8
26	 Greece	3	1	2	6
27	 Argentina	3	1	0	4
28	 Denmark	2	6	7	15

	Denmark				
29		2	6	3	11
	Sweden				
30		2	6	2	10
	South Africa				
31		2	5	4	11
	Ukraine				
32		2	4	2	8
	Serbia				



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APPENDIX F

Soccer League Ranking and 2018 Provincial population estimates for South Africa

The South African Football Association (SAFA) has introduced a provincial soccer league. They want the final rankings of the teams to be based not only on the normal way the final league table is drawn up. [In the normal league table rankings, a team gets 3 points for a win; 1 point for a drawn match and no points for a loss. The ranking is determined by the sum of the points obtained.]

SAFA is interested in the final ranking taking into account the socio-economic development of the province. For the “new” ranking system, the current scores should be adjusted by using socio-economic indicators.

Design a new ranking system to satisfy the wishes of SAFA.

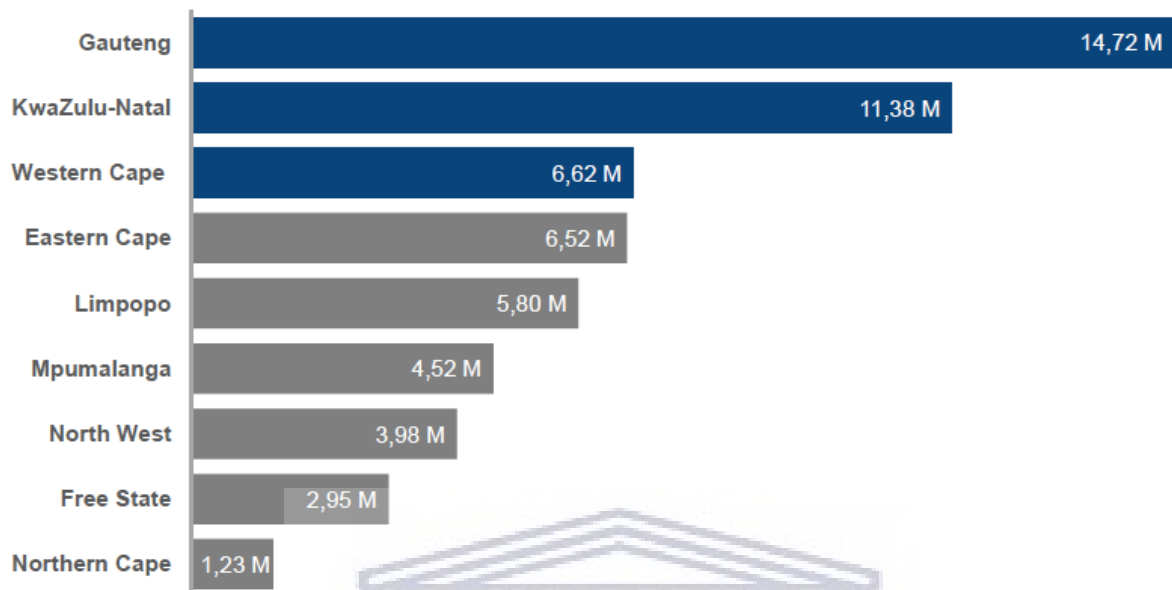
Comment on the strengths and weaknesses of your system.

Rankings according to the “normal” system

Province	Played	Won	Lost	Drawn	Total
GAU	16	11	5	0	33
MP	16	9	2	5	32
WC	16	9	4	3	30
KZN	16	9	6	1	28
FS	16	6	7	0	27
NW	16	8	6	2	26
LIM	16	7	7	2	24
NC	16	7	8	1	22
EC	16	6	7	3	21

Information you might or not want to use

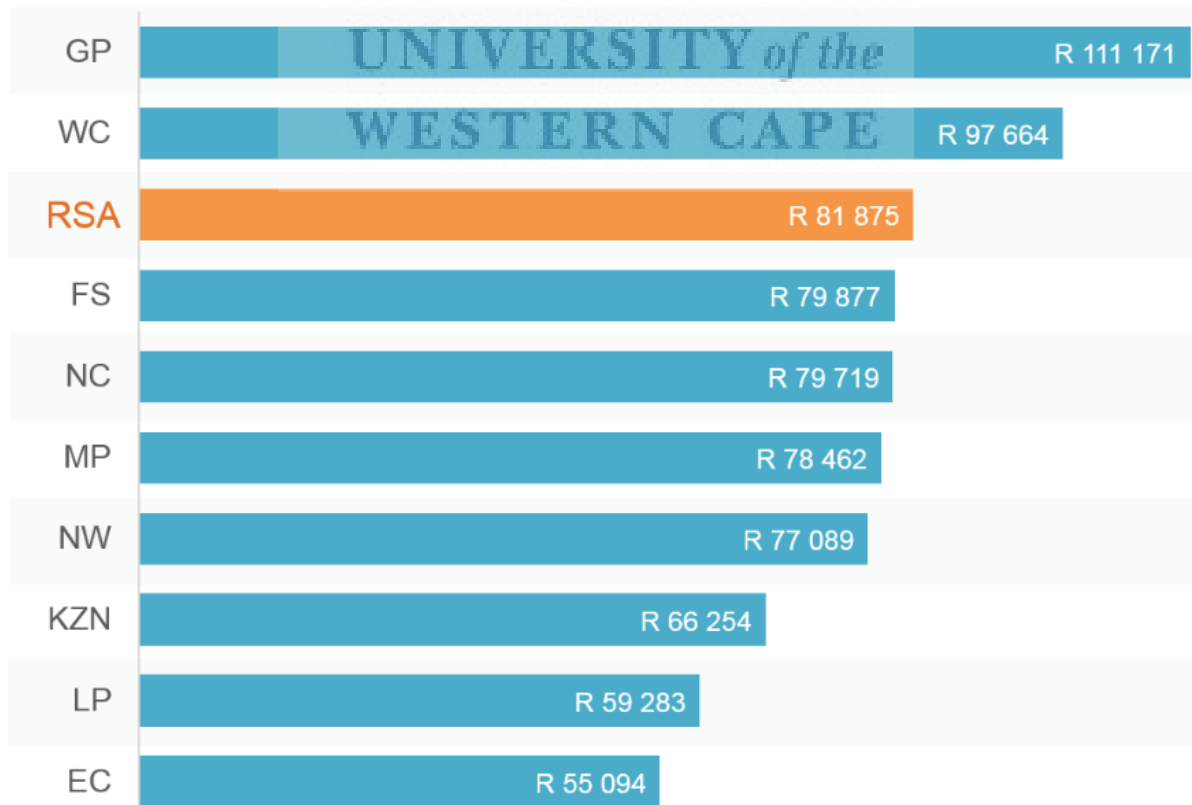
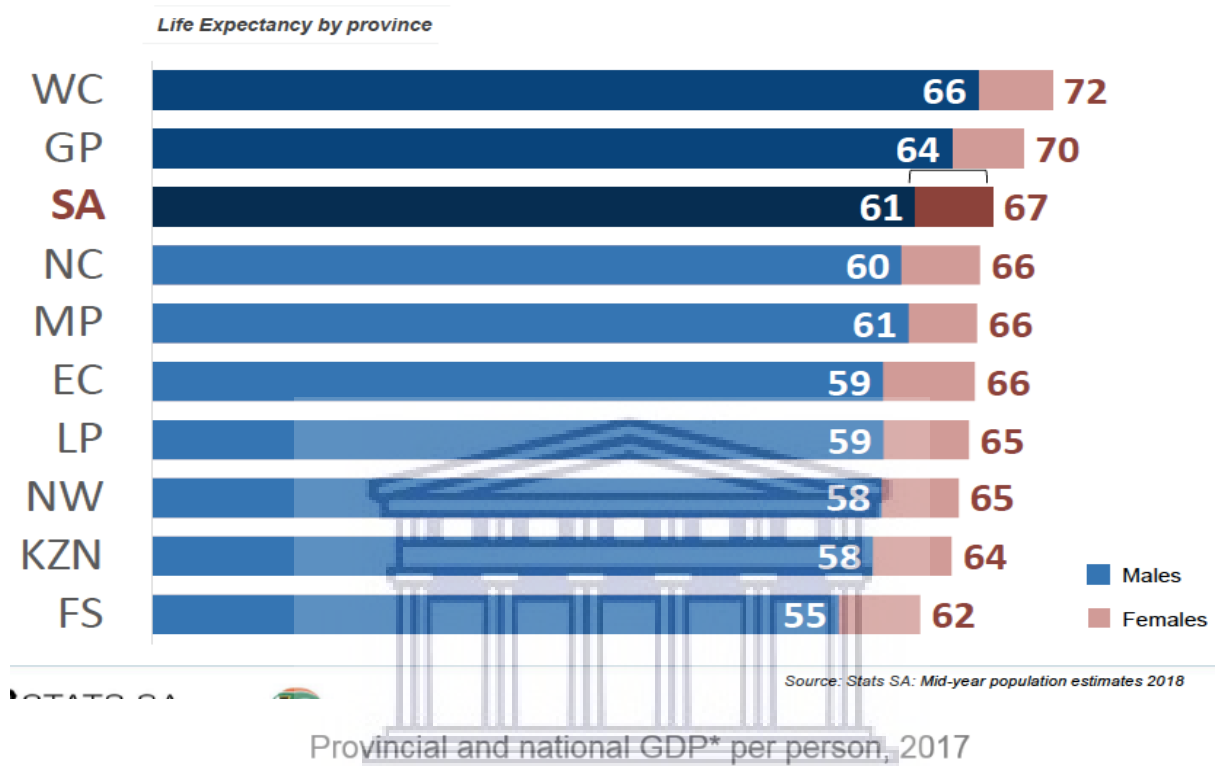
Mid-year population estimates for South Africa by province, 2018



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APPENDIX G

Provincial life expectancy and 2017 national and provincial gross domestic product per person



APPENDIX H

Transcript of Focus Group 1 – Johannesburg Stock Exchange Task

FEMALE 1: They say the company, what is it? Maybe it just was a system?

MALE 1: Ja, it was a system where the stocks are envisioned, you know because there is one in Joburg and there is one in like ...

FEMALE 2: So I didn't know that one is in Joburg.

MALE 1: Ja, but I am seeing this Alternative Prosperity, this company that Trent Chandler is doing his research for. He is being funded by the JSE.

FEMALE: You mean, commissioned by the JSE.

MALE 1: And the JSE is where these companies are being represented on. So but what is his name - the National Empowerment Fund, right, they're saying there that is only like 3% and now if you think about that.

FEMALE 1: Ja, the NEF.

MALE 1: If you think about it, the National Empowerment Fund is concerned with empowering you know, providing funding.

FEMALE 2: For blacks owned companies.

MALE 1: Yes, actually they say that black ownership on the JSE stood at only 3%, then there is most likely more money required, so the National Empowerment Fund would be prone to figures which state that there are low percentages. But the thing is the JSE has no reason to lie.

FEMALE 3: What do they mean when they say the alternative cross, what, what? When they are saying the number of black South Africans holding shares on the JSE, had overtaken the number of white.

FEMALE 1: I think

FEMALE 3: Where's that?

MALE 1: Just the last paragraph on the Prosperity ...

FEMALE 1: Maybe I think because I think I saw, I saw Jacob Zuma's name somewhere here.

FEMALE 3: Really?

FEMALE 1: So I'm just thinking the thing about Jacob Zuma and all that, like Jacob Zuma was more corruption but he was posting [inaudible] the black ones.

MALE 1: Yes and if you look at it, the weight, President Jacob Zuma contradicted them ...

FEMALE 2: But there is ANC as well.

MALE 1: Yes.

FEMALE 3: And ANC is dominated by black people.

MALE 1: And he is supporting the National Empowerment Fund with the results.

FEMALE 1: Exactly.

MALE 1: Okay I am seeing.

FEMALE 1: Okay so are you raising that both the Alternative Prosperity and National Empowerment Fund, when they were doing their research, where they look at the same facts or at the same records?

MALE 1: They were using different methods though.

MALE 2: Different methods to do the research but they're representing figures about the same thing.

FEMALE 3: The same problem.

MALE 2: Yes, but they want to – they're both saying they're correct but they're using different methods.

FEMALE 1: But I feel like the NEF, it's kind of like bias.

FEMALE 2: Yes, it's going to bias.

FEMALE 1: The Alternative Prosperity bears the hallmark of reliable interrogation.

FEMALE 2: I feel the NEF is bias because maybe it is not going to expose the bad side of all the companies.

FEMALE 3: And they didn't like ...

MALE 2: The NEF is hired by ...

FEMALE 3: Is it hired by ...

MALE 1: It's not by the JSE.

FEMALE 1: So, it is going to be like, it's not going to expose the bad side of the JSE.

FEMALE 2: Of course, you can't eat the hand that feeds you.

FEMALE 1: Exactly.

MALE 3: The JSE can't be – what do you call it, biased.

FEMALE 2: I'm just saying.

MALE 3: Has to be objective.

FEMALE 1: I'm just saying the researchers.

MALE 2: Okay so, which one do you think should we go with?

FEMALE 3: With the first one, the Prosperity one.

FEMALE 1: Prosperity because I feel like when I read here, they have like a relationship with the investors and they're sort of like active involvement because they even included the BEE thingy, certificates and stuff which is which is something the NEF didn't do.

MALE 2: So, they didn't even look at the BEE certificates.

FEMALE 1: No.

FEMALE 2: And the pension funds of the public sectors and BEE structures, what does it say?

FEMALE 3: It says including shares with a BEE list of companies, that paragraph has everything.

MALE 2: Share and share registers. So, what did the, what did National Empowerment Fund use?

FEMALE 3: It stated that the NEF has not attempted to incorporate the legislated BEE criteria, did you see that?

MALE 2: Mmm.

FEMALE 1: And then it was said that it cannot be considered independent because it's a creature of government, so a creature of the government, then they would report to our experience president.

MALE 2: He was responsible; he was responsible to Zuma, yes.

FEMALE 1: What is max of amateurism.

FEMALE 2: Yes, I was looking at this word.

FEMALE 1: Actually, loved it - where I read that.

FEMALE 2: Amateurism.

FEMALE 3: I feel like that guy, the way he writes, pussyfooting, flip flopping.

MALE 1: Can you like make a - what do you call it? That your notes please and we make kind of, we can make a table.

FEMALE 3: Or maybe a mind map

FEMALE 1: A mind map?

FEMALE 3: Like have we marked the NEF there and what each must do.

FEMALE 2: JSE.

MALE 2: Just write down the facts we've figured out for now.

MALE 1: So basically we should call it the Alternative Prosperity which is actually trying to check up the extent of transformation in shareholding okay and they presented their findings because they used all these sources right, the BEE and all this documentation but then a few days later Jacob Zuma actually released this new information about the National Empowerment Fund. Saying that, look the Alternative Prosperity Fund, their research is wrong, it was actually 3%. But now why would he then say that they are wrong considering the fact that they actually were the ones who used proper evidence even in their documentation?

FEMALE 2: To benefit.

MALE 1: You see, so it's usually like government like, okay so National Empowerment Fund, you can say results were presented like, you just say results or do you want to take it from the top.

FEMALE 3: Let's take it from the top.

MALE 1: Okay let's say National Empowerment Fund they're saying that 3% of companies on the JSE are owned by black. It is black. [Inaudible].

FEMALE 2: 3% of ...?

MALE 3: Companies.

FEMALE 1: 23?

MALE 1: No 3%, they said 3%.

FEMALE 2: Of the ...?

MALE 1: Of companies listed on JSE are black owned.

FEMALE 3: All right and then ...?

FEMALE 2: All right and then what else? Oh okay, we can even say this thingy is subjected to the government.

MALE 3: Ja, did you say, did you say, they are responsible to Zuma and then the reason we are saying that is because Zuma is the one who is the championing this information over the Alternative Prosperity one.

FEMALE 2: No way.

MALE 3: So, you say, responsible as well.

FEMALE 2: Hmm?

MALE 3: Responsible to Zuma. And then like, then I make a further arrow and then you just say that the reason for that is because after the Alternative Prosperity results were presented ...

MALE 1: So, do we know who we're supporting?

FEMALE 2: The Alternative or the NEF?

MALE 3: Alternative Prosperity. They're different to the NEF in that they are an independent research and they were commissioned by the JSE itself, the company that investing these themselves.

FEMALE 1: I'm just saying also are we going to support this one?

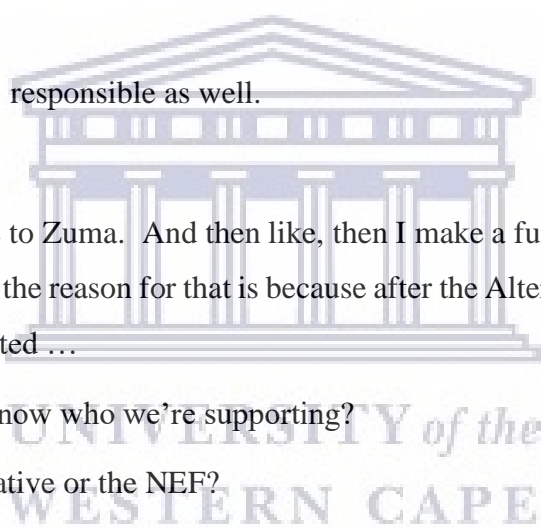
FEMALE 2: I think if like if we just layout everything on paper.

FEMALE 3: Ja, the differences.

FEMALE 2: Like decide which one, is actually like more.

MALE 2: The government is trying to prescribe how effective BEE is, right?

FEMALE 3: All right.



MALE 1: But they are supporting the research that doesn't even include the proper BEE grade area, whereas the JSE has to abide by the BEE rules right, so they are the place where these results are being like, almost like the stock points of the companies are being represented at the JSE. So they are now doing their research but if you're on the JSE there has to be a lot of paperwork that proves that this is how much points and this is what [inaudible] ...

MALE 3: In the response to the Alternative Prosperity.

FEMALE 2: After the AP release results you responded to that?

MALE 3: Yes, using these results, using NEF results. That's why we say that they are responsible to you.

MALE 2: Wait, I think.

FEMALE 2: I think this one and the overall NEF highlights, the privileged few rather than all blacks on those, you see that one?

MALE 3: It's almost like a little bit of confusion in terms of the NEF is almost like saying, no it is where [inaudible] is owned by like black owned now, finish but then, it kind of like looks at okay what is BEE actually mean, does it mean that there is more companies that's is going to be owned on the stock exchange by black privilege [inaudible] or does it mean that more black people are being granted opportunities in that framework, what is it? Do you get what I am saying because they never actually explicitly come out and state what it is but they present these results that have effects on the finding that is going to come? You know what I am saying?

FEMALE 1: Nobody got to say they got.

FEMALE 2: So basically, they must just make a.....

MALE 2: We know what our point of view is about this thing.

FEMALE 1: Let us just make – do a summary.

MALE 3: Sure are we supporting the Alternative Prosperity Results, right? The reason I am saying we are supporting it, is because they used a lot of information

FEMALE 1: And it's is extensive.

FEMALE 3: It's extensive. So, they're looking at okay. And then?

MALE 2: The NEF was looking at biased type of results.

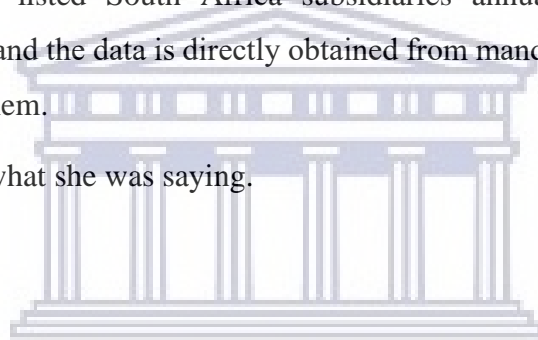
FEMALE 1: Oh, so they were bias just to fail her.

MALE 2: And those bias things are even though they weren't supported by evidence, Zuma supported their findings. Shady.

FEMALE 3: The one that we chose was the Alternative Prosperity method and the reason we chose that one was because is it an independent research and we also said that they are consistent with the BEE codes and approximately 40% of the JSE stock 100 listed companies are owned by black South Africans according to that approach and it also includes annual reports and financial statements which means that they have a variety of information sources which include the share registers of based E listed companies, BEE certificates of these companies and then under listed South Africa subsidiaries annual reports and financial statements and the data is directly obtained from mandated research, that's why we chose them.

FEMALE 1: So, this is what she was saying.

MALE 2: That is it.



[END OF TRANSCRIPTION]
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APPENDIX I

Transcript of Focus Group 2 – Johannesburg Stock Exchange Task

FEMALE 1: Okay I'm just making notes quickly just to see what I can discuss.

FEMALE 2: That is to say that ANC is corrupt.

FEMALE 3: Okay obviously, so because of the Alternative Prosperity

FEMALE 4: It is biased because by president JSE you know.

FEMALE 1: JSE can't be bias ...

FEMALE 4: Over the here they say unlike the privileged few

FEMALE 4: I know where they are going considered they created the creature of government ultimately responsible to Zuma.

FEMALE 2: So, it means ...

FEMALE 3: So, Zuma forms with the government and manipulate results to push it and ...

FEMALE 4: Then again ...

FEMALE 1: Got to make notes, I've got to make notes.

FEMALE 2: So, we have the indirect and direct?

FEMALE 1: Okay I'm just making notes quickly, just to see what I can discuss. I saw Jacob Zuma's notes and I'm working on them.

FEMALE 4: Sometimes they say ANC as well.

FEMALE 3: Okay so obviously, NEF so it goes with Alternative Prosperity.

FEMALE 4: It going to bias, it is bias because it's you know.

FEMALE 2: Because over here they say a privileged few.

FEMALE 1: I have something we can discuss. So we now this is independent research that was done now, so independent research according to me is based on like, you must be neutral, like it's your being because it's an independent thing, you come in and you do basic research. So, the person's name is Trevor Chandler, now he

created Alternative Prosperity..... this is his company or the main thing of the JSE.

FEMALE 2: That's his approach?

FEMALE 1: Approach ja something like that and they found out the JSE is the Johannesburg what, stock exchange now and with the JSE what do they really do? Does anybody really know?

FEMALE 3: It's like where ...

FEMALE 1: Exchange of the rand or but now I think the ...

FEMALE 2: It's is almost like the purpose of this is to see like because it has to do with like stakeholders and are going to see how many black people actually have a share.

FEMALE 3: A share in that.

FEMALE 4: Because back in the day it was only white people so now they want to see like well I think they are trying to just showcase here is to see how did the roles maybe change because they did mention.

FEMALE 2: Yes, for the first time ...

FEMALE 4: Black people and it's actually mentioned like here it's saying the number of black South Africans holding shares on the JSE has overtaken the number of white shareholders.

FEMALE 2: For the first time.

FEMALE 1: So now obviously the two approaches this studies that he done was different.

FEMALE 3: Ja, the direct and indirect.

FEMALE 6: So, we have to decide which one was the best, which one is the fairest, I think because now they saying it was AP here, the Alternative Prosperity.

FEMALE 1: But the thing is that who do we support?

FEMALE 2: Exactly that's how we're getting there. So I just want to see the options, so which of the two methods. So, the two methods were AP study and the NEF study.

FEMALE 1: Is that the black?

FEMALE 4: That they compared, right? So, with the NEF something that was major that I do count a bit, it says that they mentioned here in the article that just black people must be held directly with the black stakeholders. So, they didn't even incorporate the criteria of the BEE. Okay that is what they said there. Then with the AP approach, in that approach then they used a variety of information sources including the JSE listed companies and BEE certificates. So now that is what I found.

FEMALE 3: And here they said the findings, they found that the black people are holding more shares in the JSE because they use their pension money. Now they want to know like usually, I wouldn't – I don't know, I'm speaking now in general like the white people would use, they will do part of the JSE companies and they do it throughout the years but whereas the black people are like on pension and then they invest in the JSE. And that is why.

FEMALE 1: In the Alternative Prosperity, the AP, I think I heard them say the number of black South Africans holding shares on the JSE has overtaken the number of whites.

FEMALE 3: Whites yes.

FEMALE 4: So basically, there was a majority of blacks compared to the whites, so their approach, maybe they were, they were maybe not anti whatever, but they really wanted to more involve the black people.

FEMALE 2: The black people.

FEMALE 4: Because of they have seen as a pool.

FEMALE 2: I don't think they want to get involved, because here they say, the shares must be held directly by black individuals what do they mean by that?

FEMALE 1: That is for the – there was a section, was it the NEF?

FEMALE 3: Yes, by the contrast the NEF is saying in affect that the shares must be held directly by black individuals or vehicle belonging to those individuals otherwise they are not recognized.

FEMALE 1: But NEF.

FEMALE 6: Such an approach ignores the way in which no shares are held and floods even companies and principles.

FEMALE 1: They are speaking about Jacob Zuma.

FEMALE 6: I spoke about the AP approach.

FEMALE 2: So now what you were saying is that like I've mentioned before, they are not, they are not incorporating any of the like the criteria. Just doing their own thing, so it's like – we need to ask ourselves is that fair what they're doing?

FEMALE 3: Whereas the NEF is just strictly for black people. Only black people can own shares.

FEMALE 6: And the AP is for both.

FEMALE 3: And if you think like there is more, like there is more things because what I think what I read they said that they used a variety of information so for me it means, it feels like they try to accommodate both.

FEMALE 4: Both sides.

FEMALE 3: More racial.

FEMALE 5: Because we're a very diverse country.

FEMALE 4: So okay, so, so I think we mean the AP?

FEMALE 5: In AP yes.

FEMALE 2: AP okay but now we can write, we can write on one page. Like I think we can do the head, is Trevor Chandler of the JSE? So that we know.

FEMALE 1: What did you say about the indirect thingy.

FEMALE 4: This is the AP it is an indirect approach where I think the NEF is a more direct approach because on the black people and what they, what they both,

FEMALE 1: Because I'm thinking.

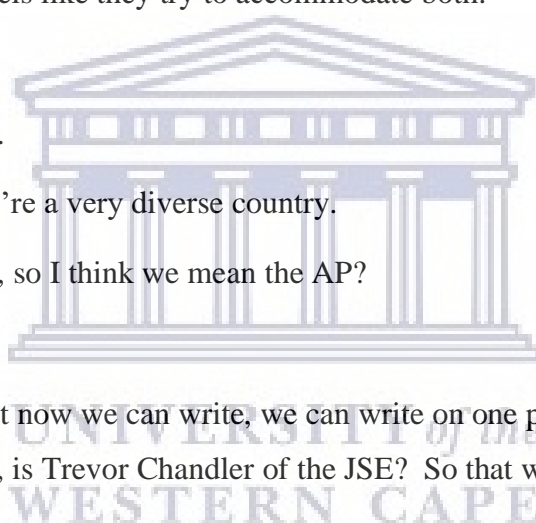
FEMALE 2: Conclusions which directly and conclusions which indirectly do apply indirect per say.

FEMALE 3: We can always, - we can just take it out.

FEMALE 6: I think it's just this opposite around.

FEMALE 3: Opposite of what she just said.

FEMALE 4: Okay so it is a direct approach?



FEMALE 1: So, AP is an indirect?

FEMALE 3: So, AP indirectly so it verifies of Trevor of the yes,

FEMALE 6: The independent.

FEMALE 3: The independent, so it will be the indirect.

FEMALE 1: Independent meaning?

FEMALE 4: Because in its conception. Because these people are like there was a misconception, so people can approach the same thing but, in their thoughts, they think about different things. See they lose conception. If we can teach that maybe the child because child is different, they going to be a misconception, even here I think this to me it is a misconception of this.

FEMALE 3: Thinking the one but he is the other.

FEMALE 2: Exactly.

FEMALE 4: Okay so what it is, so we know it's the Alternative and the other one is which is AP.

FEMALE 2: That's AP in brackets.

FEMALE 3: Some of them mentioned, the only difference, between direct and indirect shares is of procedural, so the methodologies, they use are just different. The one sticks to strictly black people who can invest and the outlook of other one is broader multicultural. I mean any person can invest.

FEMALE 1: Well it says here that the NEF states -the shares must be held directly by black individuals.

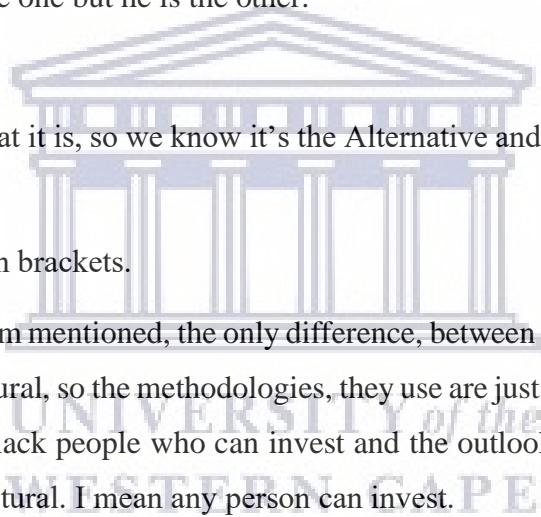
FEMALE 3: But then those who are investing through pension funds or whatever else they're indirectly owning shares.

FEMALE 2: Involved yes in the AP. So that is what?

FEMALE 3: But now if we are saying – here they are saying the number of black South Africans holding shares okay has overtaken oh and that makes sense.

FEMALE 4: So even though they are multicultural, the black people are dominating whereas in the past, I am assuming the white people dominated.

FEMALE 6: And the reason for this is because black people are using their pensions.



FEMALE 1: I wonder now, doesn't even make sense.

FEMALE 3: Because they are saying, like or we are saying that we are choosing the AP approach why? Because they make it more multicultural and it is broader. But how is it that the blacks are still more than the whites?

FEMALE 3: So technically the AP.

FEMALE 2: Here they're saying, the only guess 23% of the JSE's top 100 listed companies, almost closer to thirty whereas the NEF saying they only own 3%.

FEMALE 6: 3%.

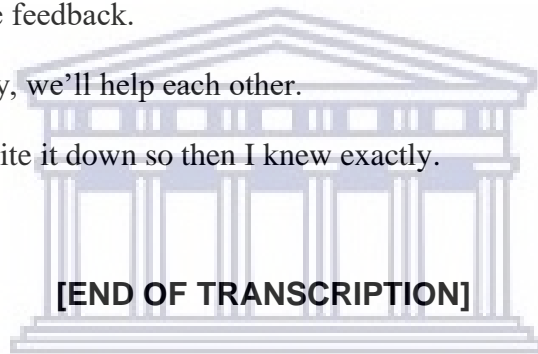
FEMALE 1: So I don't understand that why they are giving us that information?

FEMALE 3: I don't know how to do that to be honest. Only what they want.

FEMALE 4: Let's do the feedback.

FEMALE 3: Don't worry, we'll help each other.

FEMALE 4: Can you write it down so then I knew exactly.



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APPENDIX J

Transcript of Focus Group 3 – Johannesburg Stock Exchange Task

MALE 1: So, it sounds like, I mean the numbers they've got to, I suppose mathematically speaking are right. But it's the scope that they've used.

FEMALE 1: Exactly.

MALE 1: That's the issue. So, this NEF, has only looked at those that have physically bought shares.

FEMALE 2: Yes.

FEMALE 3: So, it must be direct.

MALE 2: So, yes, it's very much direct whereas the alternative is looking at – so if I buy unit trusts I don't own any share in particular on a whole post. But it's not counting the sort of black individual that owns ...

FEMALE 1: Yes. It doesn't include everyone, yes.

MALE 2: Then obviously like it mentions pension funds whatever else. I mean they make use of shares. So, they're not, you know black people, I mean all people I suppose in a way invest in that. So surely you want to take that into account.

FEMALE 3: Into account.

MALE 2: Because otherwise if that's, if you're going on 3% of black owners maybe I don't know, 30% of white owner – that leaves like 60 something percent that are then not you know captured. But they're shares so they must be there somewhere.

FEMALE 2: Yes.

FEMALE 3: I just maybe feel that we're not really, like we can't relate to this that's why we're not understanding. Because for me, I can't relate to this. I can't relate to like the stock exchange.

FEMALE 1: So, they're asking in the question for us to compare the NEF and the AP.

FEMALE 2: So, I want you to choose which method you would agree with.

FEMALE 1: I'd say the AP.

MALE 2: Yes.

MALE 1: I want to say AP as well. I just I feel like it takes a more holistic.

FEMALE 1: Because they even say it ...

FEMALE 3: Where?

FEMALE 1: And here it says the NEF highlights the privileged few rather than all black South Africans.

FEMALE 2: The NEF don't account for everyone.

FEMALE 1: Yes. They don't even follow the BEE criteria.

FEMALE 2: So, it wouldn't actually be statistically correct. It wouldn't be you know fair to take the NEF because they don't account for everybody.

FEMALE 1: And they say the AP's consistent with like the BEE codes and the king three

FEMALE 2: And they also want to like make BEE more like available, or [inaudible] prevalent in that company ...

FEMALE 3: Yes.

MALE 2: Even...

FEMALE 1: Shall we start writing?

FEMALE 2: Okay. So, I think maybe you can do that. Like a comparison.

FEMALE 1: And at the end you can just say why we agree with.

MALE 1: Paragraph as well. Like a hit list. All the different sources that alternative prosperities made or to make use of.

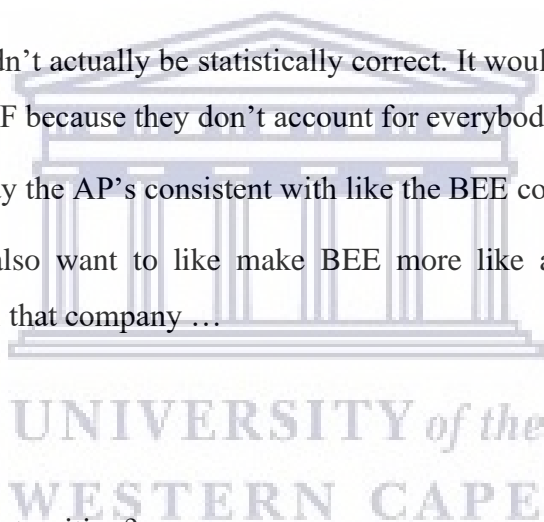
FEMALE 3: So, they ...

FEMALE 2: Let's start do a comparison between NEF and AP.

FEMALE 1: So yes, the AP sounds more positive, right?

MALE 3: With – or points so AP use multiple sources.

FEMALE 1: Yes.



FEMALE 2: AP has a list of companies with BEE certificates.

FEMALE 3: Say again?

FEMALE 2: JSE listed company - dash listed companies ...

FEMALE 1: BEE certificates.

FEMALE 2: And the NEF is more like bias.

FEMALE 1: They use annual reports.

FEMALE 2: More like bias for me because higher than JSE.

FEMALE 1: Financial statements.

FEMALE 3: So, NEF highlights the privileged few.

FEMALE 1: The NEF highlights only the privileged few.

FEMALE 2: Privileged few rather than all black - would you say all South Africans?

MALE 1: Well it says here that the NEF states - the shares must be held directly by black individuals.

FEMALE 1: But isn't that contradictory though?

FEMALE 3: Why?

FEMALE 2: So over here they say highlight the privileged few rather than or lack.

MALE 2: Yes. So, the privileged few who own direct shares.

MALE 3: But then those who are investing through pension funds or whatever else ...they're indirectly owning shares.

FEMALE 1: So, the AP is that it's consistent with reality...

FEMALE 2: Does the AP, and does have the AP have foreign investors like you were saying here?

FEMALE 2: Consistent with realities of modern-day share life or modern-day share ownership.

MALE 2: I read something else through the lines. It sounds like the NEF is pushing the government agenda. It says [inaudible] there is nowhere that the NEF can be considered independent, it's a creature of government, ultimately responsible to Zuma.

FEMALE 2: So, the NEF is bias.

FEMALE 1: So it's linked to Zuma.

FEMALE 2: Yes.

MALE 2: So, Zuma or the government can manipulate results to push its own agenda.

FEMALE 1: So what should I say?

FEMALE 2: The NEF's controlled by government.

MALE 3: Yes. Results are manipulated by government.

FEMALE 2: Well it says, there's no way the NEF can be considered independent. It's a creature of government.

FEMALE 1: Yes.

FEMALE 2: So, it's dependant on government.

FEMALE 1: And also this is a 2015 article. It's quite old.

MALE 2: What's your point?

FEMALE 1: Like it is four years old.

MALE 2: Issues are still there.

FEMALE 2: But not a lot of things change ...

FEMALE 1: It's recent if it's been five years.

FEMALE 2: ... within four years.

FEMALE 1: Yes. It takes like 10 years, 20 years.

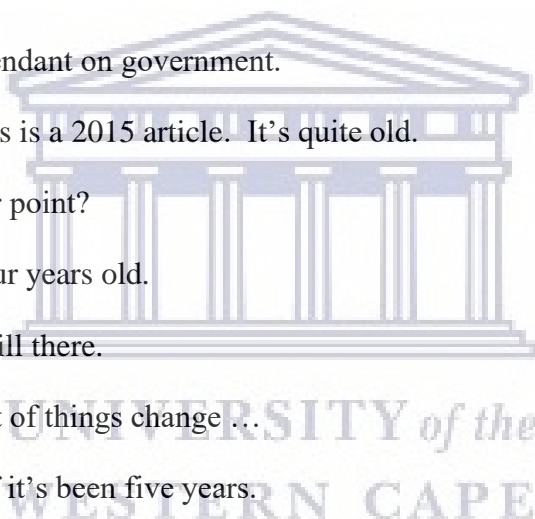
FEMALE 2: But still.

FEMALE 1: But now with regards to the numbers that they give us and the percentages in the table, what can we gather ...?

MALE 3: I don't understand that.

FEMALE 3: Yes. I'm trying to understand that.

MALE 3: I don't have a clue. AP study finding based on JSE conclusions reached on directly.



FEMALE 1: Based on local operations. So, they separated local operations and based on the JSE.

FEMALE 2: This is calculating the BEE.

FEMALE 1: Yes.

MALE 1: Okay. So, you add the two so there you get the 23%, AP study filing based on JSE is that 23% [inaudible] black people. 13% indirectly and 10% directly.

FEMALE 3: Why does it say not applicable there?

FEMALE 1: So we could say from that, that the NEF understates basically the ...

MALE 2: So, this is not applicable because the NEF doesn't take indirect.

FEMALE 1: They don't take indirect, yes, into account.

FEMALE 3: Hectic.

MALE 1: There's a block here so the NEF did not....

FEMALE 2: Not done.

MALE 2: So, the NEF do not study indirect ...

FEMALE 1: Yes.

FEMALE 2: So maybe we didn't even have to read that article.

FEMALE 3: I was thinking because ...

FEMALE 2: So, must we adhere to the table.

FEMALE 1: ... you went straight the numbers. No, but we needed to get a sense of ...

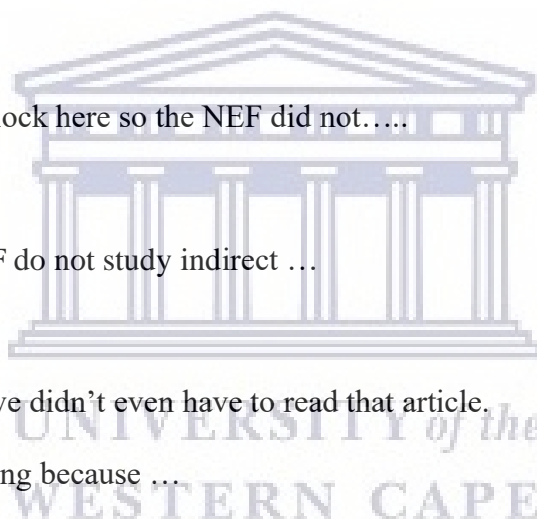
FEMALE 2: So what is the question again? Which of the two models we would support? So, we would support the AP.

FEMALE 3: Yes.

MALE 1: The AP just seems fair.... like it takes a bigger amount of people into consideration.

MALE 2: It's also mandated by the JSE. So they're ultimately trying to ...

FEMALE 3: Yes.



FEMALE 1: Because also, how easy and accessible is it for a black person or any person in general to directly hold shares?

FEMALE 3: Yes.

FEMALE 2: Like yes, we're all involved in some way so you can't say that we need it directly.

FEMALE 1: So, the AP just seems more realistic.

FEMALE 3: Exactly.

MALE 1: Yes. The only, the one negative with AP though is that if it's commissioned by JSE, JSE, not to say they manipulate but obviously, they're going to try and get the best looking results coming out of it.

FEMALE 3: Yes, exactly.

MALE 1: So also, and I mean it does state somewhere here, the end that it might ...

FEMALE 2: Might well be imperfections in the AP, yes.

MALE 1: Yes, it might be imperfections, but it just seems more realistic considering they take a more holistic kind of approach to it.

FEMALE 1: But it's also like, I'm sure it's deductible as well. So, I mean, if you look at like real life situations. You put something in place but then you can find faults. You can correct it for next time.

FEMALE 2: For the next time, yes.

FEMALE 1: So, I guess it's a good starting.

FEMALE 2: So, it's better to use that and work on it.

FEMALE 3: Yes.

MALE 2: But they also – they have more access. I mean if the NEF is just looking at one group, I suppose that's easy. But they have obviously all the shareholders and then the – sort of indirect shareholders because then they can find that information out. So, they have more information available to them, and yes, so they're probably going to want to bump it up to make it look like there's more BEE participation because that makes them look good. But I think it's a lot more – it's probably a lot more regulated than the NEF where government is saying

you need more shareholders so you just, you find the smallest percentage possible to kind of push your claim that you need to be more transformative or whatever the buzzwords are. Transformative, economical participation. We'll work with it.

FEMALE 1: Words.

MALE 3: That's all it is.

FEMALE 2: So clearly you understood what you were reading.

MALE 2: To a degree.

MALE 1: Shares are interesting.

FEMALE 2: For you?

MALE 2: Investment, you need to invest. It's an interesting ...

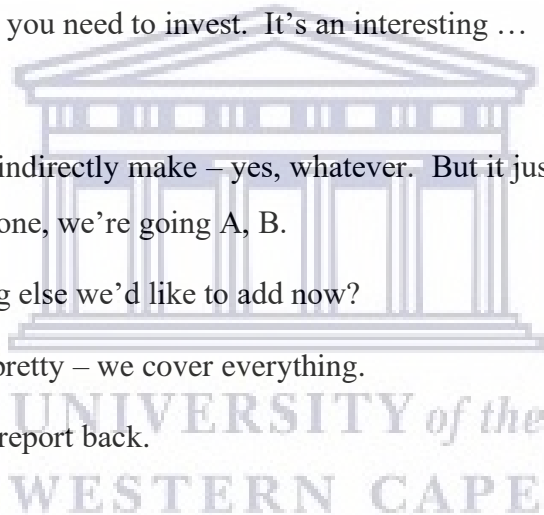
FEMALE 1: Indirectly.

MALE 1: Directly or indirectly make – yes, whatever. But it just, it's interesting. Okay.
So, we're done, we're going A, B.

FEMALE 2: So, anything else we'd like to add now?

FEMALE 1: I think it's pretty – we cover everything.

MALE 1: It's time to report back.



[END OF TRANSCRIPTION]

APPENDIX K

Transcript of Focus Group 1 – Soccer Ranking Task

FEMALE 1: Population really matters and this ...

MALE 2: Is it?

FEMALE 2: No.

MALE 1: But they say we must consider the socio-economic development.

FEMALE 1: Uh hum.

FEMALE 1: Does the population count, like, how many people are there?

MALE 1: I don't think so.

FEMALE 1: Huh uh.

FEMALE 2: Okay. I don't know then.

MALE 1: Those things do have a link. Hey? Okay, the amount of people in the population does affect the life expectancy because viruses are more easily spread amongst a lot of people. But, if you think about it, like that, then the amount of people you know are really affected by this one here already counts for that – the life expectancy. You know what I'm saying?

FEMALE 2: Ja.

MALE 1: The life expectancy includes like, the population factors and all of that.

FEMALE 2: Yes.

MALE 1: So and/or. When is this and/or? The income? The GDP is definitely important.

FEMALE 1: Yes. The GDP is definite. Otherwise the [indistinct] the GDP ... Another thing I learnt ...

FEMALE 2: But what can we already see the GDP and the life expectancy of this?

MALE 1: You can use both. You can, because ...

FEMALE 1: I want to ask – the bigger the life expectancy there, one of the ...

FEMALE 2: More players develop in their old age – maybe players retire late in sport. Maybe they play that – thirty-five can still play and be good. Maybe the number is forth. You can be a player that is forty.

MALE 1: Sure. Maybe the older players and one that you got to have younger players only.

FEMALE1: Ja.

MALE 2: Okay. So what they say here, hey, they mean development based on life expectancy and ...

FEMALE 1: If you stay in the Western Cape?

FEMALE 2: Ajax, Cape Town ...

FEMALE 1: All rules are allowed.

FEMALE 2: Dude. I can't believe we have a soccer star in our room.

MALE 1: So we all have different populations, right? They can be one part of the formula where we divide the population by a certain number, like divide by a hundred. You know what I'm saying?

FEMALE 2: One hundred.

MALE 1: Because you are going to give a different number for each different population and then we somehow use that number as the contributing ... Okay. This is what I mean.

FEMALE 1: What do you mean?

MALE 1: We have to like divide – for me to know – wait, wait, wait, wait, wait.

FEMALE 2: We need to design a system ...

MALE 2: Okay? A new ranking system.

FEMALE 2: Considering these points.

MALE 1: So – where were we? I'm thinking, I'm thinking, I'm thinking.

FEMALE 2: Let's complement ... we can compare.

FEMALE 1: What is this sixteen for?

FEMALE 2: Oh, games played. I think.

FEMALE 1: So, I was thinking né? Let's, for example – let's compare.

FEMALE 2: We can compare the GDP - the GDP of the province. How rich or poor people ... Is it? Is it about that? Is the GDP like that?

FEMALE 1: Looking into, ja.

FEMALE 2: So, do you think we can compare a soccer player in the.....

FEMALE 1: Western Cape.

MALE 3: So now, comparing a soccer player in the Western Cape ... Comparing maybe a Gauteng player and an Eastern Cape player ...

FEMALE 1: Or a Northern Cape player.

MALE 2: It said here, like you can still take into account the amount of games won and lost. Do you know what I'm saying? Do you think we must somehow multiply it by a factor that includes the Fiscus?

MALE 3: We must include the GDP and the life expectancy as well.

FEMALE 1: So, in this normal system they're ignoring the social what, what.

FEMALE 2: The socio-economic thing, yes.

MALE 3: Yes.

MALE 2: Basically.

FEMALE 1: Because it makes sense that Isi lost seven games. Haibo, Isi in Gauteng. That's totally different.

MALE 2: We can actually compare two things. I mean, doesn't the GDP one relate to the population one?

FEMALE 1: The GDP?

MALE 2: Yes.

FEMALE 2: I think it does.

MALE 2: Because check this out. So, the GDP for Gauteng province is 111 000 and Gauteng is the most populated city, so somehow that is to be taken into consideration when we look at the socio-economic factors. And then, Western Cape is third ...

FEMALE 1: So, are you saying, the more ...?

MALE 2: Western Cape is third based on population size, but it's second based on GDP.

FEMALE 2: Gauteng is happening. I mean like, everything is in Jo'burg.

MALE 1: Hey, I see we have a division factor for the GDP because, they're saying that RSA is standard GDP – is 81 000. So then, we can divide the GDP...

FEMALE 2: Oh, the RSA is like the total.

MALE 1: Yeah, we divide the GDP by that total ...

FEMALE 2: Times a hundred.

MALE 1: And then we are going to get a number. Ja, then we going to get a percentage. But um ...

FEMALE 1: Even here ...

MALE 2: So, how are we going to use this one?

FEMALE 2: It's there. You see?

MALE 1: Oh ja. So, we have figures for the SA. Oh.

FEMALE 1: So, the relationship between GDP and the country's population is that the more populated the country is, the higher the GDP.

FEMALE 2: Province.

FEMALE 1: I mean the province is, the more GDP.

FEMALE 2: Obviously. Because a lot of people need money there ...

MALE 1: [Indistinct] there's more population but it's GDP is like third large. You know what I'm saying?

FEMALE 2: Ja, and also Eastern Cape. GDP is very low and it's ...

FEMALE 1: The Eastern Cape has more people ...

MALE 2: Ja, there's more people, so we have to look at that as a contributing factor now, because that needs to say that the provinces have different numbers of population and those different numbers of population are being exposed to different economic understandings.

FEMALE 2: We don't have to use much, or not [indistinct] information. You don't have to use all of this ...

MALE 2: Because I don't really see how we are going to use this ...

FEMALE 1: And also, I also think the gross population, it comes from the fact that how many people are working, right? [Talking together] Like when you are looking at Eastern Cape, there are no – what do you call it? I don't know – industries for working and ... You understand?

FEMALE 2: So more people are in Gauteng and KZN.

FEMALE 1: In KZN it's understandable because there's the ship harbour.

FEMALE 2: So basically, the relationship is not between the ... it's not more populated, more GDP. It's about the ... So, we are comparing the GDP.

FEMALE 1: Of the resources.

FEMALE 2: Of goods and services.

FEMALE 1: Goods and services. It's because, we can have a lot of people but then, they are not working. You understand?

FEMALE 2: Then the GDP will be lower.

FEMALE 1: The GDP will be lower.

FEMALE 2: And if it's ... I actually understand now, why Gauteng, the Western Cape and thingy would have like a high thing because here in the Western Cape, we have Cape Town.

FEMALE 1: Exactly.

FEMALE 2: And the thingy here – the harbour.

MALE 1: And Jo'burg is in GP.

FEMALE 1: In Jo'burg, like, you have tons of opportunities. In Durban, there's also the harbour.

FEMALE 2: And the spices and sugar.

FEMALE 1: Exactly.

MALE 2: Shoes.

FEMALE 1: Shoes. Leather.

FEMALE 2: Leather isn't obvious.

FEMALE 1: Okay, so how do we take all that to the soccer now? How does it update?

FEMALE 2: So, are we going to talk about the GDP or what? Are we looking at GDP?

MALE 1: Do they ask us to make a new ranking for them?

FEMALE 1: Yes.

FEMALE 2: How do we incorporate ...?

MALE 2: And look, is this a man's tournament? Is this for the men's? For the men's only?

FEMALE 1: Not only.

FEMALE 2: They didn't specify.

FEMALE 1: It wasn't specified.

FEMALE 2: It's SAFA

MALE 1: But here's a thing. If you check this detail, they've shown us the life expectancy ... Yes.

FEMALE 1: And females.

MALE 2: Female and males. Because if it's only a male tournament, then we are only supposed to use the male figure, isn't it?

FEMALE 2: Ja [indistinct]

MALE 1: See the sixty-six, sixty-four, sixty one ... All those things.

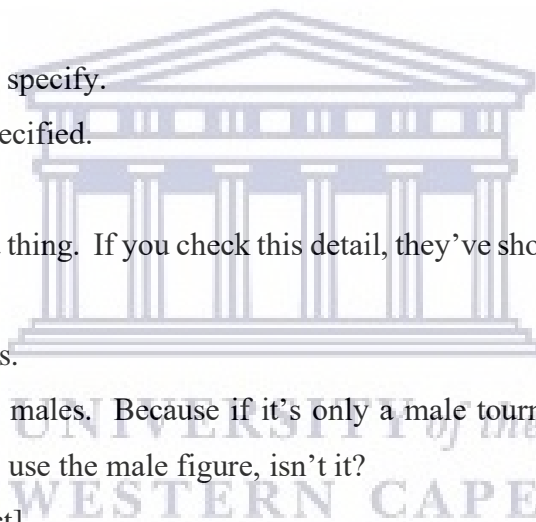
FEMALE 2: But now, are we going to be choosing life expectancy?

MALE 1: We can. The reason why I'm doing that ... Oh, I get it. So, we are only supposed to use the socio-economic factors. Because, if that's the case, then we are only going to divide the ... We can divide the GDP by the population size, multiply that by a hundred.

FEMALE 1: Okay?

MALE 2: Or we can just do GDP divided by the population size and add that to the total there.

FEMALE 2: Or maybe we could do the GDP divided by the total and then maybe times it with the total? I don't know, like the wins, the loss and the draws.



MALE 1: Because if you look at this man, like wait – how did they add these four up?
 Played ...

FEMALE 1: They, they played ...

MALE 2: Oh, it's played plus won plus lost and drawn ...

FEMALE 2: And then you've got the thirty-three.

FEMALE 1: So we're going to say the sixteen played and then we add the win, the loss and the drawn and get a total. After that, multiply maybe that total by the thingy that we got here.

MALE 2: By the GDP divided by the population size?

FEMALE 2: GDP divided by the [talking together]

MALE 1: No. But here's the thing man. There's an issue because there's some provinces right, there's more people, but the GDP is lower than somewhere where there's less people. But now the thing is, the place where there's less people, there might be more opportunities so their socio-economic mix ...

MALE 2: It's different, right?

FEMALE 1: It's different.

MALE 1: It needs to show the population size and the ... but here's the thing. If you come from a population where the GDP is low, but there's a lot of people ... Ag! My brain.

MALE 2: It's quite taxing.

FEMALE 1: No. Or maybe – I don't know. Or maybe we can ...

FEMALE 2: Okay, so we have thirty-three for the total what, what.

FEMALE 1: Or maybe like we can ... we can add the number of games played. I don't know. Or maybe we can say thirty-three né, because now we want to consider economic factors right? So that is going like GDP, how healthy people are and stuff like that. So, can't we take the thirty-three né, and multiply it by the actual GDP of that province...?

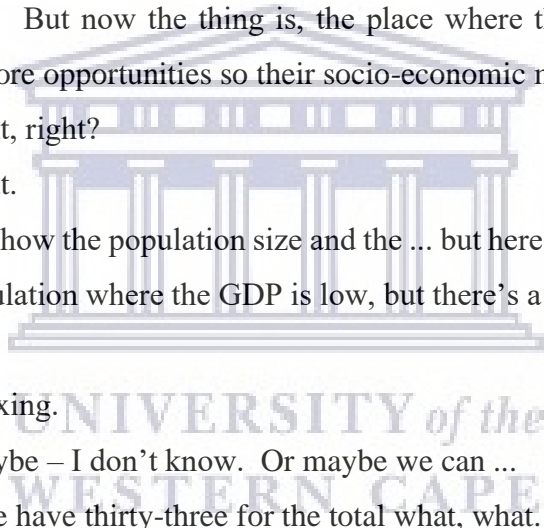
FEMALE 2: Each province.

FEMALE 1: Divided by the total GDP for the whole country and then see how that ..

FEMALE 2: South Africa.....Ja. I see. Okay. Let's just do it for one – for Gauteng né? Say, thirty-three? Thirty-three né? And then we multiply by ...

FEMALE 1: Like the total ... multiplied by the actual GDP that a province but divided by the total of the country.

FEMALE 2: Why that?



FEMALE 1: Because socio-economic factors of each province.

FEMALE 2: So, are we ignoring the life expectancy?

FEMALE 1: But we really don't have to use all of the information.

FEMALE 2: Ja. GDP.

FEMALE 1: I think if we use ...

FEMALE 2: GDP and population.

FEMALE 1: How are you going to use both of them?

MALE 1: I'm just using this system real quick. I want to see if Mpumalanga, which has a smaller population than Gauteng, is still going to land second to Gauteng if I'm using this other system, so I'm just going to ...

FEMALE 2: Okay. Let's do that.

FEMALE 1: Okay guys. Okay now, let me ask. What do we want to have at the end of the day? Like do we want to put? Okay, maybe let's say ... do we want to put the EC in the first place, considering the fact that it has low – like, most of the things are low?

MALE 1: Ja. That could be a result of.....

FEMALE 2: So that could be that ...

MALE 2: I'm just checking about Mpumalanga, would it be still second if I take the life expectancy.

FEMALE 1: Do you think it's fair that we actually consider the same criteria for men and women.

FEMALE 2: It's not fair.

FEMALE 1: Because, I feel like, you can't expect the life expectancy of both male and female to be the same and obviously, it's not the same so you can't like subject them under the same conditions.

FEMALE 2: So, it's men are weak.

FEMALE 1: But females live longer.

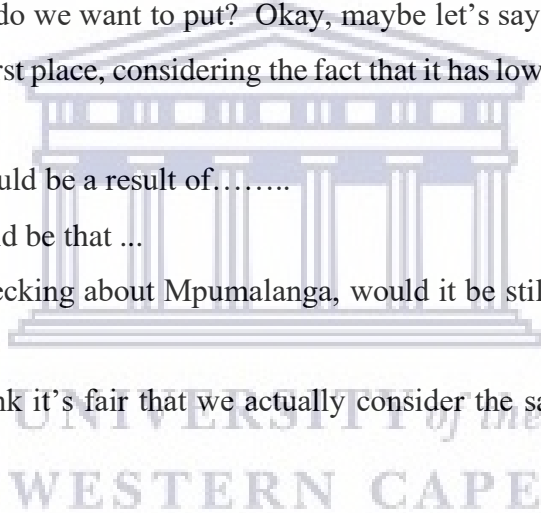
FEMALE 2: It is true.

FEMALE 1: So, what do you think? Haven't you tried this? I'm going to take the EC - say it's twenty one right? So, the total plus economic one. This is ... What's this? What is this for?

FEMALE 2: Do you have population?

FEMALE 1: Oh, it's the population.

FEMALE 2: It's almost fifty or fifty-seven.



FEMALE 1: Fifty-seven.

FEMALE 2: How about I touch this [indistinct]

FEMALE 1: Sixty-three.

FEMALE 2: 2008. 2013.

FEMALE 1: This is so confusing.

MALE 1: Hey. If I divide – if you divide the GDP – no. Not the GDP. Let's say you divide the population size by the GDP. Then you multiply their points that you got for the total. Then basically, you are going to start seeing differences in between their ranking, like, according to that multiplication, you multiplied it like that. I got 436 for Gauteng.

FEMALE 1: What is this?

MALE 2: Like, I switched it around and that is the population size, divided by the GDP.

FEMALE 1: Are we wielding like the same results?

MALE 2: Over GDP. No. Like, according to the ranking, if you include the socio-economic circumstance like, the GDP – no, no, no the amount of people in relation to the GDP, then you'll notice there's differences in where they rank.

FEMALE 1: Where is the Eastern Cape?

MALE 2: So, the Eastern Cape is over here, there ...

FEMALE 1: Twenty-one.

MALE 2: Yes.

FEMALE 1: Like, I was saying that, we take this, we multiply it by the number – this, I mean ... Yes, we multiply it by this, divide it by that.

FEMALE 2: The total number [talking together]

FEMALE 1: Here's Western Cape, so Gauteng, Mpumalanga, Western Cape ...

FEMALE 2: That is what I was saying.

FEMALE 1: Joh, this is complicated, shame.

FEMALE 2: What are you saying?

MALE 1: You're actually supposed to divide the GDP of the one province over the country.

FEMALE 2: And then multiply it by the total and then see if maybe there is a difference.

MALE 1: That would make far more sense, ja. So, let's say Gauteng, then I would say one in every.

FEMALE 1: Dude. I feel like the only quiet person.

FEMALE 2: What factors we think – we considered and stuck and stuff.

FEMALE 1: Adjusted by using socio-economic entities. So, we can just write it down

FEMALE 2: Population and ...

FEMALE 1: And are we supposed to even write down the table as well?

FEMALE 2: I don't know.

FEMALE 1: A new one. I think we're going to write down a new one. After we've done this.

FEMALE 2: Does it work?

MALE 1: Ja. I'm just here like, I got the total for the first one. It's ...

MALE 2: It seems MP will actually be lower in this ranking. Because, according to these new figures that I've had, GP is forty-four and MP has thirty. I multiplied them by their GDP over the country's. Is that how you supposed to divide it?

FEMALE 2: Ja.

MALE 2: So, if you divide it like that, that's how it happens. So then, this is thirty, so I see ... Okay. So, EC will be twenty-one multiplied by fifty four [calculating]

FEMALE 1: There's no relationship. No clear relationship.

FEMALE 2: Are you winning?

FEMALE 1: Does it work?

MALE 1: Wait. How did they get thirty-three?

FEMALE 2: They added ...

FEMALE 1: They added what?

MALE 2: But if you add those together, it's thirty-two.

FEMALE 1: It's thirty-two?

MALE 2: Sixty-two plus eleven plus five, so you got a thirty-two. So where does that extra two come from?

FEMALE 2: Isn't it the one point for drawn.

MALE 2: Is it?

FEMALE 1: Ja. Just add the Mpumalanga. Just add the next one.....

MALE 2: Sixty plus two plus four.

FEMALE 1: Let me just see how much we get.

MALE 2: So it seems like you get one point for every game played as well.

FEMALE 1: For whatever, you don't draw.

FEMALE 2: Let me see?

MALE 2: Like, just check it out man, like, that's the next one.

FEMALE 2: Hey, but the next one ...

MALE 2: You didn't get the point for every game that you play as well. Though every team played 16 games.

FEMALE 1: [Calculating] Here's another one with a zero on it.

FEMALE 2: There's no point for [indistinct]. It's two points for a win and one point for the drawn match. There's no point for a loss.

FEMALE 1: Six plus seven.

MALE 1: See. They're seeming to get points for games lost man, according to this new system.

FEMALE 2: How did they get the total?

FEMALE 1: Okay. They didn't lose.

FEMALE 2: It's Twenty-nine.

MALE 1: So, in fact. Are we only supposed to look at the games won and the games drawn?

FEMALE 2: Okay. Because I feel like, if it was they got a draw, they had some points.

MALE 1: Ja, it could be one - one, two - two? You know what I'm saying?

FEMALE 2: They have points after all.

FEMALE 1: Ja but guys, this really don't make sense.

MALE 2: So let's only look at the games won and the games drawn.

FEMALE 1: A team gets three points for a win, so there's six. So, three times six it's eighteen [calculating]

FEMALE 2: How did you get to that number?

MALE 1: Thirty-three is when you added that one drawn game, plus five plus eleven plus sixteen. That's thirty-three.

FEMALE 2: No. Look. Three times eleven - it's thirty-three.

FEMALE 1: Three times six - it's eighteen, plus ...

MALE 2: I don't get it. Why would they multiply by three?

FEMALE 1: Because they say, three points for a win. If you win, you get three points.

MALE 2: Oh. Where do they say that?

FEMALE 1: There. The table.

MALE 2: Aaah. Okay.

FEMALE 1: So, three times eleven is thirty-three.

MALE 2: Okay. I get it. I get it.

FEMALE 1: And then, let's say now we win all nine games

MALE 1: Oh. One point for drawn.

FEMALE 1: But three times nine...

MALE 1: So do you think we should...?

FEMALE 1: But three times nine is twenty-seven. Oh, and then plus [talking together] and then ... ja. Plus five.

FEMALE 2: And then, they've drawn five.

FEMALE 1: And then trials ... ja, it's five.

FEMALE 2: What is it?

MALE 2: So, for every drawn game, it's plus one point.

FEMALE 1: Yes.

MALE 2: For every game won, it's plus three points. Okay. So then ...

FEMALE 1: So, you multiply the won by three, you multiply the drawn by one, you add and then you get the total. So then ... You understand?

FEMALE 2: Ja. So you can say.

FEMALE 1: Guys. So, this is times three and this is times one and then you get the total.

FEMALE 2: How does the normal system work?

MALE 2: Heh, you know it's weird né. That like, what you call it? Because it seems like Northern Cape lost more games than Eastern Cape lost. You know what I'm saying?

FEMALE 2: Oh, it lost seven ... Eight.

MALE 2: Northern Cape lost three games, but I think it's like ranked higher.

FEMALE 1: But it's ... is it?

MALE 2: Based on their seven wins. Let's look at them and just compare them for the one that they drawn.

FEMALE 2: They had three draws. Eastern Cape had three draws. Northern Cape had one.

MALE 2: And you see there, they even had more draws, meaning they had more games and with less scores.

FEMALE 2: I think, what we should focus is ...

FEMALE 1: Why is a draw given a point?

FEMALE 2: But, you were playing a game.

MALE 2: You did score.

FEMALE 2: It can be a four – four draw.

FEMALE 1: You didn't lose. I think that's fair.

FEMALE 2: There was no-one that lost.

FEMALE 1: But the only thing, they didn't consider the socio-economic factors.

MALE 1: Think about how we used that – how I used that human development index.

MALE 2: GDP products over GDP.

FEMALE 2: We're also trying to see if how the population ...

FEMALE 1: And the GDP?

FEMALE 2: Yes, the relationship between the population, the life expectancy and the GDP, because what are we saying is that, it really – when it comes to GDP, sometimes the number - what it shows here, that the number of people doesn't really matter.

MALE 2: It doesn't really like ... ja.

FEMALE 1: Ja. Because look, Eastern Cape - there's a lot of people but still the GDP is lower.

MALE 2: So we have to take that into consideration.

FEMALE 2: Ja, so we thinking that we have to take into consideration that the cities like Cape Town, Western Cape, where there's a lot of job opportunities, that ... so it doesn't ... Now we're trying to find what is the relationship between population and the GDP.

MALE 1: Seven comma Nine.

FEMALE 2: How can we show that?

MALE 1: I'm just checking now [calculating]

FEMALE 1: Ooh ah ah. Some of this is too much.

FEMALE 2: Okay. Gauteng is ranked first. Then it changes here. Life expectancy. So, it makes sense. But no, when it comes to my Eastern Cape, it's the last one, it's the last one, it's the last one.

FEMALE 1: I think, if we can use GDP [talking together] ...and the population ...

FEMALE 2: The less you have, the less complicated your life will be.

FEMALE 1: Exactly.

FEMALE 2: Just not put all the [indistinct]

MALE 2: Shall we have the real GDP of the country plus the actual GDP of the province divided by the population size of that province? Can we perhaps use that?

FEMALE 1: The actual ... of ...?

MALE 2: Ja, like this man. Like we can use this RSA plus the actual one of the province and then we divide it by the size of the ...

FEMALE 1: Population ...

MALE 2: Province.

MALE 1: And then we can plus that to the ... What figures are we going to use from this table?

FEMALE 2: We can use maybe the games?

FEMALE 1: Why do we add ... ?

MALE 2: Like, there is this one part where they were showing, that is how you make an index on everything. It's like – actual, minus minimum, over maximum, minus minimum. It's like a good index for us to multiply with. You know what I'm saying?

FEMALE 1: Now I understand.

FEMALE 2: So, you're asking which point can we use in there?

MALE 2: Okay, like which of these are we going to use because clearly here, they use ...

FEMALE 2: You can use ... Maybe you can use the win.

MALE 2: So they're using wins plus loss.

FEMALE 1: Oh. Wins plus draw.

MALE 1: Wins plus draw.

FEMALE 1: Wins plus draw.

MALE 2: But even in this case you know, then they only got points for the win because, that's eleven multiplied by three and that's thirty three, then they only multiplied this and they didn't consider that.

FEMALE 1: Ja. So we can just ... How many games were won?

MALE 2: Okay. So just look at how many games were won and then we ... like, what? Are we going to plus or multiply by this? We're going to multiply by it? Because, if you multiply all of them by this man, then they are all being weighted against this, like ... you get what I'm saying? It's like, if you multiply them at that ratio, it's almost like when you multiply a fraction by a hundred and get a percentage.

FEMALE 1: Oh, so this will all be over that.

MALE 2: Yes. It's almost like, if we multiply this specific figure out of this, then ...

FEMALE 2: Okay. Let's try it. Let's try a province.

MALE 2: Actual. So, we're going to use Gauteng né? So then, yellow is GDP for Gauteng [calculating]. Must I write it as a complete number?

FEMALE 2: Let's just write it as a complete number.

MALE 2: And then we multiply ... Are we going to take this total as well? Are we going to do the same thing where we just use the wins?

FEMALE 2: I think let's just use the wins, so that ...

FEMALE 1: Wins?

FEMALE 2: Ja, because, do you remember what you – the win, because you said, when we calculated – the win they calculated, they just said ...

MALE: 1 They just multiplied the wins with ...

FEMALE 1: But a loss doesn't count for any points, right?

MALE 1: Ja, but drawing does.

FEMALE 2: The draw.

FEMALE 1: Because there are points that are awarded there.

MALE 1: So, here by this.

FEMALE 2: So, what if we didn't multiply anything there, we just use the actual points? How many they win.

MALE 1: So okay. Yes, because we looking at new systems now. Ja, so we're not going to multiply that three.

FEMALE 2: We are doing our own thing.

FEMALE 1: Ja, okay. That's true.

FEMALE 2: The multiplication – it was their system

FEMALE 1: I'm just looking at how many games did they win. Out of how many games did they play?

MALE 2: Ja, ja, but listen ...

FEMALE 2: How many games did they play and how many did they win?

MALE 1: Now. You know what? They have their system of which they did this, right? And the question he's actually asking us now, the current scores should be adjusted.

FEMALE 1: Oh.

MALE 1: So, we're not supposed to be making a new system. We are supposed to adjust this system so that it includes that.

FEMALE 2: Oh, okay. So let's use 33 then.

MALE 2: We can use the same thing but then we multiply by this. You know what I'm saying? Because then, that figure would include the GDP, the population size, all those things.

FEMALE 2: Okay.

MALE 2: So let's say ...

FEMALE 1: So, we are adjusting? We are not starting from scratch.

FEMALE 2: I'm becoming colour blind or something.

FEMALE 1: Why?

FEMALE 2: Already on my colours – I can't differentiate between black, purple and navy.

FEMALE 1: I can't figure it out.

FEMALE 2: What are you getting?

MALE 2: Sorry. I'm just ... [indistinct]

MALE 1: Didn't give us one goal. 1! Now, check out this system though. So, if I use this index to multiply them with né, then I'm finding that Mpumalanga is actually higher than Gauteng, if you consider the fact that Mpumalanga is actually a place with a very small population and considering the fact that Mpumalanga has ...

FEMALE 2: Sixty six – life expectancy.

MALE 1: Oh ja, let me go to the life expectancy, but ...

FEMALE 2: But I don't think it that much.

MALE 1: Like if you look at it here, then even though Mpumalanga is like second in this ranking, if you consider the fact that Gauteng has a far higher GDP ...

FEMALE 2: Can you just put Eastern Cape? Can I look ...? For Eastern Cape? I want to see something.

MALE 2: So, for Eastern Cape, we're going to have – what's the population for Eastern Cape? 6.52 million. And their ... what is their GDP?

FEMALE 2: GDP is 55 094.

MALE 2: And the points that they got?

FEMALE 2: Twenty-one.

FEMALE 1: How many points did they get now?

MALE 1: Okay. Zero comma four points – which is the same points Gauteng gets.

FEMALE 2: So now ... Oh. It's the same points Gauteng got. Ja. It's the same. I think so.

FEMALE 1: And guys, another thing that I wanted to ask ...

FEMALE 2: We need to see distance and weaknesses of this system that we are using.

FEMALE 1: And the other thing is I wanted to ask, of which I think it's also going to help us, how do we calculate the GDP of the province or the country, whatever. How do we calculate the GDP?

FEMALE 2: I don't know that. I don't know how is it calculated.

MALE 1: But it ultimately comes down to is like, if a country has a high GDP, it's more likely that you've got good resources.

FEMALE 2: Ja. Gold.

MALE 2: Nee. It's like, if there's more people have a lot of money in there, there's obviously more opportunities for them to train into how to become higher earners and therefore they become higher earning.

FEMALE 1: Minimum salary. How much is the minimum salary? How much is the maximum salary? How many people earning the maximum salary?

FEMALE 2: Okay, so it means also the population is included there.

FEMALE 1: Ja. Let's just use GDP and population, guys. That's it – to work it out.

FEMALE 2: Let's just do three provinces.

FEMALE 1: It would be a good idea.

FEMALE 2: Every system ... Like, every system does have its weakness.

MALE 1: Ja, but you have to know what the weakness is. That's what we have to ...

FEMALE 2: How can we actually ... if maybe ... if another person was to like maybe develop this model. Like, what can we improve on? What can we improve on in order like to counteract that short coming any that the previous system had, in order for it to like be more effective and for it to be more fair?

FEMALE 1: I think, in this one, we can consider gender. Gender.

FEMALE 2: But we didn't talk about gender. Because, it just said that its iSAFA.

FEMALE 1: And, the GDP – how is it calculated?

FEMALE 1: I don't know.

FEMALE 2: How can we include the GDP? Like, I don't know how to say this.

FEMALE: What was the number for Mpumalanga?

MALE 1: One comma one.

FEMALE 2: One comma one. And then for Eastern Cape?

FEMALE 1: The new points no?

MALE 2: The new point of the Eastern Cape is zero comma four. The new point for Northern Cape is two comma eight. Joh! They are going to be very high on the list because they have a smaller population, but now, here is actually where the population sizes are starting to influence the results. The population sizes are starting to influence the results.

FEMALE 1: I feel like we are on the right track.

FEMALE 2: Then it's ... If you want to like ... just like ... if maybe that, this is a game, actually, we've got Northern Cape, what is it? Does it have fewer people or more people?

MALE 1: Northern? Northern Cape has like the least amount of people.

FEMALE 1: Least amount of people? But there's higher thing there.

MALE 1: Do you think we should possibly the divide the population size by the actual [indistinct]? Because then we are going to see how many people are being subjected to a certain amount of money.

FEMALE 2: No guys. I think we on the right track when we're saying ... like, for this socio-economic what, what indic... When we tried to include them, we focus on the population size. Because, we all know, the bigger the population ...

FEMALE 1: But, I feel like, the bigger the population, the bigger the fans are.

FEMALE 2: Except for Ajax, Cape Town.

MALE 1: But I'm guessing ...

FEMALE 1: Kaiser Chiefs and Pirates.

MALE 2: So, basically now man, what I was looking at is this. What this calculation is actually saying that, the more people there is, the more likely will be that they will choose, like ... It's almost like saying that, because the population is bigger, there's going to be better athletes. But that's not what we're saying.

FEMALE 2: It expires.

FEMALE 1: So, what are you saying again? The more population ...

MALE 2: It's almost like we're making an assumption that the bigger the population is, the more athletes there are ... wait - but, according to this here né ...?

FEMALE 2: It can't. Because look, we've got Northern Cape which, not always with fewer people but with higher thingy.

MALE 2: Yeh, when I think about it like this also, oh – oh, okay, okay. [Talking together]

FEMALE 1: Now, just say the calculation again?

MALE 1: The things that make sense in terms of socio-economic standings are like, then the results are going to start being skew towards something like ...

FEMALE 1: Like what?

FEMALE 2: Say that again, sorry.

MALE 1: Look, we can use this system, right?

FEMALE 2: I think this system is right.

MALE 1: Well, we're just going to have to admit that it's going to place people higher, based on the fact that ...

FEMALE 2: The population size.

MALE 1: Yes. Population size is going to start coming into effect here.

FEMALE 1: I think that.

MALE 1: But it does incorporate the socio-economic circumstances with ...

FEMALE 2: So, we can start with the table, beginning with the table.

FEMALE 1: Wait up. Okay, let me ask you now. [Indistinct] to balance – are you saying, the more population size, the higher score the province get?

MALE 1: No. Like, according to this calculation that we have here, if you have a big population, the chances are of you being high on the list is lower because if you divide a number by a bigger number, the answer is going to get smaller.

FEMALE 2: I think that's right.

FEMALE 1: But that old factor?

FEMALE 2: Also né, when we're considering it, say like we are four. Right? And then one, two, three are working. So you guys are bringing in income. The GDP .. But is there's like a lot of people and then, most of them are not working and then four working, the GDP will be low.

MALE 1: Yes. Even though it's still four people.

FEMALE 2: Now I feel like, divide into population size.

MALE 1: Should we do that?

FEMALE 2: Ja. I think so.

MALE 2: So, should we continue with ...?

FEMALE 2: Ja, just continue with this.

FEMALE 1: Ja, we should just continue with our calculations.

MALE 2: Okay. Cool.

FEMALE 1: No. I feel, at some point, the population size is

MALE 2: I'm just going to add the numbers here now, and then we can basically write down the ...

FEMALE 2: Write the shortcomings.

MALE 2: That we are using ...

FEMALE 2: And we know that when there is like, more people, it's usually slow service delivery, very [talking together] So those are the socio-economic factors. Where there is more people, where the place is overcrowded, usually ...

FEMALE 1: Ja. There's more problems. So, if we're saying that the result shows more population means less scores, and then ... why?

MALE 2: I'm just going to reverse it real quick and just see what happens.

FEMALE 1: Are you going to go for a table or what?

FEMALE 2: You know, I think you must show the formula that we use and then we must show the new scores and then we can put bubbles or something, showing our shortcomings, our strengths and weaknesses in.

FEMALE 1: So that it can be nice.

FEMALE 2: Give me like we've done enough - we just have to do writing.

FEMALE 1: The formula is an actual né?

MALE 1: Uh uhm, uh uhm, uh uhm.

FEMALE 1: Make sure. Plus real. Real what?

MALE 1: Like – the real GDP versus the actual. Okay, so the actual GDP is actually SA GDP.

FEMALE 1: Oh, the SA? Okay. Plus the real GDP over the population.

MALE 1: Yes. The population size.

MALE 2: It's so tedious to calculate it all the time.

FEMALE 2: What is the formula so that I can start writing?

FEMALE 1: Here's it.

FEMALE 2: What is it called?

MALE 1: So what are we supposed to do? We're supposed to draw a table?

FEMALE 1: I'm still unsure ... Okay guys ...

FEMALE 2: Unsure about what?

FEMALE 1: I'm still unsure that you didn't answer me why we add ...

FEMALE 2: Why are we adding?

MALE 1: Because the SA has a GDP.

FEMALE 1: Yes.

FEMALE 2: Can't we say real minus actual?

FEMALE 1: I was going to ask that, but still, what answer are we getting? We took out ... Do you guys understand?

MALE 2: That's why we're saying that the population is starting to sway the answer. So like, what do you feel we should multiply by? Which figures do you think we should divide by? Which – and then multiply? Are we only going to look at the game we won and then multiply that by a co-efficient?

FEMALE 2: I don't know if this is going to work.

FEMALE 1: Why are we adding the real to the ...? Because it's already there. That's what I think. This is already here.

MALE 2: Alright?

FEMALE 1: Can't we like maybe say actual ...

MALE 2: So okay, let's me just take the real one out then we just say the GDP divided by the population, multiplied by the score.

FEMALE 1: Multiply by?

FEMALE 2: The score.

MALE 2: The GDP man. The GDP of the place –

FEMALE 2: Of the country.

MALE 2: Of the province.

FEMALE 2: Of the province, sorry.

MALE 2: The GDP of the province over the population of the province, multiplied by the score.

FEMALE 2: Multiply by the score that they got.

FEMALE 1: Oh, ja. Just try that.

FEMALE 2: Let's try that one.

FEMALE 1: Let's try it. Okay. Let's do for Gauteng and Eastern Cape once and ...

MALE 2: So, are we going to stick with these numbers that they've got here – these totals?

FEMALE 2: I think it's better.

FEMALE 1: The GDP, did you try and divide them? The population, right?

FEMALE 2: Ja. Times the total scored.

MALE 2: I'm just going to make the bones of the thing here now and then we can just plot it into there.

FEMALE 1: GDP. Gauteng né?

FEMALE 2: It's 111 000.

FEMALE 1: 111 000?

FEMALE 2: One hundred and seventy-one.

MALE 1: This one on the top of the list.

FEMALE 2: And then population?

FEMALE 1: Divided by ...?

MALE 1: So, the GDP ...

FEMALE 2: Fourteen point seven [calculating] One, two, three, four, five, six and then we multiply by thirty-three

FEMALE 1: Yes. Is it too much?

MALE 1: A hundred and something. [Calculating]

FEMALE 1: Guys. What do we do when we're dividing? it's in a conceptual role.

FEMALE 2: We're trying to reduce ...

MALE 1: Trying to share actually.

FEMALE 2: Ja. Sharing reduction.

FEMALE 1: Oh. Why do they divide?

MALE 1: Okay, divide it like this – okay cool.

FEMALE 2: You make something smaller.

MALE 1: Like check this out – like - okay, okay, okay. So we have four, right? And then so we divide four by four, like.

FEMALE 1: You get two.

MALE 1: You get one.

MALE 2: Because like, each of us is going to get one, you know what I'm saying?

FEMALE 1: Okay?

MALE 2: I'd like divide this by four, so you are going to get one. And if I divide this four by us three, then the answer is two. Because, equally speaking, I will get these two and she will get those two.

FEMALE 1: So, it I take one ...

MALE 2: Away, right? And you divide it by us four ...

FEMALE 2: No. I didn't divide – so this is just subtracting.

MALE 1: That's just subtracting?

FEMALE 1: So it's not the same as ...

MALE 1: Dividing. So how much did you divide it by? You divided it by one fourth? And the answer is 304 isn't it? But it's not minus.

FEMALE 1: Oh. So it's not the same thing?

FEMALE 2: No, It's getting smaller.

FEMALE 1: Exactly. I don't know. That's how I interpret it.

FEMALE 2: I was just wondering – I was just wondering with this GDP thingy – just not to take the amount as raw as it is. Maybe to first like divide it with the total GDP? But I don't know what influence that will make.

MALE 1: Ja.

FEMALE 2: Because I think, we were like dividing into [indistinct] by the total population of the whole country.

MALE 1: Oh. The GPD divided by the pop of the country.

FEMALE 2: Maybe it would have made sense for us to actually take the actual GDP and divide it by the population of the country. But now, we are concentrating of the

province only, so I think it makes sense for us to use the province even [talking together] the population, right?

MALE 1: Yes. Because that's going to give you a percentage of the GDP in relation to that population.

FEMALE 2: Particular province, yes.

FEMALE 1: That's what I think too.

MALE 2: I'm just writing it all down so that we can put it properly in the ranking on the poster. So okay.

FEMALE 2: Shall I write the heading? SAFA model.

MALE 2: Rankings according to the ...

FEMALE 2: The soccer rankings.

MALE 2: Well, we can say?

FEMALE 2: Okay, use soccer rankings.

MALE 2: That's the name of this table. So, we can say, rankings according to the adjusted system?

FEMALE1 : Okay.

MALE 2: Rankings according to the adjusted system. Okay.

MALE 1: Okay. I'm going to have the totals for you now. So, that's going to be 32 multiplied by ... [calculating]

FEMALE 2: Is that six?

MALE 1: What?

FEMALE 2: So is this six or is a zero?

MALE 1: This?

FEMALE 2: No this.

MALE 1: It's a zero.

FEMALE 2: Table. What are we putting in our table?

MALE 1: You are going to basically write down the ...

FEMALE 2: How do you calculate HDI? Do you guys know?

FEMALE 1: What are you putting in the table?

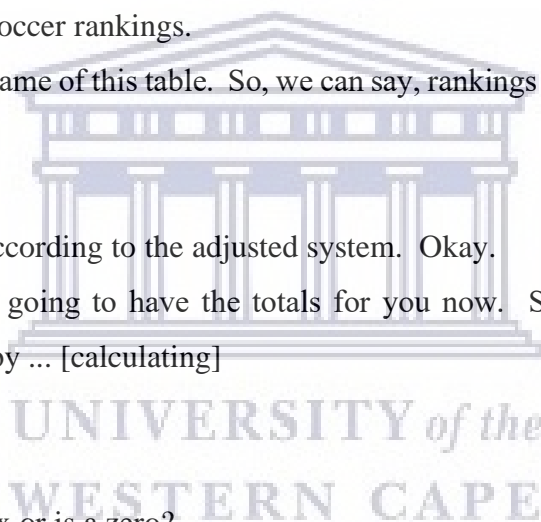
FEMALE 2: Ja. Let's just finish it.

MALE 1: It's one of these things that I'm going to be giving you now.

FEMALE 2: But we must see which one is the highest and which one is the smallest.

FEMALE 1: Oh, so we can ...

FEMALE 2: We can rank them like ...



FEMALE 1: The total. Oh. Okay.

FEMALE 2: Because we are adjusting on the total

MALE 1: If a ... we can even like a extra – just an extra column on the table because we probably not going to ... Oh ja. I was thinking, we could just put an extra column in for this and asked, but they're not going to be in the same order. You know what I'm saying?

FEMALE 2: Hand's up – you say that the new total will be – it's just – will determine our order?

MALE 1: Oh, so then we're not going to have like a total system?

FEMALE 2: Not the total one. We just use the single point system.

MALE 1: Points. Points.

FEMALE 2: Which one is the first? Which one is the first now?

MALE 1: I think the ... I'm am just writing it. So, I can just type them all into the calculator once.

FEMALE 1: You said there must ... Oh. Total.

FEMALE 2: The old total, the new total.

FEMALE 1: This table is so skew. I'm not even laughing.

MALE 1: Ok cool. There's no extra spaces here. Okay cool. I'm just doing this last thing.

FEMALE 2: I think we're going to take this one really. It doesn't matter.

FEMALE 1: What's the formula?

FEMALE 2: The GDP divided by population, times ...

FEMALE 1: When the others are busy, she can just copy from them.

FEMALE 2: Divide by the population, times total score. [Xhosa]

FEMALE 1: The total. Estimate total mos.

FEMALE 2: Total initial score.

FEMALE 1: Yes.

MALE 1: So okay, Eastern Cape's still last so let's ...

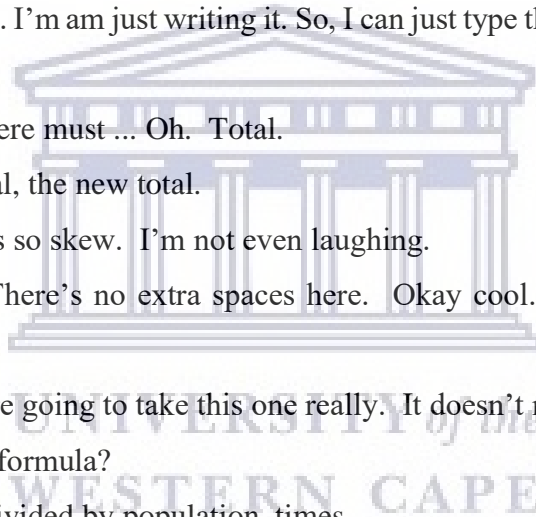
FEMALE 2: Eastern Cape is still last?

MALE 1: Uh uhm. Gauteng is still first.

FEMALE 1: Oh. Really? MP?

MALE 1: Like, I'm going to check now who's actually falling into their places now. So this is number one, here's number two.

FEMALE 2: I understand why Gauteng is ...



MALE 1: Free State is going to move up. Free State is moving up.

FEMALE 1: What is first?

FEMALE 2: Gauteng. I understand why. Like, there's no ... too much ...

MALE 1: Actually, the second one is NC.

FEMALE 2: Played? sixteen.

FEMALE 1: Ja. Write all the numbers.

FEMALE 2: Eleven.

MALE 2: Where do we ...? No, but weren't we going to write the table adjusted?

FEMALE 1: Yes.

MALE 2: Oh ja, sorry – Gauteng is still first. Okay, I'm just going to ...

FEMALE 2: Adjusted.

MALE 1: Adjusted

FEMALE 2: Two comma two six

MALE 2: Sorry? Say again please.

FEMALE 2: Two comma two six. The total.

MALE 1: According to this one, number two is Northern Cape.

FEMALE 2: Northern Cape is number two.

MALE 1: Three comma three, lower than seven.

FEMALE 1: What is the thingy?

MALE 1: Second one.

FEMALE 2: One comma four. The third one, is it MP or Free State?

MALE 1: The third one is Free State because it's zero comma seven there.

FEMALE 2: Okay. Free State.

MALE 1: But I'm thinking ...

FEMALE 1: What about the ...?

MALE 1: Here is zero comma one [indistinct]

FEMALE 2: Okay friend. Hold thumbs girl. I don't know.

FEMALE 1: Scratch out the ones that you've written down.

FEMALE 2: Scratched out GP. I think it's ... Oh. I think this one is seven three. This one is seven three. This one is seven three.

MALE 1: Now I'm just ordering them man, but I'm confused [indistinct]

FEMALE 1: Oh. So this is the first one and this is the second one. And then ...

FEMALE 2: It's seven three.

MALE 1: Okay, this is the last one, this is the second last one, this is the third last one. This is number six and then number five is the next biggest one. Which one is bigger? Zero comma five or zero comma five five?

FEMALE 1: Which one is bigger?

MALE 1: Ja. Zero comma five or zero comma five five?

FEMALE 2: Okay. Let's do it like this. Zero comma ...? Zero comma ...?

MALE 1: Five minus zero comma five five?

MALE 2: No, no, no.

FEMALE 2: Zero comma five five is smaller.

MALE 2: So zero comma five is bigger.

FEMALE 1: Which one comes first?

MALE 1: Zero comma five comes fifth.

FEMALE 2: Zero comma five comes first?

MALE 1: Fifth.

FEMALE 2: Fifth. Sorry.

MALE 1: Because zero comma five is smaller.

FEMALE 2: Ja, it's smaller than ...

MALE 1: And then zero comma five five is fourth. Zero comma seven three is third. Zero comma ... Now you see, the table makes sense. If you're starting from the smallest one, so zero comma one, see? Then zero comma one six.

FEMALE 2: The smallest. This is the smallest.

MALE 1: Zero comma one six is bigger than one...

FEMALE 2: Ja. Okay.

MALE 1: So then they're eighth. And the seventh one is zero comma two four. Then the sixth one is zero comma four four. You know what I'm saying?

FEMALE 1: I think now we need to ...

MALE 1: Zero comma five five ...

FEMALE 2: Also, the smallest one is the last one.

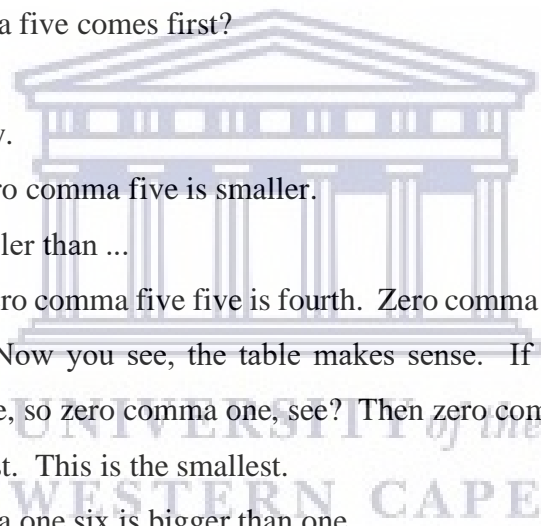
FEMALE 1: So now, it's going to be – number three is Free State?

MALE 1: Ja. Okay. Got them.

FEMALE 2: Free State. It's bigger. Getting bigger.

MALE 2: Oh. You going to write them down now?

FEMALE 1: 16?



MALE 2: Ok, write this next to the table and you'll see how the table has changed. So, Gauteng is first.

FEMALE 1: What is Free State?

MALE 2: Oh Free State? Zero comma seven three.

FEMALE 1: And then, what's next?

FEMALE 2: I think it's Western Cape. Is it Western Cape?

MALE 2: No, says number four, Mpumalanga.

FEMALE 1: Mpumalanga?

FEMALE 2: How much is it? Mpumalanga?

MALE 2: Zero comma five five.

FEMALE 1: The next one is ...

MALE 2: North West.

FEMALE 2: Variables?

MALE 2: Zero comma five.

MALE 1: So, the next one after North West is Western Cape.

FEMALE 1: So, is that a strength or it's a weakness?

FEMALE 2: I think it's a strength. I think. I don't know.

FEMALE 1: Do you think? I think it's a weakness.

FEMALE 2: Why?

FEMALE 1: Because ...

MALE 1: Zero comma four four.

MALE 2: Next one is Limpopo.

FEMALE 2: Using information about a province.

FEMALE 1: Also, we only focused on a province.

FEMALE 2: GDP, the whole of South Africa which is checked on the provinces GDP, right?

FEMALE 1: So, we didn't use the RSH Okay.

MALE 2: For their points?

MALE 1: Points is zero comma two four.

FEMALE 1: Okay. The other thing is, I feel like there maybe

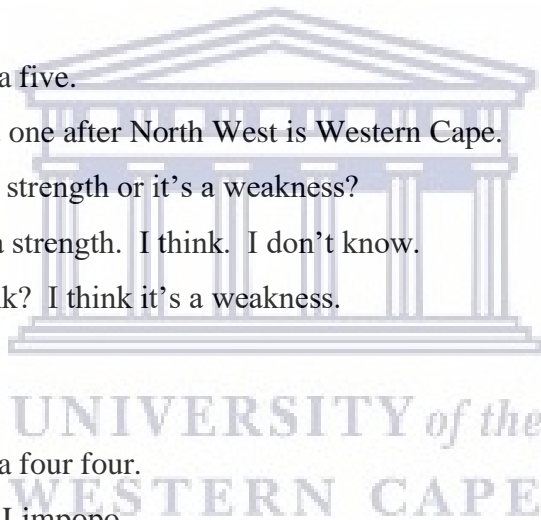
MALE 2: After Limpopo, it's Northern Cape.

FEMALE 2: Northern Cape?

FEMALE 1: Is it not West?

MALE 2: You say?

FEMALE 1: Eastern Cape.



MALE 2: Northern Cape.

MALE 1: Oh no, no, no.

FEMALE 1: Eastern Cape.

MALE 1: Wait, what?

FEMALE 1: Eastern Cape. Not the west.

FEMALE 2: Eastern Cape is the last one.

MALE 2: Eastern Cape is last. Northern Cape is second and ...

FEMALE 1: Which one is missing now? Mpumalanga ...

FEMALE 2: KZN.

MALE 1: KZN is number eight. Sorry.

FEMALE 1: And then, another weakness – focus was on..... And nowhere in our system is that we didn't use all the life expectancy thingy's?

FEMALE 2: Okay ja. We didn't use all the socio-economic ...

MALE 1: Factors.

FEMALE 2: Ja.

FEMALE 1: We didn't.

MALE 1: We only looked at GDP and population size.

FEMALE 2: And then? Zero comma ...?

FEMALE 1: Zero comma one six.

MALE 1: Ja.

FEMALE 2: Expectancy?

FEMALE 1: What is life expectancy?

MALE 1: Zero comma one.

FEMALE 1: Life expectancy.

FEMALE 2: Zero comma one?

MALE 1: Ja.

FEMALE 1: But now, let's talk about the strengths. What can we say?

FEMALE 2: It boils down to the fact that we used to learn those socio-eco don don.

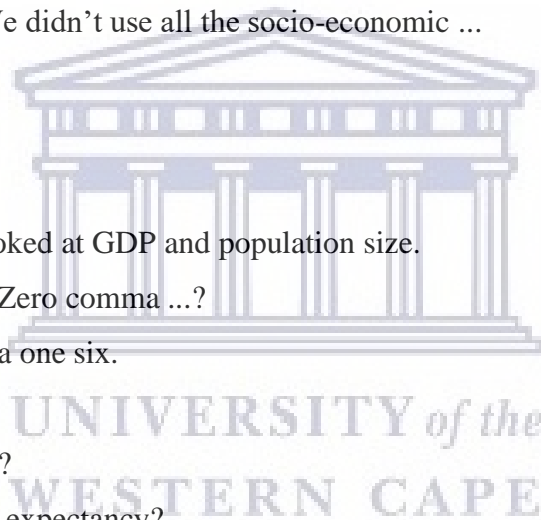
FEMALE 1: Okay. So, e-socio-economic?

FEMALE 2: Ja.

FEMALE 1: Okay, and then?

FEMALE 1: Economic ...

FEMALE 2: Your strength and your weakness. I'm saying, why don't you just write them here?



MALE 2: Okay, we just writing the strengths and the weaknesses.

MALE 1: Now we can say the strengths is specifically that we included the GDP and population sizes to the total.

FEMALE 2: Ja. Okay.

MALE 1: The new rank was the Mpumalanga won the league, Gauteng came second, Western - Cape third, Free State – Fourth, Fifth and the last four stay the last four

[END OF TRANSCRIPTION]



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APPENDIX L

Transcript of Focus Group 2 – Soccer Ranking Task

- FEMALE 1: I know nothing about ... I know nothing about soccer.
- FEMALE 4: You don't have to know soccer. You have to know it's rankings.
- FEMALE 3: You need to know human development index and their problems.
- FEMALE 1: I'm actually not going to read this here. So, what are we going to do with the socio-economic factors?
- FEMALE 2: What does GDP stand for? Gross ...
- FEMALE 4: Gross Domestic Profit.
- FEMALE 1: So, what I'm basically understanding is, we take into effect the population ...
- FEMALE 4: We take the life expectancy ...
- FEMALE 5: So, the three of those stuff and the GDP.
- FEMALE 4: The GDP shows obviously socio-economic stuff as well. That's how it is. It's like a poverty index.
- FEMALE 1: And this formulation thing?
- FEMALE 5: I don't know, why don't we take the life expectancy in?
- FEMALE 4: Apparently, according to people, population plays a role, which means that obviously you need to know up until what age people live because that effects the population.
- FEMALE 1: This is true.
- FEMALE 4: And apparently, that places your soccer team at an advantage or a disadvantage.
- FEMALE 2: I am also confused as to how the population affects an Olympics team for example. Like, they made that. I don't get it.
- FEMALE 5: It's the population of ...
- FEMALE 4: Ja, like, I just say the province specifically with the life expectancy.
- FEMALE 5: Or does the population affect socio-economics – that is where the effect is.
- FEMALE 3: No. The population shows – say if you are a country that has ten people and she is a country that has 350 people. You've got nine people taking part in the Olympics and say she's got nine also. You got nine and I got maybe –
- FEMALE 4: We both have nine.
- FEMALE 6: No. I'm listening to her, no, I know, listen to this one.

FEMALE 4: Do you understand? Okay, so let's draw it.

FEMALE 1: But I don't understand how it affects the relation in a few participants.

FEMALE 2: Ja, same. I can't ... So we have nine out of ten people participating in the Olympics. She has got nine out of a hundred and fifty. What's the expectancy of

FEMALE 5: Because they will have more people to participate.

FEMALE 1: But how many people are participating?

FEMALE 6: No, I'm just saying ... I'm not saying we are going to use it, it's for me to understand.

FEMALE 4: The thing is, both variables are changeable, so

FEMALE 6: Let's say ...

FEMALE 4: The thing is, we need to just divide it by the number of people there is in the population.

FEMALE 5: This actually doesn't – you don't need GDP.

FEMALE 3: Why not?

FEMALE 1: Why do you need GDP in this? They just want to know the socio-economic indicator ...

FEMALE 2: No, you do need to add GDP.

FEMALE 6: Ja.

FEMALE 4: You need to include GDP.

FEMALE 5: It's just how you do it.

FEMALE 4: I just don't know how you're going to include it, ja. That's all I was saying. So, I think – it needs to be something like ...

FEMALE 3: We just all need to keep the population. We know where the population is.

FEMALE 2: It's the soccer. It's the team over the population - it needs to be that ratio.

FEMALE 1: Remember, that needs to be the ratio. The team over the population.

FEMALE 3: But how?

FEMALE 1: Because, not the whole population partakes in the thing.....

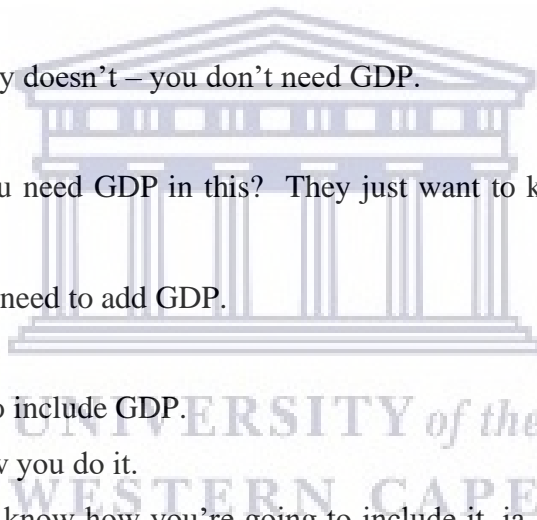
FEMALE 1: To get the percentage of?

FEMALE 3: No, we're not using percentage.

FEMALE 2: That much I know.

FEMALE 1: So, something needs to go over the population, right? So it's obviously....

FEMALE 2: How can we add the totals there as well? Because we are adjusting the total now.



FEMALE 1: What do you mean? What total?

FEMALE 2: These totals here.

FEMALE 1: No. We're not changing that total. That's just how many points they got while they played soccer.

FEMALE 2: We need to change it.

FEMALE 1: It's going to change after we do the calculation basically.

FEMALE 4: No. The points aren't changing. Their ranking is changing. Their points have nothing to do with it. They will still have thirty-three points at the end of the day, because they still played sixteen games, they won eleven games. That's how they got thirty-three points.

FEMALE 6: Okay, ja.

FEMALE 1: The amount of points they've got has got nothing to do with this whole thing. This is just their ranking in soccer.

FEMALE 4: We need this. We don't need the total column. We need the rest of the information.

FEMALE 5: We just need like one, two, three, four, five, six, seven, eight.

FEMALE 4: We just need that, ja.

FEMALE 3: So, that's just extra information. That's just how much they won.

FEMALE 2: Because they just want the system to include – like yes, your points is included, but they want you to include in there, socio-economic.

FEMALE 1: But how are we going to total it?

FEMALE 5: Let's see something. Because how do we ... how?

FEMALE 1: What was the HDI thing?

FEMALE 6: Didn't she write it down?

FEMALE 3: I didn't write it down.

FEMALE 5: I don't know if population comes into play.

FEMALE 3: There, the population must be there. But then it needs to be the population times the GDP.

FEMALE 1: Isn't it the life expectancy?

FEMALE 2: Population? Times? Gross Domestic Product.

FEMALE 1: Why times?

FEMALE 3: Because the population is the total and the GDP is per person, so it needs to be the total times the population.

FEMALE 4: This is per person? Is that what you're saying?

FEMALE 2: So, this must be multiplied with the ...

FEMALE 3: The mid-year population.

FEMALE 4: And I think that actually needs to be divided by the life expectancy. I don't know. Making everything up as I'm sitting here.

FEMALE 5: The thing is, it's not wrong.

FEMALE 2: What did you say? Times?

FEMALE 4: Because it's per person.

FEMALE 3: It's supposed to be

FEMALE 1: I just want to know why, in this table does not have an amount.

FEMALE 4: They played a total of sixteen games.

FEMALE 6: That's the number of games.

FEMALE 5: In the case of Gauteng, eleven were won, twelve were lost. MP, nine were won, two were lost. Sorry in Gauteng, five were lost.

FEMALE 1: So what's the life expectancy -? Where does life expectancy come from?

FEMALE 3: What am I dividing this by?

FEMALE 4: Life expectancy.

FEMALE 1: But I said it doesn't make sense.

FEMALE 3: But I can understand that.

FEMALE 4: You can divide by the population.

FEMALE 6: I can understand this that you're getting ...

FEMALE 4: And divide by the population again. But you can do that.

FEMALE 1: But then it's going to be one.

FEMALE 2: I see.

FEMALE 1: You're basically multiplying with the thing by one.

FEMALE 3: No, I'm just saying, all I know is that I would use this big number as ...

FEMALE 1: The bottom part.

FEMALE 4: The denominator.

FEMALE 1: Guys, how does this relate to the number of games they played? I'm so lost.

FEMALE 4: It's not the number of games they played mos now. It's three, two ... the ranking differently.

FEMALE 6: But why is the total thirty-three?

FEMALE 4: Because the points come here.

FEMALE 5: No, listen. Three points for a win, one point for a draw and zero points for a loss.

FEMALE 4: No points for a draw, so three times eleven is thirty-three.

FEMALE 1: So, they get no points for how the games they lost?

FEMALE 4: They don't get a point for a loss.

FEMALE 5: Which is why ...

FEMALE 2: So, this must be out then?

FEMALE 3: Basically. Just do this here on top.

FEMALE 5: It is basically.

FEMALE 4: But you don't get points for a loss.

FEMALE 3: In terms of points, yes.

FEMALE 1: Yes. That's what I'm asking.

FEMALE 2: In terms of soccer.

FEMALE 3: But then we must say in terms of points because you can't scrap the number of games ...

FEMALE 6: I say divide by life expectancy, I don't know. And it does make sense. To me it does.

FEMALE 2: Would not need a big number?

FEMALE 4: The population must be at the bottom.

FEMALE 1: No. This isn't the total number.

FEMALE 4: And the life expectancy must be on top.

FEMALE 5: I don't know. You can even – you can put the population times the GDP as a denominator if you want even. You can. Because, I've also been saying it should be a denominator.

FEMALE 4: Then life expectancy on top?

FEMALE 3: I'm not too sure hey. My brain's a little fried.

FEMALE 6: No, this point seven ...

FEMALE 5: But then, the thing is, ultimately what this comes down to is, we still need to multiply this by the number of wins.

FEMALE 3: And draws.

FEMALE 4: And draws. But then, you need to create a ratio of wins to draws.

FEMALE 6: Because you don't have the same – does it make sense?

FEMALE 4: You know what? Just relate it to the number of wins and the number of draws, because you all looked at me.

FEMALE 2: I understand what you're saying.

FEMALE 5: Do you understand? We're creating an index that you need to multiply by the wins or the losses or the draws to get to a point system.

FEMALE 1: It's not working out now ma'am.

FEMALE 3: Just give me a low-down then we see, how is it going to work out if we do this key thing, the GDP and then you'll see what happens.

FEMALE 2: Are you going to try the expectancy times the GDP?

FEMALE 3: Ja. You just include that, ja.

FEMALE 5: So, let's use Gauteng

FEMALE 4: Life expectancy and GDP don't go together. Expectancy and population go together.

FEMALE 3: So okay, let's see. We do a bracket ...

FEMALE 2: Expectancy and population. Ja, those two are a relationship.

FEMALE 3: They are inverting one another because the population changes according to the life expectancy.

FEMALE 4: So divide .

FEMALE 2: That's an answer. So this is, I'd say ...

FEMALE 3: Write it in terms of an equation what you're saying?

FEMALE 1: That's what we're busy with now.

FEMALE 6: We don't have an equation yet

FEMALE 4: An index, ja.

FEMALE 5: Yes. It needs to be that. So that's definite. But we don't know where it goes.

FEMALE 1: Okay. And then, let's say ... where did I put all the stuff?

FEMALE 2: Oh sorry.

FEMALE 4: That's the games.

FEMALE 6: I think you can do something in relation to life expectancy and population as well.

FEMALE 1: How?

FEMALE 3: But that's what I was saying, if we do it again, it's basically saying times one. But they think that what you're coming down to is the GDP over life expectancy, or to life expectancy over the GDP.

FEMALE 4: I can't, you have got to tell her.

FEMALE 6: Which would make sense. Um ...

FEMALE 3: What do you want to do?

FEMALE 4: Life expectancy over GDP ...

FEMALE 6: And then you ...? Or is that the final one? Do we take...? We can do that.

FEMALE 3: Because then you've related both the things that are related to population to population, without making population

FEMALE 4: Life expectancy divided by the GDP and then we multiply that with the population. Okay? Life expectancy ...?

FEMALE 6: One thirty-four ...

FEMALE 1: Now they're getting scientific

FEMALE 2: And you divide the GDP, okay? One [calculating] times population which is fourteen seventy-one - one two three. That gives you a total of ... What is this? What is this giving me?

FEMALE 4: We don't know yet.

FEMALE 5: Just socio-economic index.

FEMALE 1: Are we saying that this is socio-economic ...

FEMALE 5: Ja.

FEMALE 3: What would you like to ...? I don't know guys. If you guys want to call it anything else, it's the best my brain can do for you guys.

FEMALE 2: I mean ... Oh okay. Okay? So that will give us ...?

FEMALE 6: What province is this now?

FEMALE 4: This is Gauteng.

FEMALE 1: Gauteng.

FEMALE 5: Okay? We need to draw a table for this whole thing.

FEMALE 4: So, we say one, two, for example, one, one seven one [calculating] one four seven two.

FEMALE 1: Is this for Gauteng? Are you going to work it out for all of them now?

FEMALE 4: I shall.

FEMALE 3: We must give in a page, so ja, I'm going to write it down.

FEMALE 5: Ja so, total for everyone.

FEMALE 3: One, seven, seven, four, two point

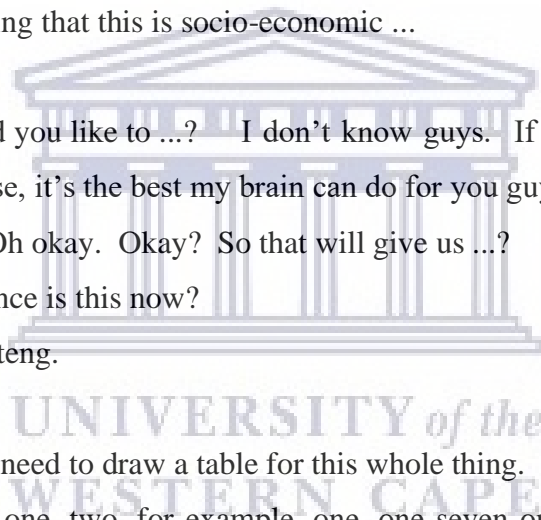
FEMALE 1: And then?

FEMALE 4: The difference is ... yes, it's provinces.

FEMALE 2: What about this value?

FEMALE 1: That's that.

FEMALE 4: And you said that is related, the number of wins and losses – not losses – and draws.



FEMALE 6: Draws. I don't know.

FEMALE 4: Or we can just say this now. Because this is the total number of points and so you don't even have [indistinct] for that. Just say the thirty-three.

FEMALE 3: Ja. Total number.

FEMALE 1: So what about this ... ?

FEMALE 2: So, then we relate it to the total number.

FEMALE 1: How do we relate it?

FEMALE 3: Ja, but this is the points. This isn't the total number. This is multiplied by the points.

Female 2: Yes, but it says points earned.

FEMALE 4: We're trying to create a different system to what they are giving to get this total.

FEMALE 1: But you must include your ... It says here ...

FEMALE 3: We can't change this because this is how many times they won and how many times they draw.

FEMALE 6: They want you to include your points. Somewhere here it said ... Somewhere it said ... he's interested in the final ranking you can take into account the socio-economic development for the province.

FEMALE 4: We need to design an alternative ranking system.

FEMALE 3: They just say about the current scores. This current scores three points should be adjusted.

FEMALE 1: It doesn't make sense.

FEMALE 3: So, if we are going to rank them just according to socio-economic index, rewarding this ...

FEMALE 2: A number of games played.

FEMALE 4: No, they've all played the same amount of games.

FEMALE 5: Number of games won. So, we are relating it to the number games won.

FEMALE 6: And the draws?

FEMALE 4: We can look at the draws as well. But we can't relate it to this. This is the point for B, point for C. Remember, they gave three points for a win and one point for a draw and zero for a loss.

FEMALE 1: But here they say, for the new ranking system, the current scores just needs to be adjusted by using the socio-economic factors. So you mustn't change it.

FEMALE 5: Let's just ... okay then, let's adjust the scores first. We're going to ... Oh. We can't use the same table.

FEMALE 1: What do you mean? You must use the same scores.

FEMALE 2: We need to use the scores but relate it to this. Okay? In relation to that, just then you need to get a new point.

FEMALE 4: Am I ...? Okay, this is Gauteng.

FEMALE 1: Sorry. I didn't understand that. But how ...?

FEMALE 3: Can I just write S- E- R-?

FEMALE 5: Yes.

FEMALE 2: There's actually more numbers but I'm rounding this off quickly.

FEMALE 1: Can we just see how we are going to relate the two?

FEMALE 6: Each total number.

FEMALE 1: Because I don't understand how.

FEMALE 3: Are you going to use the calculator?

FEMALE 4: No. I'm not going to. I'm going to give it back now, sorry. Where is your number count?

FEMALE 3: Where? There?

FEMALE 6: No. It's something else.

FEMALE 4: One thirty-four. Why are you changing it?

FEMALE 3: One thirty-four? Gauteng?

FEMALE 2: Yes. No – that's Western Cape.

FEMALE 1: Oh. Sorry.

FEMALE 3: So that's the answer. Ja. Now let me write this one. It will be better than to use big numbers throughout.

FEMALE 5: I think we were supposed to use it the whole time. Not the individual amount.....

FEMALE 4: We were supposed to.

FEMALE 5: Why don't we read? Because that's a fixed index there.

FEMALE 6: It makes sense.

FEMALE 3: So, it will be one twenty-eight ...

FEMALE 5: So, then it will be the population of each.

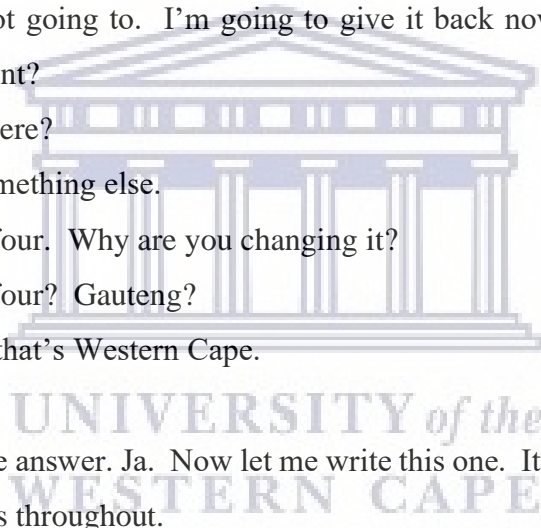
FEMALE 6: Of each?

FEMALE 4: Times the population of each.?

FEMALE 5: Yes.

FEMALE 6: Province?

FEMALE 4: That will change. The population of the province will only change not the



FEMALE 1: Ja. So that's the ...

FEMALE 2: So, it's the life expectancy and the GDP?

FEMALE 3: So, it's this one and this one is fixed?

FEMALE 6: We going to use the total and then we are just going to do it individually there.

FEMALE 2: Why do we get such a big total? I feel like I must write pictures now.

FEMALE 4: This is part of South Africa.

FEMALE 6: But now, this number is big right? This is two point three million.

FEMALE 2: No. That's twenty-three thousand and twelve.

FEMALE 3: Is there a comma here? I can't see clearly.

FEMALE 4: No. It's a full stop. Yes – a comma, a comma.

FEMALE 5: Okay. That's better. That's a better number for us. Don't you think?

FEMALE 4: Because then we divide it by the number of wins.

FEMALE 6: And – I don't know what we're going to do with the ...

FEMALE 4: Not their number of wins. Their points.

FEMALE 5: The final total points?

FEMALE 2: Let's just see. Wait.

FEMALE 1: So, this number will be ...?

FEMALE 3: This is a constant.

FEMALE 6: So, this number will be ...? So, what are you going to do with this number?

FEMALE 5: You must divide that by the total.

FEMALE 4: By the population?

FEMALE 6: So this is ... What did you write down?

FEMALE 3: Constant?

FEMALE 6: This is your life expectancy divided by your?

FEMALE 4: We are not going to use this.

FEMALE 6: We did use this. To get this, we're not going to use this.

FEMALE 1: I've got individual problems.

FEMALE 3: And then, what do I multiply with?

FEMALE 6: Each province?

FEMALE 2: Times population of province.

FEMALE 5: Guys? How's about ...? Guys. You put there then you multiply it by the number.

FEMALE 4: No. I just want to see this. What about this?

FEMALE 6: Okay. You can make an ending.

FEMALE 3: Times the GDP over the population.

FEMALE 4: Of each province.

FEMALE 6: Population of the province times the number of wins and total. Total, sorry.

FEMALE 1: Was that the one?

FEMALE 3: Okay? So, you were saying ...?

FEMALE 5: It's this times that and it will give us that.

FEMALE 4: Because that's the result that we are going to give if we use this formula. So, this is if I use ...

FEMALE 2: That makes a bit more sense for me.

FEMALE 3: It does, ja.

FEMALE 6: Because, if you multiply your life expectancy, multiply how much money you earn. Divide that total by how many people. Like, your population should always be ...

FEMALE 4: But I've said the population should be the denominator.

FEMALE 3: Ja.

FEMALE 4: It must be the denominator and then you times it by the total score.

FEMALE 6: So that's our socio-economic index.

FEMALE 3: Can I just say the Total Given?

FEMALE 4: Start a new page.

FEMALE 3: Can I say Total Given?

FEMALE 4: Total Score.

FEMALE 6: Total Score. Because it's your score.

FEMALE 3: So, is this going to be individually?

FEMALE 4: For each province we are going to need to do that ja.

FEMALE 6: The province changes, ja.

FEMALE 4: So that first one ...

FEMALE 3: The population?

FEMALE 6: The population changes and your population will change and your total score for each one.

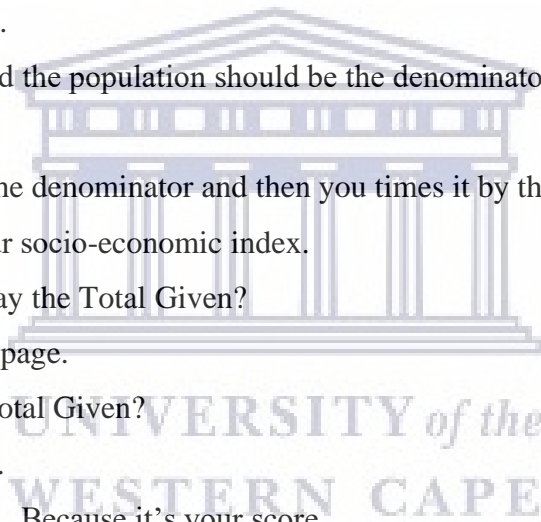
FEMALE 4: This is a constant.

FEMALE 1: So that will stay constant. That's what I want to know.

FEMALE 4: Okay. Now let's see. I already gave you one.

FEMALE 6: What did you get for Gauteng?

FEMALE 3: We give a twenty-three point for Gauteng.



FEMALE 4: Okay. Thanks.

FEMALE 3: Okay. What am I doing next?

FEMALE 6: Shouldn't you then first give this one?

FEMALE 4: Alright. Which is ... one twenty-eight times eighty-one eight, seven, five. Constant. Won't change. Never change. Write it in pen.

FEMALE 6: You must get the total of it.

FEMALE 3: Ja but, what I'm saying is, the total and then you can use that for ...

FEMALE 4: That one.

FEMALE 5: Ja, that's what I ...

FEMALE 4: One seven five. It's a big number, guys. [Calculating] It's ten million.

FEMALE 6: Okay. [Calculating] divided by ...?

FEMALE 4: So then I can help with that.

FEMALE 3: Are you busy with the Western Cape now?

FEMALE 4: Is that the next one?

FEMALE 6: It's one because then each of us can just do a province then it's going to go quicker.

FEMALE 1: I'm just asking.

FEMALE 6: One o, one eight ...

FEMALE 3: And then four zeros.

FEMALE 4: Four zeros.

FEMALE 2: So, I'm going to do the Western Cape hey?

FEMALE 6: And how much did they get? What was their score?

FEMALE 2: Thirty.

FEMALE 3: So it's forty seven – let me just change this.

FEMALE 5: Are you going to do the Eastern Cape or the Western Cape?

FEMALE 6: So this is fine

FEMALE 4: Five hundred and eight million.

FEMALE 6: Are you doing Limpopo?

FEMALE 5: Limpopo is forty-three.

FEMALE 4: Eastern Cape is thirty-three point seven five.

FEMALE 2: Rounded off to thirty-four.

FEMALE 4: Um, so, Western Cape is forty-seven.

FEMALE 6: Mpumalanga is seventy-four point one nine, rounded off to seventy-four

FEMALE 5: KZN is twenty-six.

FEMALE 4: Free State is ninety-six.

FEMALE 6: North West is sixty-eight.

FEMALE 5: I'm going to look through all again, just to check.

FEMALE 3: It is the life expectancy.

FEMALE 1: What is this now because, I get a different number for Mpumalanga.

FEMALE 6: What did you get?

FEMALE 1: I got seventy-four.

FEMALE 6: That's what I got.

FEMALE 4: She already wrote that down.

FEMALE 6: The Northern Cape is ranked first hey.

FEMALE 5: So, we not going to relate to the draws?

FEMALE 1: What do you mean?

FEMALE 4: This is their total scores.

FEMALE 1: Oh, so it's included with it.

FEMALE 2: It that what you got?

FEMALE 3: Ja, I got it as you wrote it down. And then I also rounded it off.

FEMALE 5: So, what's that column for?

FEMALE 3: I wrote it before the time. I'm going to write ...

FEMALE 4: Why don't you write there the total scores and then write adjusted total scores?

FEMALE 3: I'm going to. This alright here?

FEMALE 2: Ja. Six ...

FEMALE 1: In our table on the drawing

FEMALE 3: First of all, I must go on the poster so I can start ...

FEMALE 4: First you are going to start with how many times that goes in there.

FEMALE 3: So, this?

FEMALE 4: Something like that, ja.

FEMALE 3: Okay.

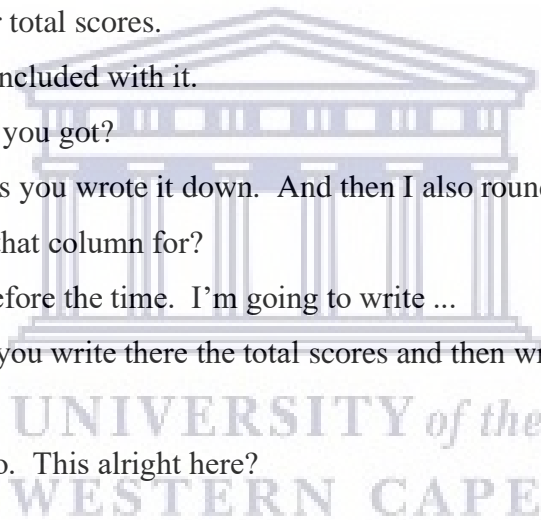
FEMALE 5: I think. I don't know.

FEMALE 4: Change the name.

FEMALE 6: Okay. So, should we do it this way? So, use half of it to write and then half of it's for the table.

FEMALE 4: Are you going to do the table? I don't have a ruler.

FEMALE 3: The smallest actually. So, this will be number one.



FEMALE 1: So, what is that ranking based on? The adjusted one.

FEMALE 4: That one must go from the highest to the lowest?

FEMALE 3: Oh yes. That's right.

FEMALE 6: Unless you want to do two tables and show it with the total from highest to lowest and then show the diff ... Yes. We need to do the comparison.

FEMALE 4: We just copy the totals direct from this.

FEMALE 3: And we make it like this. So, I can take up the whole space.

FEMALE 6: You going to make it how?

FEMALE 3: Look, like this.

FEMALE 6: Yes, it's fine.

FEMALE 1: No but ...

FEMALE 4: What you can also do né, you could write it out, like words – socio-economic index whatever, what we came up with in words, life expectancy times GDP over population of each.

FEMALE 2: And then? So, okay ...

FEMALE 4: Then you can abbreviate it and make it like an equation. Then you can write it out with our consent.

FEMALE 3: Okay. Got it and then I'm going to put the tables on top of each other. Just draw where I must stop writing

FEMALE 6: Must you draw over the space, you say?

FEMALE 3: Alright. Guys, this is not going right. But we'll make it work.

FEMALE 1: A little panic here.

FEMALE 4: So, the first table, she's going to do it according to....

FEMALE 3: Can I put it down ...

FEMALE 4: Yes.

FEMALE 2: Gross development.

FEMALE 4: No. We just go GDP.

FEMALE 3: Whatever you want.

FEMALE 6: I would go with GDP.

FEMALE 2: You can't agree there. It's against the law.

FEMALE 1: Put your half back.

FEMALE 3: What? How do you mean? This is my first table. Then I'm going to do another table at the bottom.

FEMALE 2: Who said yes for development?

FEMALE 1: No. She says development.

FEMALE 4: It's not the gross domestic.

FEMALE 3: I said domestic.

FEMALE 4: Population.

FEMALE 3: I'm going to write this smaller. Make the line here. A bit up. Let me erase that. I'm going to write smaller.

FEMALE 2: Are you going to make it ...

FEMALE 3: Ja. So that everything can fit in. Look at my table. Do you think that's big enough? For the first one?

FEMALE 2: If it's right, we don't know.

FEMALE 1: So what are we writing in here?

FEMALE 4: Province and total.

FEMALE 3: Is this the one?

FEMALE 2: This is what I'm talking about. Thank you, friend.

FEMALE 1: And this one?

FEMALE 2: Total.

FEMALE 3: I don't know if I'm going to say total points or total score but it is according to ... What do they say here?

FEMALE 4: I say score.

FEMALE 3: Must I put score here?

FEMALE 6: Or you could say total waiting. What did I say? I can't read upside down.

FEMALE 2: Table one.

FEMALE 3: Can I get a new page?

FEMALE 6: You can mark with ...

FEMALE 3: Table one.

FEMALE 4: It's a table. It's not a figure.

FEMALE 5: A figure will be a graph.

FEMALE 4: And then you put the figure at the bottom of the graph.

FEMALE 6: I can erase that darling, now continue writing.

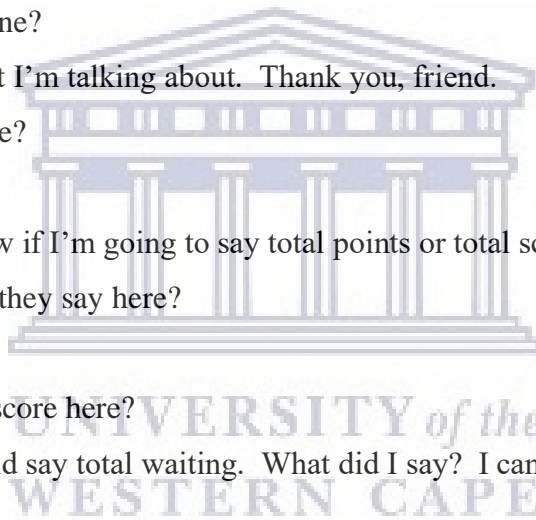
FEMALE 1: I'm just trying to see...

FEMALE 4: You can always add another column if you want to.

FEMALE 3: I just wrote in small letters

FEMALE 1: Economy?

FEMALE 4: So, is this socio-economic index? Is that what it's called?



FEMALE 1: Are we doing ...?

FEMALE 5: That's right.

FEMALE 4: Yes. It sounds right.

FEMALE 6: Are you going to name it here?

FEMALE 4: You knew that there's an equation that needs to be SEI is equal to?

FEMALE 3: Ja. What's the first one?

FEMALE 6: Gauteng.

FEMALE 4: No, no. Oh ja, this one. Here, there, there.

FEMALE 1: Which one?

FEMALE 5: This is how they are totalled. So, you first going to give that total and then the new one.

FEMALE 3: Adjusted total score.

FEMALE 1: Because, the thing is only this long.

FEMALE 3: Where did I write that word? Socio-economic ...

FEMALE 4: And then, in brackets and then you abbreviate it as SEI so that they know.

FEMALE 2: Okay. It's going to be SEI.

FEMALE 3: What else must I write?

FEMALE 5: That's it. And then you're going to go....

FEMALE 1: Do we need to show our calculations, or ...

FEMALE 6: You see, if you, now you're going to ... do you want to abbreviate it or do you just want to go straight into how it's going to be?

FEMALE 1: I don't know what it's going to be.

FEMALE 5: With the constant. Like, because this is a constant.

FEMALE 3: I think I'm going to abbreviate it. So that you can understand it.

FEMALE 2: So you want to go LE, now you want to say SE ..

FEMALE 3: So it's the LE times the GP.

FEMALE 4: Ja.

FEMALE 6: Why don't you first calculate that – the LE times the GP?

FEMALE 4: No, we are going to get to the constant. We are giving the constant. It's basically building up to our finding. But that's going to always be a constant, so you can write it. Make sense?

FEMALE 5: Mmm.

FEMALE 4: That will always be a constant and in this case, that constant is equal to...?

FEMALE 6: One o four

FEMALE 4: That's what I'm saying – you must write that as a constant.

FEMALE 3: But then I must make an arrow here saying it's of South Africa – because this is of the whole South Africa.

FEMALE 4: No. The South Africa's here.

FEMALE 3: What?

FEMALE 4: Do you understand? Like this here, we used the entire South Africa for both of these.

FEMALE 6: Or if you want, you can write here, you can say life expectancy of RSA – GDP of RSA and then, that's how we used them in the equation.

FEMALE 5: Abbreviate it man like this – LE of ...

FEMALE 4: But then she must do it here at the bottom.

FEMALE 5: Ja, that's what I'm saying.

FEMALE 3: You see. No. I forgot to write of South Africa here.

FEMALE 4: It's fine. Write it here. So now you write out LE of ...

FEMALE 5: You either write it like that or you can state it on top, saying life expectancy of....

FEMALE 2: Show on a page what you mean.

FEMALE 4: You can write it like that.

FEMALE 3: Like so?

FEMALE 4: In that corner?

FEMALE 6: And then you say equals to ...

FEMALE 5: You see. But that's what I was talking of ...

FEMALE 4: We want to get rid of the RSA part here. So basically, what I'm saying is, under there, you make a point and you go – Life Expectancy of ... and then, how you use it in the equation.

FEMALE 1: How you're using ...

FEMALE 3: Expectancy.

FEMALE 5: Then you can also write

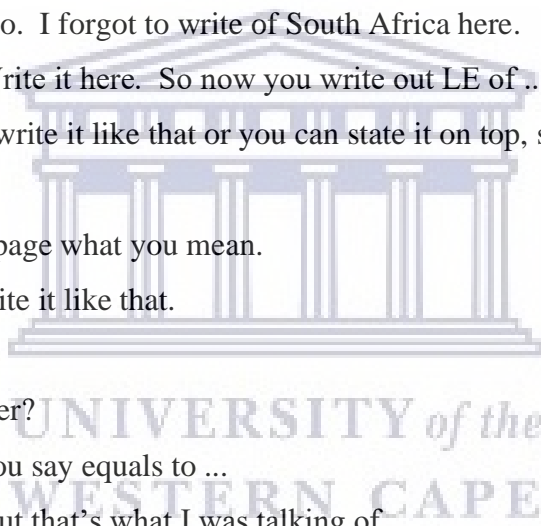
FEMALE 2: Ja. We don't have to... Do you know what I mean? So we don't have to use the RSA all the time.

FEMALE 4: And then you go – what's it? GDP.

FEMALE 3: So, we will be using ...

FEMALE 6: From RSA.

FEMALE 4: Or SA. I don't know what it said there. But it doesn't matter.



FEMALE 3: But can I say 'and'?

FEMALE 4: Ja, you can say 'and' ...

FEMALE 3: I want to write as little as possible now.

FEMALE 6: It must be strong.

FEMALE 4: Would you like me to write it in pen for you?

FEMALE 3: If you feel like it.

FEMALE 5: Gross domestic ...

FEMALE 4: Now, you want to use a different equation.

FEMALE 3: So now, it's just the normal LE times GDP, okay. Can I make it bigger now?

FEMALE 4: Yes.

FEMALE 5: Table One showing.

FEMALE 3: Must I write SAFA?

FEMALE 4: You can write SAFA because it shows in the ... right? Over ...

FEMALE 3: I'm not going to write that whole word. Pop.

FEMALE 5: Province. Population of Province.

FEMALE 4: Look at that line, now look at this line. Skew.

FEMALE 5: So, you need this one now. According to the numbers.

FEMALE 4: So I must write it according to this one?

FEMALE 6: Ja.

FEMALE 2: So, I'm going to ... must I make?

FEMALE 5: No, just this. You don't need these numbers anymore. You only need this number.

FEMALE 4: Alright.

FEMALE 3: And this.

FEMALE 4: Alright.

FEMALE 5: So, number one will be Northern Cape with that number.

FEMALE 4: So, what am I saying, Table Two ...?

FEMALE 6: Table showing adjusted ...

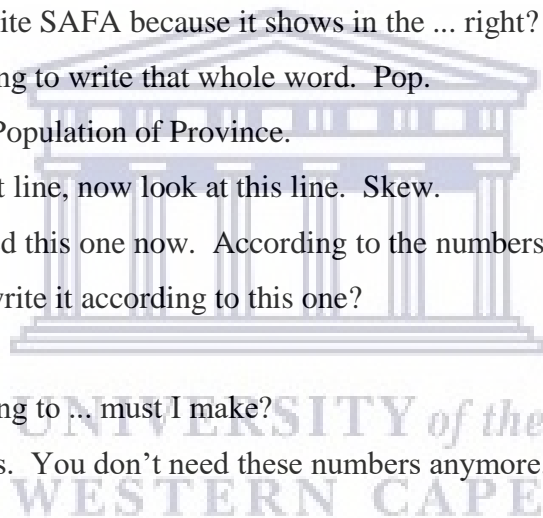
FEMALE 2: Can I use your space?

FEMALE 5: Sorry.

FEMALE 6: Total scores. Or the adjusted total scores according to SEI. Socio-economic index.

FEMALE 3: Table showing or just adjusted?

FEMALE 5: It doesn't matter how you want to start it.



FEMALE 2: It's all yours.

FEMALE 1: Adjusted what?

FEMALE 2: SEI

FEMALE 6: Adjusted – it depends how adjusted SEI total or like, total score. I think we said score.

FEMALE 3: And you can just go Total Score.

FEMALE 5: Mmm.

FEMALE 4: Somehow, I knew.

FEMALE 3: Says make it straight and this thing isn't straight.

FEMALE 4: We appreciate skewness.

FEMALE 3: I agree.

FEMALE 4: Do you see now?

FEMALE 5: You know you still have to do two more né?

FEMALE 1: Two more? Why?

FEMALE 3: Because you have to say one twenty-eight times eighty-one, eight seven five.

FEMALE 2: One twenty ... Are you going to put the numbers now?

FEMALE 4: So, must I write ...?

FEMALE 6: One twenty-eight.

FEMALE 1: LE?

FEMALE 2: One twenty-eight.

FEMALE 3: You already stated here you got to use it of South Africa.

FEMALE 4: I almost wrote out. Must I do it for all of them?

FEMALE 5: One hundred and twenty-eight ...

FEMALE 3: Write.

FEMALE 1: Is it? It's one twenty-eight.

FEMALE 2: What's the other one.

FEMALE 4: It's one ... I think it's eight one eight seven five. I don't know where my book is.

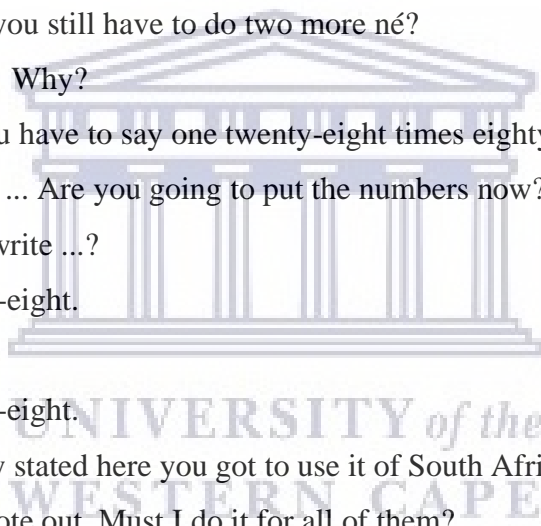
FEMALE 3: Over? I would abbreviate this as Pop hey.

FEMALE 4: Let me just ... Where's a pencil?

FEMALE 6: Times total score. You can go TS if you want. There we go and then you go to this number – ten four eight.

FEMALE 5: You can do whatever you want to.

FEMALE 4: Look how much space now there's left here.



FEMALE 6: Alright.

[END OF TRANSCRIPTION]



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APPENDIX M

Transcript of Focus Group 3 – Soccer Ranking Task

FEMALE 1: Are you guys ready?

MALE 2: There it says more info on the back here.

FEMALE 2: Mid-year population estimate is hectic. Look here I am all for incorporating social practice and stuff but doesn't that take away from the sport itself?

MALE 1: It is easy to make use of the model like this, is there really a winner to Olympics for example?

MALE 2: It's a talent that you need, sacrifice, it is about the individual not about the country.

FEMALE 2: It's fairness of.

MALE 2: It's ranked like that so it's easy to at least see what country they produce what athletes but at the end of the day is there a winner, now they don't get like a special, they don't get given like the torch four years because they won the Olympics I mean.

FEMALE 1: That's also like because Olympics is an individual sport, like doesn't mean that background is like genuinely going to be the same background as your country, even if you come from that country. And also with team sports you can all come from different backgrounds but you are all so good that you made it into the national team, if you think about it, so it doesn't matter your background in this case because you are still good enough to get into the team.

MALE 1: I hear, you could have someone that comes from the worst situation but still ...

FEMALE 2: Exactly but they can be better than someone that comes from the best situation.

MALE 3: I suppose it has got to do with opportunity, so how much weight do we give to opportunity because obviously you get soccer maybe you look at whether it's athletics or rugby or cricket or whatever, or golf. But generally those provinces that have a higher GDP, are going to be playing those sports because you need money in order to, you know, succeed at it because you need equipment and if

you can't afford it, chances are you are not going to go anywhere with it. Soccer is a bit different.... I think you also need talent.

FEMALE 1: Compared to someone that is, look I can't just say it like that but what I am saying is like someone who is academically smart, comes from usually better home, like where they are exposed to certain things.

FEMALE 2: Just open to more opportunities.

FEMALE 1: But whereas a sport is a talent, you can play it anywhere.

FEMALE 2: You can be dumb.

MALE 2: I just wonder so for this particular one, for me personally I think population would make a difference because obviously the more people you have the more chance you have of a talent pool. I think GDP would make a difference because also when it comes to, I mean when it comes to any sport, you need, obviously you need to develop, your body needs to develop physically. So those that have higher income will have better nutrition, which means they will be stronger, better built for sport. They might not have the talent but they have got more of a chance than someone who suffer from malnutrition. Than you actually have a super talented kid from the township, somewhere that has never had the proper nutrition, so when he tries to play soccer his bones break or he gets injured because he hasn't had that nutrition and he doesn't actually succeed. I think life expectancy ...

FEMALE 1: That for me is a bit irrelevant also because the numbers are also very similar if you look at it.

MALE 2: Ja, I just don't feel like it plays much of a role especially if you consider, it's also in the same country, I mean we are dealing with – does it say whether it's male of female soccer?

FEMALE 3: No.

FEMALE 2: Just South African Football Association.

MALE 1: You're guessing it's male?

FEMALE 1: I assume it's male.

MALE 2: So, so we're going to make our assumption straight away, it is a male thing?

FEMALE 1: Ja.

MALE 3: So, there we don't have to worry about the female life expectancy and then it ranges from 55 to 66.

FEMALE 1: I mean it's eleven years.

MALE 1: But there're playing - soccer players are what in their twenties, so does it really make that much of a difference?

FEMALE 2: True.

FEMALE 1: Ja, because there is only a specific prime time of their careers, so.

MALE 1: Probably between like ...

FEMALE 1: Like Cristiano Ronaldo I mean, he is like old.

FEMALE 3: Between 18 and 33.

MALE 2: But still, he's 34 maybe, 33?

FEMALE 2: But he has like that natural talent.

FEMALE 1: But it is over the typical general, the outlier.

FEMALE 2: But he's an exception basically.

FEMALE 3: Yes.

MALE 2: Messi is not much younger than him. They go against the grain, the usual grain but even so that is still well within ...

FEMALE 2: But why? But why?

FEMALE 1: Talent.

MALE 2: Ja, that is why.

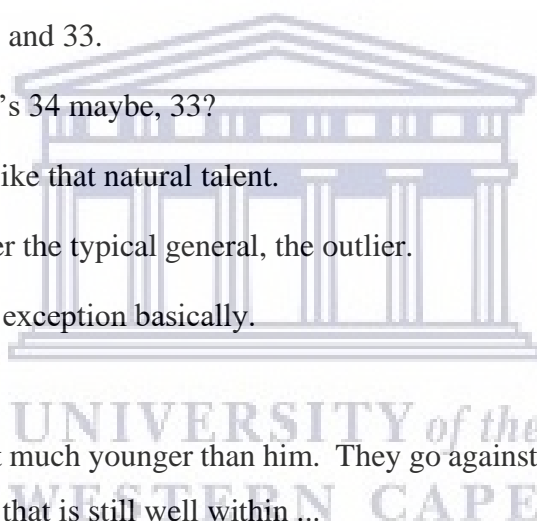
FEMALE 3: Besides talent?

FEMALE 1: He's popular.

MALE 1: Possibly because they have had better access.....

FEMALE 2: But if you look at them, they have the worst background, like they come from really poor ...

MALE 2: They come from poor backgrounds both of them but you look at them since they have been playing, they both got identified fairly early on in life and when it



comes to when they play, you know, they're playing, they are eating correctly, they have access to physios or whatever to make sure that they recover properly. They have all sorts of teams telling them where they should be with their fitness and so they have a whole lot of advisers, so financially there's a big input into their careers which helps that longevity as well. I mean I suppose in general, if you look at sports, sportsmen, ja, whether it's running, cricket, soccer, rugby whatever, they are playing longer. So that has got to do with a lot of bucks, I suppose the more money you have, the better chance you have of playing longer but I think even so, you are not, you are not playing at 55.

FEMALE 1: I don't think it is necessarily money. I think it's more like support and probably. It's like imagine you have to stop playing soccer and people are going to be like why, but you're actually still so young?

MALE 1: But I think ...

FEMALE 3: But also, I don't think it is necessarily like you don't have to come from like you say that you come from a poor background but even if you come from a poor background, if you have that support and the motivation to carry on.

MALE 2: If you get identified earlier.

FEMALE 2: Exactly, then they will support you no matter what, then it doesn't really come – stems from.

MALE 3: But let's look at general because obviously we want to look at general trends with this because you can't pin point, there will be some people that come from the very poor but there will also be some that, do more people come from wealthier homes, you know and obviously, I mean, I think if you look at it, the population is always going to play a role. It's like world numbers. The more you have the higher the chance that you are going to have talent. So, by looking at that straight away and it's kind of shows to a degree, okay KZN is an outlier. Mpumalanga is probably the biggest outlier as far as it goes but otherwise generally it seems to follow, or does it?

FEMALE 2: What are you looking at?

FEMALE 3: We need to design a new ranking system.

MALE 1: I want to look at the results on the log, so Gauteng had the most people and the most points. Mpumalanga is an outlier, meaning second on the log but sixth in population. Western Cape is third on log and third in population. KZN is second in population and fourth on log, so it is not far away. Free State is second last in population but fifth on log.

FEMALE 3: So, we're saying that there is an impact?

MALE 1: So that would impact and I think GDP. I mean soccer players - they are not playing at 55. So that's, the fact that they might not be playing till that age, so we can put a line through that.

FEMALE 2: It's not relevant.

FEMALE 1: Maybe they will become like David Beckham.

MALE 2: Is he 55? No.

FEMALE 1: Pretty old though.

MALE 2: He's like 40. He's just over 40.

FEMALE: But he's still like significantly older than the usual player.

MALE 1: He was like 20 in 99. Just over 40, early 40's. He's still living even with his life expectancy as 55, he would still be earning a lot of money.

FEMALE 2: Ja, you never know.

MALE 1: Okay.

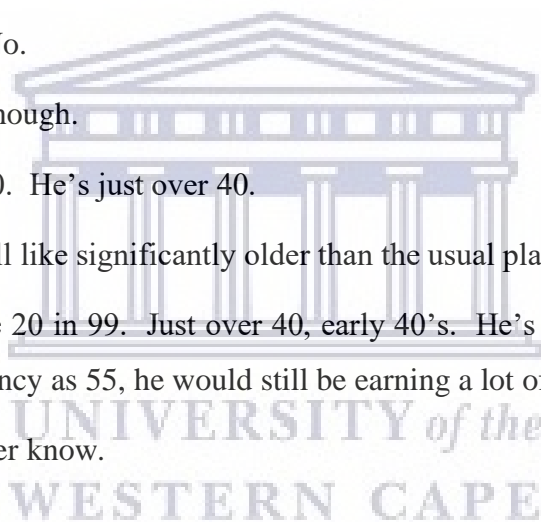
FEMALE 2: No.

MALE 1: So, Mpumalanga basically must be pushed out but how do we do it?

FEMALE 3: We can find a formula to exclude Mpumalanga?

MALE 1: So, these need to be put together in order to create a percentage that it is to going to apply by? So what do we multiply population with? I suppose we can find out the total population of the country, find out the percentage of the population in each or the ratio of each, each province has, multiply that by the GDP and then find the square root.

FEMALE 1: Why, why?



MALE 2: So, for the HDI they had the three criteria right, multiply them and then find the cube root. We only using two criteria's, so we multiply the two ratios, so again find the percentage of the total GDP in each province, that ratio multiplied by the ratio of the total population in each province and then find the square root of that and then that is the ratio that the total points are multiplied by it. As far as how many points ...

FEMALE 1: Oh, so we're sticking with the current system?

MALE 2: Yes. I mean we can look at maybe allocating different points.

FEMALE 3: No, I don't think so

MALE 2: But I think it.

FEMALE 1: Because for me like that is also an international way of ranking soccer.

MALE 1: So, we just want to find an HDI whatever type of ratio to kind of adjust it so that it's fairly in line with their – ja with their upbringing or with their socio-economic backgrounds.

FEMALE 2: Just want to make sure that we are sticking with the current system but we are just incorporating that index?

FEMALE 3: Okay, so what is the formula we're going to use?

MALE 2: So, we are going to take the ratio of population, multiply that by the ratio of their GDP and that's going, we're going to find the square root of that product.

FEMALE 1: So that will be?

MALE 2: And then we're going to take the total points divided by that ratio, by that answer.

FEMALE 1: Ja (yes) to get the actual points?

MALE 1: To get the adjusted weight, their weighted points.

FEMALE 2: What can we call this, it's some kind of index?

MALE 1: The socio-economic index. The SEI.

FEMALE 3: The HDI.

MALE 1: No, it is not the human development whatever they call it.

FEMALE 3: The standard of living index but ja that also doesn't also necessarily show that.

FEMALE 2: Just say RP and RDDP[?].

MALE 1: No, so ...

FEMALE 1: What is a socio economic?

MALE 2: What is the population GDP index.

FEMALE 1: Okay.

MALE 1: PGDP.

FEMALE 1: So, the PDGP.

FEMALE 3: So, the total points divided by your PGDPI because the index is equal to the new number of points?

MALE 2: Ja. You know people - like this is someone's job

FEMALE 1: You know, we sound so smart now.

MALE 3: Some people do like this for a job, it seems so ridiculous.

FEMALE 2: Do we need to actually work out each one or can we just say that is what we would do?

FEMALE 1: I think we must work it out.

MALE 2: Okay.

FEMALE 3: We can. It depends how much time we have.

FEMALE: You've got a what?

MALE 2: I've got a calculator.

FEMALE 1: Is that our ratio?

MALE 2: That's the ratio, ja.

FEMALE 3: What number is this?

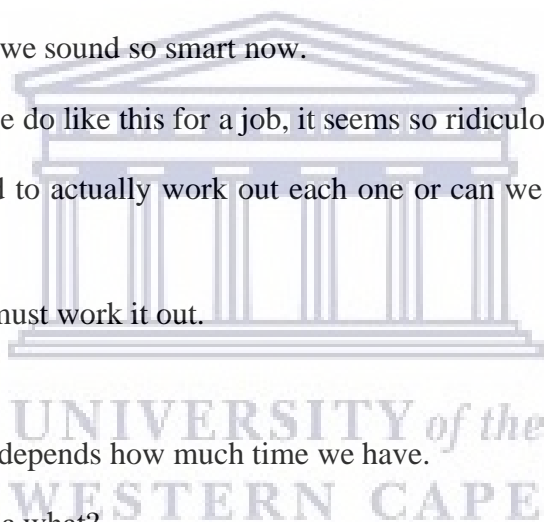
MALE 1: That's the total when it's added up. That's the denominator.

FEMALE 2: Mpumalanga? North West.

FEMALE 1: I can't see, it's upside down, what's happening.

FEMALE 3: So, you worked out the ratio?

FEMALE 1: Of the population.



FEMALE 3: Of each of them.

FEMALE 2: Is that the ratio, right?

MALE 2: Ja those are the ratios.

FEMALE 1: Of the GDP did you do that?

MALE 1: I'm busy doing that now.

FEMALE 1: Oh, this isn't the PGD?

MALE 2: No, no, it's the one part.

FEMALE 2: Did you add all the provincials together?

FEMALE 1: Did you not add the RSA?

MALE 1: What? Oops.

FEMALE 3: Ja I knew it, I knew it, I knew it.

MALE 1: Well spotted. Okay, so that is our denominator.

MALE 2: Just round off to the fourth decimal.

FEMALE 1: Present this new system.

MALE 1: We can say the points columns and then take the final points divided by the 18 you know the PGDI whatever and then show how we worked that out and then kind of work out the new ranking system.

FEMALE 2: Colour?

MALE 2: Ja.

FEMALE 2: The actual calculation, you can just do on the calculator, we don't have to ...

FEMALE 1: No, we don't have to do ...

FEMALE 2: I'm going to say here okay so basically their number of points are now equal, 33 and then we can work out that, using – I'm incorrectly using an equal sign but that is fine.

FEMALE 3: This is normally how it goes in the group work.

MALE 1: Ja, I do all the work.

MALE 2: You know there's like that one, remember that slacks, I've got two every time.

FEMALE 1: So, you can do the PGDPI on the calculator and then just give it to me.

MALE 1: Oh okay, so we've got this – I'm not doing any of this colouring business, hey.

FEMALE 3: No, they are doing that, the creatives.

MALE 2: Point one point seven eight and then I need to find the square root as it is one over two and then ...

FEMALE 1: Did you remember what the other ratio is?

FEMALE 2: Did you already multiply the other ratio?

MALE 3: No, I'm going to check it now.

MALE 1: So, for Gauteng it is point two zero zero six.

FEMALE 2: When it comes to the actual points, are we rounding up and down or do we just give the whole number? Because that gives 164,51.

MALE 2: Maybe just two decimals.

FEMALE 1: Two decimals.

MALE 3: I think that's fair.

FEMALE 1: But on a log really?

MALE 2: The thing is though, sometimes it will be the same, so I think let's ...

FEMALE 2: And we, for now and then our last column can be okay.

MALE 1: Soon then we see our works.

FEMALE 1: Our last column can be okay.

MALE 2: So Western Cape is

FEMALE 1: Wait, why are you doing Western Cape?

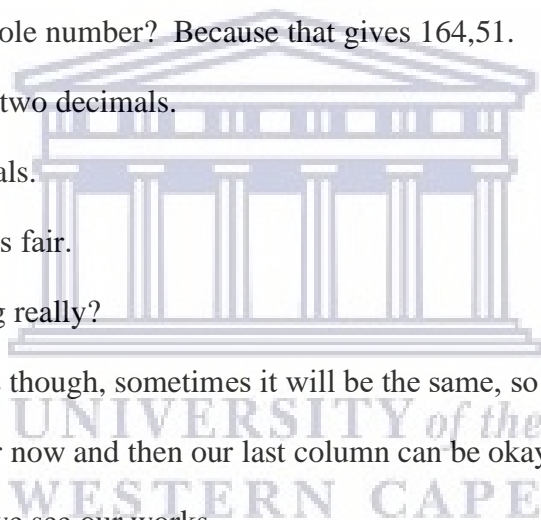
MALE 2: Well that's the next one on the list here.

FEMALE 3: Are we going to do it on the spread sheet and I just kind of fold it?

FEMALE 2: We'll have to clear the table for enough space.

MALE 2: Tick Free State.

FEMALE 1: So, are we going to write literally everything of that just over in colour?



MALE 2: That's the Free State. There's zero point zero seven six one. Northern Cape.
Okay Northern Cape is next.

FEMALE 3: Put it in the tea cup. There we go.

FEMALE 2: Are we going to make a mathematical modelling?

FEMALE 1: Ja we can.

MALE 3: Zero point zero four nine one, zero four nine one.

FEMALE 1: Oh my gosh.

MALE 2: Mpumalanga. Oh no.

MALE 3: Mpumalanga is point zero nine three four.

FEMALE 2: Where are we now, North West?

MALE 2: North West, ja.

FEMALE 1: Can we write our formula?

FEMALE 3: But wait maybe instead of saying PGDPI we do say that over there.

FEMALE 2: Instead of writing ...

FEMALE 3: Oh, put this whole thing here?

FEMALE 1: Yes.

FEMALE 3: No but?

FEMALE 2: Then we don't need an acronym.

FEMALE 1: Just say PGDPI is equal to the whatever, whatever, whatever.

FEMALE 2: Okay, must I write this new ranking system?

MALE 1: It looks for official.

MALE 2: Okay so North West is zero point zero eight six eight.

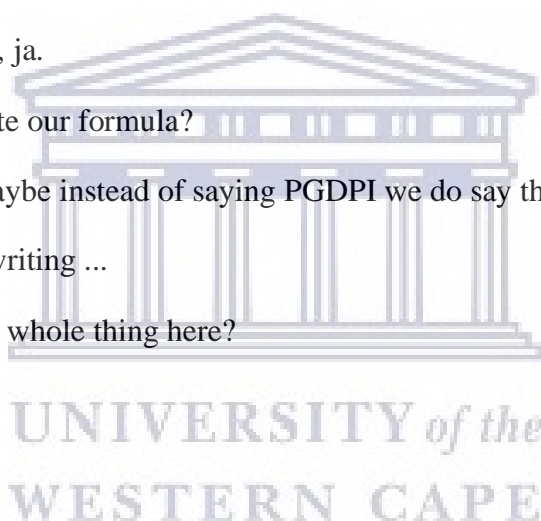
FEMALE 1: Okay.

MALE 2: KZN is next.

FEMALE 1: Those numbers seem pretty high, hey?

FEMALE 3: I know.

FEMALE 2: That's the formula used when we write that formula.



MALE 2: KZN it's point one three six one.

FEMALE 2: Formula used and we can write it in black.

MALE 3: Not zero point zero just zero point.

FEMALE 2: Oh sorry.

FEMALE 1: Or just say design formula. Or proposed formula ja because you're proposing.

MALE 2: Limpopo's next and then ...

MALE 3: Zero point zero nine one nine. I believe there's only one left.

FEMALE 3: Ratio of populace.

MALE 1: What have I done?

FEMALE 2: Times ratio.

FEMALE 3: Can I say GDP?

FEMALE 1: Times ratio of GDP.

FEMALE 2: And just carry on at the bottom of GDP and then we just draw a line. Oh no it is the one in brackets.

MALE 1: Eastern Cape is point nine – point zero nine three nine.

FEMALE 3: Write it here of - and then GDP.

FEMALE 2: Are you sure you worked it out correctly, hey?

MALE 1: Yes.

FEMALE 2: You're sure?

FEMALE 1: Okay, next one, what colour?

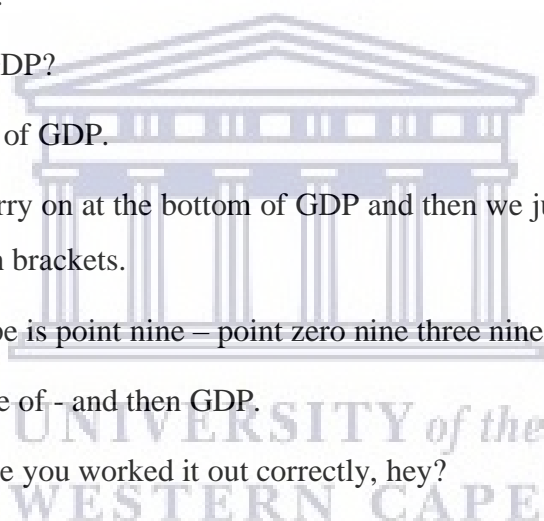
FEMALE 2: Because you ...

FEMALE 3: You pressed which exponent stuff [inaudible].

MALE 2: That one is brown.

FEMALE 1: Because I can't understand how the Northern Cape comes out top but they are second last.

MALE 2: Because - so that will be because look how small the fraction is, so to make that in the denominator so to make that one you have to multiply it by more.



FEMALE 3: So, should we stop writing?

FEMALE 1: I think so.

MALE 1: See, I hear what you're saying because you look at that, it means that the lower rank thing has to score like very min points to win league effectively. Because what we say, who has won it, one that, the [inaudible]?

FEMALE 2: Is Northern Cape.

MALE 3: Northern Cape.

FEMALE 1: Because to me like the point system that is already in place should play the biggest role but this should obviously, the population on the GDP should influence it in some way but not to this extent where someone who is second last comes top, do you know what I mean?

MALE 3: What if ...

FEMALE 1: Like Gauteng, because they're such, because they have more people why does that disadvantage them so that they are now last?

MALE 2: So, what if

FEMALE 1: So maybe we shouldn't have actually taken the population into account because now that I'm thinking about it.

MALE 2: So, we get a ranking of the - so we rank this one to nine, right? And we give them points say eighteen, sixteen and so on so two times the position they're at. Two points - where the position they're at.

FEMALE 2: Okay.

MALE 3: So, it starts with top one eighteen bottom one two. Okay, you with me? And then for that whoever is top, the top one gets nine and the lowest gets one and then we add those, combine those points, so almost two tables together so you get a mean out of the two. What, Catherine? You're lost hey because you don't care about soccer?

FEMALE 1: Everything you are saying is going in the one, going out the other.

MALE 2: So, we're saying that this is now that they're getting eighteen, sixteen, fourteen?

FEMALE 3: But then what are we going to do with that number?

FEMALE 1: Why don't you want to then just leave this total as is?

MALE 2: So, we want to add that in but we only want to give it a third of a weighting for the adjusted total. We're saying this is making up two thirds? This total here? And then for that, whoever has got most, so who has got most, Northern Cape, so Northern Cape get nine, so their total points overall was thirteen but Gauteng has got eighteen plus, where do they rank, probably the last?

FEMALE 1: Gauteng?

FEMALE 3: They're last.

MALE 2: So they get one there, so they get nineteen points overall.

FEMALE 2: That's a nine.

MALE 2: Where does Mpumalanga? So let's just rank them one two ...

FEMALE 1: Can we do this one now ...?

MALE 2: No, no just - just they have one, two, three, four.

FEMALE 1: Now then this isn't going to be everything that you ...?

MALE 2: Okay, Gauteng are getting one, Mpumalanga are getting three,

FEMALE 1: I thought that's wrong.

FEMALE 2: I thought so too.

FEMALE 3: Or we can say we revised the form.

FEMALE 1: What is he doing? No-one knows?

MALE 3: But like after this he is going to go on the map because it's too much work.

MALE 2: Not too much, you've been training me for like the last semester.

FEMALE 1: It's true.

MALE 3: And two years.

MALE 1: What am I doing?

FEMALE 2: What are you doing?

FEMALE 1: That's what we're asking. [Giggling].

MALE 2: Okay, so that's not the point, so I guess they get one point, they get nine. They get eight.

FEMALE 1: That's usually how it goes so [talking together].

FEMALE 2: On the basis of what, of what is the basis?

MALE 2: I'll tell you now, hang on. That's right. So, this is saying, we're giving them a point.

FEMALE 3: So, they're saying they are last, they get one?

MALE 1: Yes. So, they getting points for where they rank after the PGDPI, ja we're adding this plus the log points and adding those together, whoever has the most points after that points, so okay. Mpumalanga will get seven, Western Cape will get four.

FEMALE 3: So, is this the number of new points now?

MALE 1: Ja. So that's their total overall points where this worked ...

FEMALE 3: But it's not the new number of points?

MALE 2: This will be the total, so it is the amount of points they get for finishing on the log and then added the number of points they get after those log points are gone through our system and so there's a two ranking. So, there's a one to nine ranking over here, a one to nine ranking with adjusted points and then we add the two.

FEMALE 2: So, you basically checked where they are on this ranking and where they are there?

MALE 1: And we've given more weight onto the ranking that they have on the log.

FEMALE 3: With regards to how many games they won, loss and drawn, okay that makes sense.

MALE 1: Who is next, Free State? Gets eight, North west six, Limpopo gets five, so that will be our new points total.

FEMALE 2: Let's see.

MALE 1: So, then Limpopo would, Mpumalanga would win because they've finished second but yet their PGDPI was obviously quite low, which means you would have expected them to struggle and do badly so they have done well despite the fact that the economic and population equation was poor. So that has given them the extra boost of points. Where Gauteng kind of - because the PGDPI is

high, you expect them to win because they've got the most money, they've got the most people to choose from, so theoretically they should be one's - they're getting in a way, almost penalised for that.

FEMALE 3: So, what's the new ranking?

FEMALE 1: What?

FEMALE 2: I gave him this.

FEMALE 1: It makes sense.

MALE 1: The only way we can ...

MALE 2: The only other way is that this, is this pointing system.

FEMALE 1: Where's this coming from that? So, because there are nine.

MALE 2: The thing is we have given them one to nine.

FEMALE 2: You doubled them?

MALE 2: But I feel like that's ...

FEMALE 2: You've doubled it and then you've added on what they ranked here.

FEMALE 1: So, you have points here, you have points there and points there?

FEMALE 2: Ja.

FEMALE 1: So, you have three sets of points?

MALE 2: No, these points don't count for anything.

FEMALE 1: They go into the system.

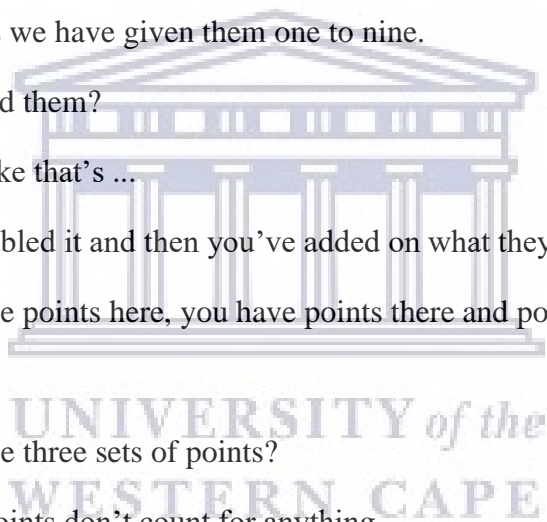
MALE 2: So, it's one, two sets effectively but I feel like that also not ...

FEMALE 3: You can have a system like this because remember all of this goes through a computer so ...

MALE 1: I feel like at the same time, it is also not fair though.

FEMALE 3: Why?

MALE 2: So, I mean Gauteng have won eleven matches, it is two more than Mpumalanga and the Western Cape. Realistically, mostly because their PGDPI is so much more than anyone else's. Realistically they're only going to get nineteen points because they are going to get eighteen for winning the league but they're very



rarely going to be higher than last place when it comes to the – going through this, so they are always going to be nineteen. It's not like Mpumalanga, they, okay they are only one point behind one the log, so they probably do serve the win but like you look at ...

MALE 1: Nineteen.

FEMALE 2: A much lower GDP.

MALE 3: So, I don't know whether we ...

FEMALE 1: And people.

MALE 1: Maybe change the points for this. Divide this by 100.

FEMALE 2: But why?

MALE 1: Then you add that to the points. So, it's thirty-three plus one point whatever plus three points, maybe that's a fairer way of working it out.

FEMALE 2: I also think so, hey.

MALE 1: So, whatever their log points plus.

FEMALE 2: So, let's see where they rank if we do that?

MALE 1: Plus, a 100th of whatever. Okay.

FEMALE 3: So, if we say, so we said divide by 100?

FEMALE 2: Now must we add divide by 100 now?

FEMALE 1: And then, we're going to say?

FEMALE 2: Mpumalanga is three comma four three?

FEMALE 1: No, the changing is not ...

FEMALE 3: What are you adding?

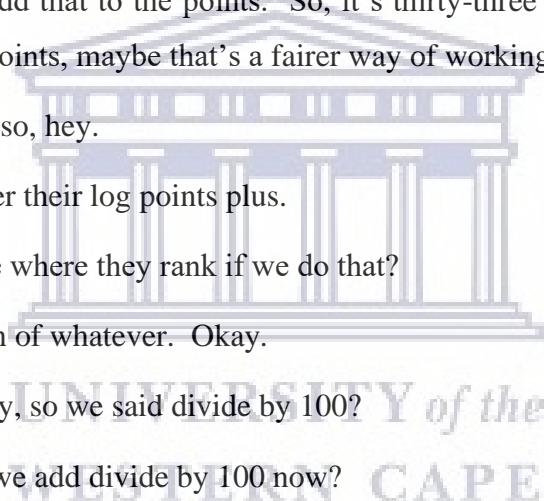
FEMALE 2: The original points.

FEMALE 2: To the original and what about this?

FEMALE 1: No, we're abandoning that for now, we're checking ...

FEMALE 3: I'm not, I'm not happy with this. I'm not happy with this?

FEMALE 1: Two comma three eight.



FEMALE 2: Because then this is taking like the main, we're giving a lot to this, then to the actual? Hey?

FEMALE 3: Are we done after this? Do we need to go home?

MALE 2: Are you moving towards your masterpiece?

FEMALE 3: No.

MALE 2: You can display it

FEMALE 1: It looks a bit, like there's about two different moves.

MALE 2: So, what do you reckon, this is a bit more fair then?

FEMALE 1: I think this is more fair because you're putting, you still giving this the, the upper hand compared to now you're introducing ...

FEMALE 3: New values.

FEMALE 2: And also, we are sticking with our original system, but we are just now dividing this by 100.

MALE 2: Yes.

FEMALE 1: I think this, so maybe.

FEMALE 3: So, what is the new formula, what is the right revised formula?

MALE 1: So, it's not a new number of points now, it's a new ...

FEMALE 2: Adjusted.

MALE 3: So, call it there, the weighted points.

FEMALE 1: We can just say ...

FEMALE 3: You could just say, we just adjust this formula, so we'd make it ...

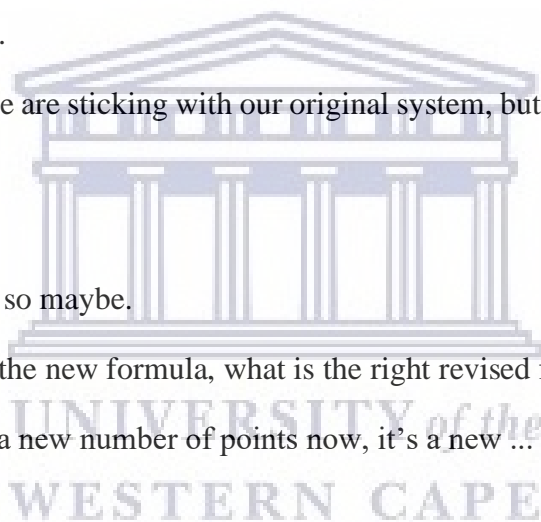
MALE 1: Or we just ...

MALE 3: So, it's basically this ration divided by 100.

FEMALE 1: Times the PGDPI.

MALE 3: Or whatever ja, so either take that away and just put that whole thing divided by 100 or 100 or, so anyway that 100 [inaudible] so that means it's fine, we work, in my.

FEMALE 2: We're putting this on there.



MALE 3: Yes.

FEMALE 3: Each country now?

MALE 3: It is each Province.

FEMALE 1: I heard the same thing man.

MALE 2: Is it really though?

FEMALE 1: Cape Town is its own country anyway.

MALE 2: Fair enough.

FEMALE 1: Okay so I'm going to say here Province is first, just make a heading.

MALE 3: Ratio, wait should we add before that?

FEMALE 2: That was me.

MALE 3: Because these numbers point, we've got probably make reference to the fact that this needs to be added to the current points.

FEMALE 1: Yes. Yes.

FEMALE 2: We will. In bold and big.

FEMALE 1: We should have used the form.

FEMALE 3: It's on that but you can try.

FEMALE 1: Okay provinces, who's ranked number one?

MALE 2: Messing up my whole day.

FEMALE 3: No don't rank them now. Just do it like that then we rank them afterwards. And then we see.

MALE 3: We haven't worked out what the ...

FEMALE 2: New rankings are?

FEMALE 1: Ja, here's it.

FEMALE 2: So, must I just write anyone?

FEMALE 1: Gauteng. You can just say GAU.

FEMALE 3: What's your opinion on the ...

FEMALE 2: Is equal to thirty-three divided by – should I just give the whole number?

MALE 3: You can multiply it so ...

FEMALE 2: So, 200,6?

MALE 3: Isn't it twenty comma six?

FEMALE 2: No.

MALE 3: Twenty comma zero six?

FEMALE 2: I don't know.

FEMALE 1: No, it's 200.

FEMALE 3: Is it 200?

MALE 3: You mean twenty comma six?

FEMALE 3: It's twenty commas.

FEMALE 2: Twenty comma?

MALE 2: You only move it two places.

MALE 1: You just need to ask.

MALE 3: So, we said it should be one point, four points added, is going to be twenty. So, it's the comma is only moving two places, maybe do that.

FEMALE 2: Ja, that's what I did, I actually ja, I just said one comma six four, three commas, ja.

MALE 1: Ja. So, it is divided by twenty point zero six.

FEMALE 3: Okay, so twenty comma six?

FEMALE 2: Twenty comma ...

FEMALE 3: Six zero six.

MALE 1: Zero six.

FEMALE 2: One comma six, I rounded it up, should I - six five,

FEMALE 3: One comma six five right.

FEMALE 1: There next. Okay?

FEMALE 2: Ninety comma?

FEMALE 3: No, nine comma three four.

MALE 1: Nine point ...

FEMALE 3: Nine comma three four.

FEMALE 2: Ja but ...

MALE 2: Fix it.

FEMALE 2: But it's going to be so ugly.

MALE 2: Fix it.

FEMALE 1: Just scratch out the zero.

MALE 2: Then you have to refine it.

FEMALE 1: That looks like eight.

MALE 2: Scratch out the whole thing.

FEMALE 3: Is equal to three comma four three right, Western Cape WC.

FEMALE 2: Thirty divided by twelve comma six.

FEMALE 1: So, we settled with that?

FEMALE 3: Two comma three eight. Right KZN equal to twenty-eight divided by thirteen comma six one, is equal to two comma zero six. Okay.

FEMALE 2: What's this word here?

FEMALE 1: Provinces.

FEMALE 3: Free State

FEMALE 1: Twenty-seven divided by ...

FEMALE 3: Okay North West?

FEMALE 2: Twenty-six divided by.

FEMALE 1: Eight comma six eight.

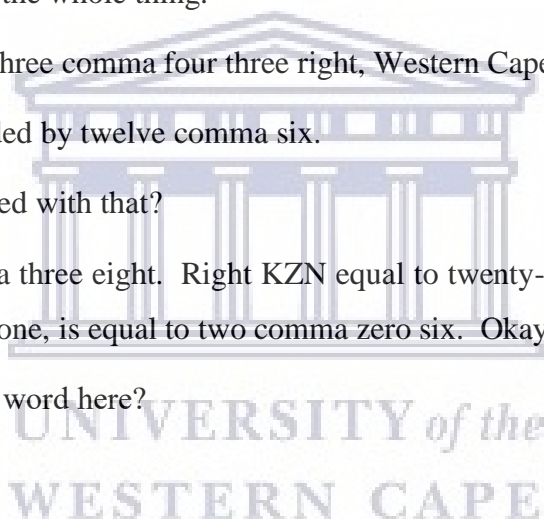
FEMALE 3: Equal to three.

FEMALE 1: Comma zero, zero.

MALE 2: So, it's not ...

FEMALE 3: Equal to twenty-four divided by nine comma one nine.

FEMALE 1: Northern Cape is equal to twenty-two divided by four comma nine one



FEMALE 3: Divided by four comma nine one, is equal to four comma four eight.

FEMALE 1: And then Eastern Cape

FEMALE 3: Nine comma three nine equal to two comma two four

FEMALE 1: Now we're ranking them according how the rank.

FEMALE 3: So now we take this number and we add it to the total number of points on the normal system.

FEMALE 1: As the rank?

MALE 3: But should we maybe make note of that?

FEMALE 1: Ja we can say.

FEMALE 3: We can make a column.

FEMALE 1: Okay so make a column. So, a line?

MALE 3: Okay and call it, what's that? What is that log point?

FEMALE 2: So, make a new heading.

MALE 3: And then we can go total point is log point plus ...

FEMALE 1: But you should have used the black for everything then

FEMALE 2: No, we should actually put that points here because we want one.

FEMALE 1: It's the log points and then ...?

MALE 2: Total.

FEMALE 1: Two, three columns.

MALE 2: We want total points as the.....

FEMALE 1: Because we going to have the log points here and then we ...

MALE 2: Total points.

FEMALE 2: And then the total points will – it is not going to be in order, so then we will actually start ranking them.

FEMALE 1: So, we can just say log and then ...

MALE 3: Points.

MALE 2: Put log points and then the total points.

FEMALE 1: Ja, log total and then ...?

MALE 3: And then rank. Make it straight.

FEMALE 2: And then perfect and then rank, that's the last one.

MALE 3: Ja but now underline it.

FEMALE 2: So, their log points will then add and then we would add

MALE 2: It's thirty-three, their log points are thirty-three.

FEMALE 1: Add these two?

FEMALE 2: Okay so what's it, log points is ...

FEMALE 3: Thirty-three. Okay next.

MALE 1: I don't even know which paper I'm working off anymore, like there are so many pages here.

FEMALE 2: Okay next thirty-two.

FEMALE 3: That's the points.

MALE 2: Total points is then thirty-four.

MALE 3: We don't know what the rank is yet.

FEMALE 2: Ja, guys.

FEMALE 3: Okay green, thirty-two.

FEMALE 1: And then thirty-five comma four is red. Okay that is thirty.

FEMALE 2: Just thirty?

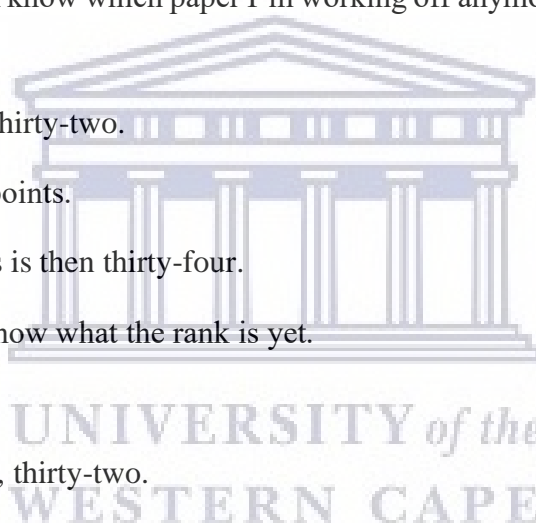
FEMALE 3: And then thirty-two comma three eight. Okay then it's twenty-eight and thirty comma zero six. Then it's twenty-seven and thirty comma five five. Okay twenty-six ...

FEMALE 1: Twenty-nine?

FEMALE 3: Twenty-nine, then it's twenty-four.

FEMALE 2: What? What? Oh?

FEMALE 3: And then it's twenty-six comma six one. Then it's twenty-two, so it's twenty-six comma, thank you very much, Liam [inaudible].



FEMALE 1: Twenty-six comma?

FEMALE 3: Four eight. And then it's twenty-one, so it's twenty-three comma two four.

FEMALE 1: So, the new rank will be Mpumalanga is number none.

FEMALE 2: So, can I add that one?

FEMALE 3: So, they're one then obviously Gauteng is two. Then ...

FEMALE 1: Western Cape.

FEMALE 2: Ja is three. Then Free State is four.

FEMALE 3: And then what is ...?

FEMALE 1: Kwazulu Natal.

FEMALE 2: Kwazulu Natal is five. North West is six. Limpopo ...

FEMALE 3: Seven.

FEMALE 2: Seven, eight and nine.

MALE 2: Which is great because ultimately, it is still very similar to what ...

FEMALE 1: It's similar yes.

MALE 2: Ultimate log points are.

FEMALE 1: So, it's just a shift here and here. Do we have to say anything else? If they say like.

FEMALE 2: What's this?

MALE 3: We can redo this whole table though on another page.

FEMALE 2: No, we get the message across, we get the message across.

MALE 3: Make it just a neat table but this is like our formula together.

FEMALE 3: Exactly.

[END OF TRANSCRIPTION]

APPENDIX N

Transcript of Focus Group 1 – Olympic Ranking Task

FEMALE 1: I have something that will ...

MALE 2: Yes. But basically, they are melting phones, like they are doing that fractionation man, when you burn things to get the elements out of it.

FEMALE 1: Yes.

MALE 2: So, then they're going to burn that so that they can get all the gold out of all the used phones. And then make gold medals out of that.

FEMALE 1: Wow.

FEMALE 2: But won't it make sort of like, oh, no it won't because they would have like extracted other materials.

MALE 1: Yes, like this.

FEMALE 2: But even impurities.

MALE 1: Think about fraction and burning man. Like when you burn at different temperatures then different things are busy melting. Like in the gold would melt out.

FEMALE 1: Boiling point.

MALE 2: Yes. Those things. Now the other thing is I'm seeing that they are measured like – because did you see what these numbers actually represent?

FEMALE 1: Yes, the total number of medals.

MALE 1: The total medals till by the ranking position, If that makes sense? Like a total podium position. But now they're saying that you should include a ranking system.

FEMALE 1: Because we need to complete the activity.

MALE 3: This Olympic Ranking table is pointing out that there's countries who got a lot of silver medals right, but then a country who got far less silver medals than

them but only got like one more gold medal. They are ranked higher on this given ranking list. This is a problem.

FEMALE 2: Higher, yes.

FEMALE 1: But, like why?

FEMALE 3 : Look at Switzerland, it has like seven medals in total. And look at like Sweden it has 11. Yet, it is lower than Switzerland.

MALE 2: And Sweden only have one less gold medal than Switzerland.

MALE 1: But they have like ...

FEMALE 1: Six silver medals and three bronze medals.

MALE 3: Sweden have four more silver medals, yes, in silver medals. And one medal more on the bronze medals meaning they are ...

MALE 2: ... a better performing country at the Olympics.

FEMALE 3: So, what can you focus on here, on the core quantity?

FEMALE 1: They are focusing more on the...

FEMALE 3: Gold.

MALE 2: On the gold.

FEMALE 1: Or maybe it's developed countries more than like your under- developed countries or I don't know.

FEMALE 3: But not the number of people just ...

FEMALE 2: Yes. That participated. Like what was asking.

MALE 3: So okay, would we say then the alternate model would have to be how many athletes were in the first, second and third place, meaning how many athletes obtained gold, silver and bronze medals? Then we would rank them according to the total number of medals.

FEMALE 1: But the thing is the value of the medal, I think the value of the medal also counts.

FEMALE 2: Yes. It's what they focus on.

FEMALE 1: They focus on the value of the medal.

FEMALE 3: How many people got gold and all that?

FEMALE 1: But okay I'm just saying, look at the gold medal for example, you won a gold medal but why would they count gold medal, as what? Like it's the most for the medal but when they're counting it is [talking together].

FEMALE 2: And it's really – it really shows that because if you can like see from Switzerland and all the countries with three gold medals and then you see it's silver and bronze. If for example Iran has the same amount of gold medals as Switzerland, Switzerland has one more silver medal as Iran but Iran has 2 more bronze medals as Switzerland and Iran is ranked lower than Switzerland.

FEMALE 1: The medal table ranks countries on the number of gold, silver, and bronze medals they have won. When there are ties, they look at the number of silver medals and thereafter the number of bronze medals.

FEMALE 2: ...all the countries. They disregard silver and bronze.

FEMALE 3: But why do they count them in the total if they are only focusing on gold?

MALE 3: But do you feel that these rankings are accurate? Do you think they are accurate if you base them on the gold medals only?

FEMALE 1: No, I don't think they are.

MALE 3: So then what do you think is being like ignored in this table?

FEMALE 1: I think, okay. They can generate a score for each medal. They can award for example, three points for a gold medal, two points for bronze and one point for silver. Then the weight total will be 3: 2 : 1.

MALE 3: Like then take into account the total number of medals that each country has. Because otherwise they should have showed only the gold medals.

FEMALE 1: Now they're ranking it according to all the medals won.

FEMALE 3: I disagree because if you look at the table, Denmark have fifteen medals, yet their position is 28 and Switzerland obtained seven medals and their position is 24. Do you understand?

FEMALE 2: I understand. So, if ...

MALE 1: Oh, if they're presenting all this data then they have to include all the data into why they are ranked. Okay.

FEMALE 3: This is just like, it's like it's just there to be there.

FEMALE 2: Yes.

MALE 3: This is the data that's used by the media. This is important for the media. The media uses these rankings. So, the media ...

FEMALE 1: For what?

MALE 3: Like this is what they represent.

FEMALE 2: For us to see which one is good.

MALE 3: Apparently, the Olympics rank the country according to how many gold medals won. They don't rank the country according to the total amounts of medals won. If that makes sense. If there is an equal amount of golds, then the order is based on the number of silver then bronze.

FEMALE 1: Can we look at our model?

MALE 2: I think a weighted ranking model is more reasonable and will allow contributions from all athletes.

FEMALE 1: Our model must be an improvement of the given model. It must give the most credit for gold medals and some credit for silver and bronze medals.

MALE 2: Maybe it can also include the country's population and gross domestic product. I'm not sure if it would help us.

FEMALE 1: I think our model must be reasonable.

FEMALE 3: Let's look at Ukraine and Sweden, they have the same total of medals and yet Ukraine is ranked at number 31 and Sweden is ranked at number 29.

MALE 2: Okay. Wait let me just check.

FEMALE 1: I don't know.

FEMALE 3: So I think like when we reconstructing on the designing or we can like focus on the total models. Then like we put the Denmark as the first one because it has many medals.

FEMALE 1: Maybe we can arrange this in a certain the order.

FEMALE 3: And like we should focus on the total medals won.

MALE 2: Check this out. So, if Switzerland has three gold medals and Iran has three gold medals, right, they are saying then that even though Iran has more bronze medals but Switzerland is ranked lower than Iran.

FEMALE 1: Exactly what I was saying.

MALE 2: They have more bronze medals and their total medals are higher.

FEMALE 3: Exactly. They're not looking.

MALE 2: But they have one more silver medal. Wait. What if every medal counts for one point? Like if you're measuring it like that. Like let's say they say you have ...

FEMALE 3: If you have got one gold medal.

MALE 2: You have one gold medal that's- but then we spread it into three man. If you have one gold medal you have three points.

FEMALE 2: Okay.

MALE 1: Do you hear what I'm saying?

FEMALE 2: But if you have got silver you've got two points and then bronze is one point.

MALE 1: One point. So then if you add them up like that then the ranking would make more sense. Do you get what I'm saying?

FEMALE 2: Yes.

MALE 3: So then in that case, so let's just check if that - how that system works. Let's say ...

FEMALE 2: If you have one gold.

MALE 3: Let's use that model to describe Switzerland quickly. So, Switzerland would have ...

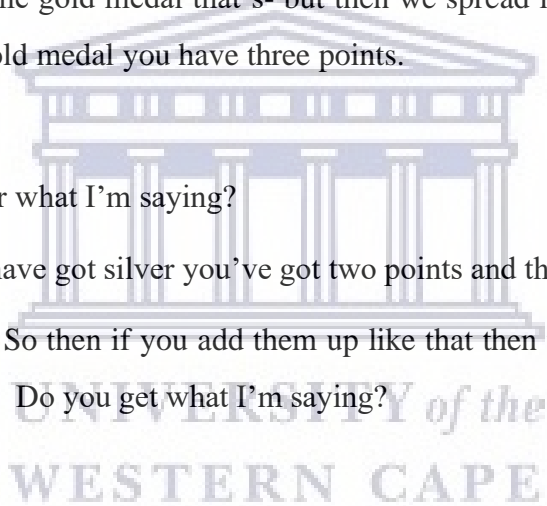
FEMALE 1: Okay, gold would be three times three that's 9.

MALE 3: Three times three and silver, it would have two times two and

FEMALE 1: So, and then bronze, that's like one times two.

FEMALE 2: So, it's going to be a total of 15.

FEMALE 3: Okay, Switzerland would have a total of 15.



FEMALE 2: No guys. What ties mean because it's saying there that currently the media is ranking the countries according to the number of gold medals of which it's one and the same. And then it continues and says when there are ties the number of silvers come into context.

MALE 3: Yes.

FEMALE 2: What does that mean?

MALE 3: Then they're looking at the silver, who has the most silver and all that stuff. But like that's quite a tedious process, man. If you just had one system that one time said look here, so gold is this many points. Silver is that many points. Bronze is this many points. And if you have this much then you must be able to compare it against the other country. Do you hear what I'm saying?

FEMALE 1: So basically, the rankings are just based on the number of medals won.

MALE 2: Yes.

FEMALE 1: It's unfair

MALE 2: Firstly, on gold medals. Like even with people because they are saying now it's like they're first measuring it on gold.

FEMALE 1: Yes.

MALE 2: The gold tie then they measure it on the silver. Silver tie then they measure it on the bronze. But like what does that exactly then say about the ranking?

FEMALE 3: So, I feel like this way. I think maybe our model should be based on 3, 2 and 1.

MALE 2: Yes.

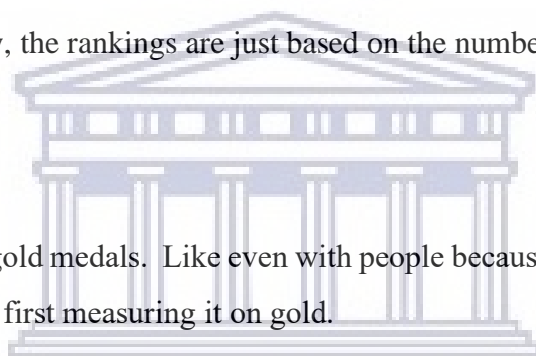
FEMALE 1: You say that okay, if you got one gold it counts for three.

MALE 2: Yes.

FEMALE 3: Each gold counts as 3.

MALE 2: Yes.

FEMALE 2: ...counts for three and then make silver count for two and then bronze counts for 1.



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MALE 2: Then it will make sense if you have three bronze medals and then you have nine points. But then the person above you in the ranking only have one gold medal.

FEMALE 2: You see, now it makes more sense.

MALE 3: He has three medals and you have three medals but it's fair now because according to the points the one with the three bronze medals earned three points each. And according to the points, the one who only won one gold medal earns three points because a gold medal is worth three points.

FEMALE 2: This ranking is more fair.

MALE 3: Yes, more fairness in that.

FEMALE 1: So, if you have one gold medal, then you have three points.

MALE 3: And then one silver, two points.

FEMALE 2: And then one bronze let's say one point.

MALE 3: So then if we get a tie it's like, it's a tie.

FEMALE 2: It's a tie. You've got gold. We've got gold.

MALE 3: This is how we weigh the tie—do you get what I'm saying?

FEMALE 2: Yes.

MALE 3: Because if they then put this country over that country or whatever you can make your own assumptions on that. But the system is making them according to certain points.

FEMALE 1: But it's for one bronze is?

MALE 3: One point.

FEMALE 2: Yes.

FEMALE 1: Okay.

FEMALE 2: Silver, one silver two points.

MALE 3: The model ...

FEMALE 2: One gold, three points.

MALE 3: Yes. So, like, I'm just checking according to our system.

FEMALE 2: Yes.

FEMALE 2: So, how manyor else the medals.

MALE 3: Yes.

FEMALE: Moment of...

MALE 1: I want to see if Iran is going to be above Switzerland in our system. Just to see how it works.

FEMALE 3: Okay.

MALE 1: So, three times three is two times one. No. One times two.

FEMALE 3: Let us stop here.



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APPENDIX O

Transcript of Focus Group 2 – Olympic Ranking Task

FEMALE 1: Okay. So obviously, if we do it in terms of maths tests because we're speaking mathematics maybe we rank gold as a five.

FEMALE 2: Yes.

FEMALE 1: And all for gold.

FEMALE 3: And then maybe we rank silver three.

FEMALE 2: Okay.

FEMALE 3: And then maybe we rank bronze 1 point. And now we can see, Switzerland has three gold medals. So, this is 15 and it has two silver that is six, and it has two bronze so that's two and this total will be then 15 and 6 is 21 plus 2 is 23. And then here it's again 15. And then from the totals we'll see who's actually ranked first. Because I mean here, this person what this country here, Denmark has seven bronze and I mean that is good even though it's not gold ...

FEMALE 1: Gold.

FEMALE 2: ...but seven people got a medal, you know what I mean. I feel like that is a fair - if you look at it in terms of maths.

FEMALE 5: Yes. Okay, that makes sense yes because I mean here it makes no sense why they like three gold, yes, three gold medals but they only have seven in total. Where here Denmark is 15 but they are ranked ...

FEMALE 1: Just let me work it out like that so we can see.

FEMALE 6: So that is three and this is four times this is four. So 15 and 3 is 18 + 4 is 22. And then this is 15 ...

FEMALE 3: This is ...

FEMALE 2: Let's just stop here.

[END OF TRANSCRIPTION]

APPENDIX P

Transcript of Focus Group 3 – Olympic Ranking Task

FEMALE 1: I think the ranking system should be about how many medals are won in total and not how many gold medals the country won.

MALE 2: And I think there should be weighting to it.

FEMALE 1: No. That's what I was. Like they should work according to a point system. So, say for example a gold medal will carry ...

MALE 1: 3 points.

FEMALE 2: Yes, gold will carry 3 points. A silver will be 2 points.

MALE 1: And a bronze will be 1 point. So, it's fair in a sense because you're ranking first, second, or third.

MALE 1: You might get more medals of a weaker model.

FEMALE 3: Because looking at Denmark who are ranked at 28th position...how can a country be so far down but they've won 15 medals in total.

FEMALE 2: They've got more than double than Switzerland who are in the 24th position.

FEMALE 1: Okay. So, if we have to reorganise. So, 3 times 3 is 9.

FEMALE 3: So, we're creating an alternative.

FEMALE 1: 2 times 2 is 4. And then that's 2.

FEMALE 2: So, by – we work on points.

MALE 3: 6 and 8 ...

FEMALE 3: We're rearranging it.

FEMALE 2: So, for gold, silver, bronze.

MALE 1: So, then this new number becomes.

FEMALE 1: 9 + 4 is 13 ...

MALE 2: 15.

FEMALE 1: Plus 2.

FEMALE 3: 11.

FEMALE 1: You want a calculator?

MALE 3: 18.

FEMALE 1: $9 + 4$ is 13.

FEMALE 2: Just now what are we going to do? Can't you set up the same thing?

MALE 3: Then the gold gets precedence.

FEMALE 1: Yes.

FEMALE 3: Okay.

MALE 3: So then silver so then, so use the new points model but then if they're the same then you go to the gold.

FEMALE 2: Gold, yes.

MALE 1: Then silver then bronze.

FEMALE 1: Should I put that down?

FEMALE 2: Yes.

FEMALE 3: But aren't you going to get to the same situation than what's already here now?

MALE 3: More or less work it out and see.

FEMALE 1: Let's see if we have ...

FEMALE 3: So let's first see, yes.

FEMALE 2: But it's good to know because at some point you will encounter something like that where they will have the same number of points.

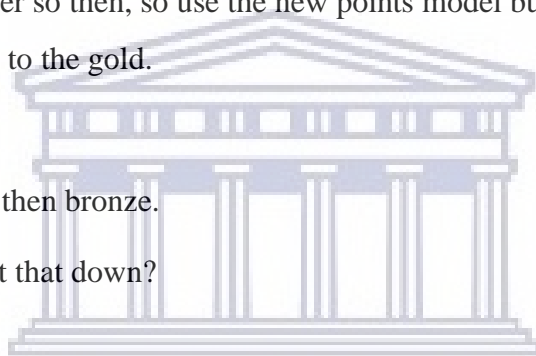
FEMALE 3: So, here's the same.

MALE 2: There's a few.

FEMALE 1: Okay.

FEMALE 2: And the first two.

MALE 1: So, by looking at South Africa and Ukraine, I see according to our model, they have the same points, on 20. South Africa though– the better the colour medals



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the more weighting it has. When looking at the given table, they both have two gold medals so then they'll be equal. Then by looking at South Africa, they have one more silver than Ukraine.

FEMALE 2: And Ukraine has two more bronze than South Africa.

MALE 1: So, then they get ranked above South Africa they have a greater total number of medals. But both will be above Switzerland in our alternative table.

FEMALE 3: Even though South Africa has two less bronze medals than Ukraine in the given table.

MALE 2: Because – yes.

FEMALE 3: But essentially Switzerland has two bronze medals in the given table.

MALE 1: The other option is to then reverse it totally. So, you have your points on weighting and then total number of medals. And then gold [inaudible] never be this ...

FEMALE 2: But...

MALE 3: Because you got a total number of medals and then gold, silver. If they have same total number of medals, then they're probably going to have the same make up.

FEMALE 1: No. They have the same total but ...

FEMALE 3: They have the same but 20 and 21.

MALE 2: That's what I'm saying. So, the points are the same but then you go to total number of medals as your next criteria, then it means that this is all going to be the same.

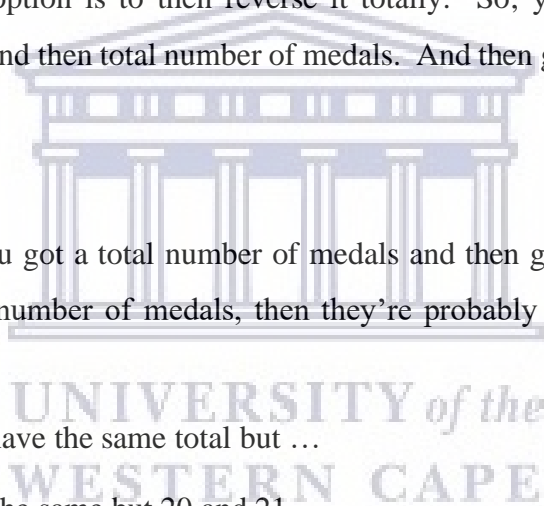
FEMALE 1: No.

MALE 2: There're going to be very few instances where you're going to have the same points, same total numbers but different make up of medals.

FEMALE 3: No. But I think I would say they are tied now but they still have more medals.

FEMALE 1: To claim? So, you'd rank them above South Africa.

FEMALE 3: So, you'd rank them above ...



MALE 1: But they've got more medals than silver. See that's, what is more important?

FEMALE 1: That's the thing exactly.

MALE 3: Is it more important to have a better type of medal, better colour medal or the more important to have overall medals?

FEMALE 2: I would say overall.

FEMALE 3: Because out of all those people that enter that specific sport, you've got into the top three.

MALE 1: And that's also in so many different categories. So that is like a big accolade I would say.

FEMALE 1: I suggest that we go to the countries who have the same total of medals and then you check the difference between the gold, silver and bronze medals.

FEMALE 3: How many medals for gold, silver and bronze.

FEMALE 1: Yes. Because if you have the quantify it, the weighting of the medals doesn't matter how many points. But the number of medals ...

FEMALE 2: Yes.

FEMALE 1: Exactly.

FEMALE 3: You've got the one you've got them all, the most.

FEMALE 2: The more?

MALE 2: Who's got them all.

FEMALE 1: Explain to me how you are going to rank the countries because we are going like completely against this ranking system.

MALE 2: Remember our weighted total is $3G+2S+1B$."

FEMALE 2: Yes, we have done all the calculations and our system looks different.

MALE 1: We are basically going to rearrange the countries.

MALE 2: I said total number and then from there then it is the rank, then colour medal after that. If you work out a mathematical equation for this there must be a way where we are going to have the same points, same number of medals but different make up of medals because we have done it.

FEMALE 3: So maybe just make up a little sub-sentence which countries have the same number of points.

FEMALE 2: First we look at the number of points then we look at the total amount of medals.

FEMALE 1: That is complicated.

MALE 3: Because if that comes about then you need to, you can't just say oh, but they've got the same points, same number, total medals so they must be equal.

FEMALE 1: Yes.

MALE 2: So there needs to be, there must be a case where that would work out. Whether it's said like they get 18 points with 9 medals you can do it either by 3 gold, 2 silver, 1 bronze or like 1 gold, 5 silver and 2 bronze. I mean don't know what that, you could work it out I suppose. But I do not feel to do that now.

FEMALE 3: And then what are we going to do in that case?

MALE 1: From there gold, then silver. Gold medals.

FEMALE 2: Yes. So, the one who has more gold medals.

MALE 1: The most gold because they've got the same total number of medals.

FEMALE 2: So, we rank them.

MALE 2: Okay. So, it'll be Argentina, not Argentina. Denmark.

FEMALE 3: Yes. Denmark then Sweden, then Ukraine, then South Africa then Serbia.

MALE 2: Just write them, yes.

FEMALE 3: Then Iran at number six.

MALE 2: So, I think country and the points, the total collective points and then when they're the same points then we can demarcate, not demarcate. We can ...

FEMALE 2: Indicate.

MALE 3: Yes, indicate that in this case, Iran be ranked higher above Switzerland because of the greater total number of medals.

FEMALE 3: And then their points – where's that mark.

FEMALE 1: I don't need to know, hey?

MALE 3: Say Denmark is first.

FEMALE 3: According to our new points system, their new point would be 25.

MALE 3: 25. And then second's Sweden, with 21.

FEMALE 3: Yes. Sweden.

MALE 2: And they got 21 points.

FEMALE 1: Yes.

MALE 2: But then we'll have Ukraine with 20...

FEMALE 2: Yes.

MALE 1: And then South Africa afterwards. Also, with 20.

FEMALE 3: Then Serbia 16

FEMALE 2: Switzerland, no, Iran sorry. I mean you read upside down. And Iran is 15.

MALE 1: 15 as well as Switzerland, same points.

FEMALE 3: Yes. And Greece? 11.

MALE 1: No, 13 for Greece.

MALE 3: And 11 for Argentina.

FEMALE 1: Yes.

MALE 3: Okay. So that's everyone. And then maybe just those other – there's two that are the same. Yes.

FEMALE 2: And then we can put a note ...

FEMALE 1: And you can put a note they have same number of medals and the same points. Then we look at the amount of gold then silver and then bronze.

FEMALE 3: You understand?

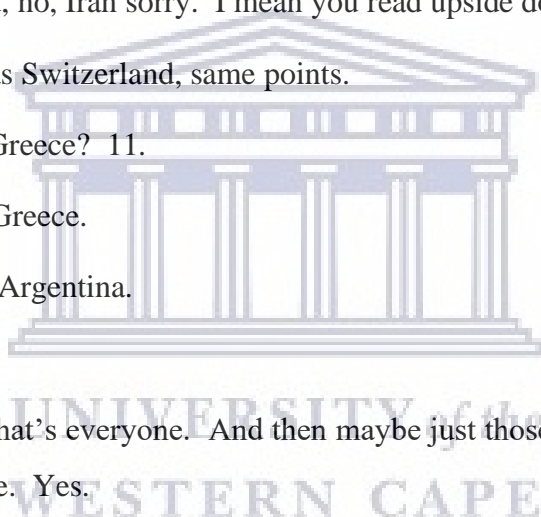
FEMALE 1: And what if they are the same...

FEMALE 3: Then they're just equal in that rank.

FEMALE 1: Then they're tie in that ranking.

MALE 2: Then they tie in the ranking

MALE 3: In Greece both had 3 gold, silver, 2 bronze. Then they will both be 25. 25 equal 27.



FEMALE 2: And then 27.

FEMALE 3: Yes.

MALE 1: You wouldn't have another 26 shame.

FEMALE 3: Yes.

FEMALE 2: But then we don't have to look at the most gold medals.

FEMALE 1: Then you can just say you were tied.

[END OF TRANSCRIPTION]



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APPENDIX Q

Plenary Session: Group Feedback for Johannesburg Stock Exchange (JSE) Task

Group 1

MALE: So, we made a, yes, made a couple of notes on both. So, the NEF, we found that it highlights only a privileged few shareholders. So, it doesn't take everyone into account. Obviously, shares must be directly held by black individuals. And that's those are the only ones that they make referred to in their results. Other things that they have is that it's regulated by government or it can be manipulated by government. There – yes, it doesn't obviously take that indirect ownership into account. With the AP we found that it does use multiple sources so with that it has more information that it considers. It's consistent with the realities of modern-day share ownership and it's consistent with the BEE codes and the king three codes. And even though there are slight imperfections as it is a JSE [inaudible] research. We just found that we would be with the results that they produced just because it takes a more holistic view of finding who the shareholders are.

Group 2

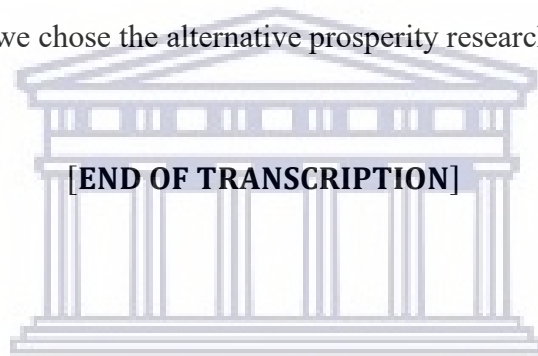
FEMALE: Okay. So, we compare the alternative prosperity to the NEF and we summed up that the alternative prosperity is very multi-cultural or diverse because they allow not just blacks but whites and coloureds to invest in the JSE. Whereas the NEF is just black and strictly black and only 3% of black people invest in it. But this is basically because there's no resources as our friend said, they're not documented. They're not incorporated enough whereas the AP as they say it's independent research and 23% of JSE is just black and for the first time black people are holding more shares in majority than whites. And this is because they allow people to invest their pension in the JSE. Because usually if you invest in the JSE there's a risk. And usually a lot of the times when you invest your pension the chances of losing your money is a risk because you need to live on pension I'm assuming. But for the first time they allow that as well. And that is why the black people are investing more than whites. Given the

background, let look at which group we chose. Our **group** chose the alternative prosperity group. And the reason we chose that one was because it's an independent research headed by Trevor Chandler of the Alternative Prosperity and we also said that they are consistent with the BEE and King three codes. This group also includes annual reports and financial statements which means that they have a variety of information sources, which include the share registers of JSE listed companies, BEE certificates of these companies and then under listed South African subsidiaries, annual reports and financial statements.

Group 3

MALE: So, my group they're supporting alternative prosperity group. So, the reason why is because this article ultimately deals with like investments. There are two sets of research stating to where the funding and empowerment has to go. So, they show the need for the research to happen, started doing the research. Presented their results but now the results actually show a positive increase in the amount of people – the amount of black ownership in the business sector and the companies listed on the JSE. Then we must look into what if they actually look at and decide that these are the results that they're going with. So then what I also noticed is that alternative prosperity, they show a need for this research to happen, but then Jacob Zuma, he contradicted them and came out with these, the new national empowerment funds results. But these funds, these results are saying only 3% are owned by black – but now when we look at the data that was used, I mean the NEF is using – not even using proper updated framework or criteria of BEE to make their results. Even though the alternative prosperity had to present a bunch of like research papers and all this. Like they had their – a bunch of sources, their share registers, the BEE certificates and all those things which makes us have to question the aim of this research. And we have to look at we're presenting this research. And because we looked at the context in how this research was presented and especially the fact that the national empowerment fund, they are looking to empower so the results would have to be an indicator that more money needs to go to empowerment if there's a low figure of black owned companies. So then there's more money needed for empowerment. And the JSE, it's saying here that they are pussyfooting

around the sets of research. So that means to say that the JSE is trying to find a very clear, like idea of even what BEE is describing. And also, how many black individuals or like however they are trying to frame it are actually involved in the JSE stocks and all that stuff. So, in terms of that, that's why it shows the alternative prosperity research because JSE is just going to go do all the facts for research. Oh, yes. Oh, no that's not the reason. JSE, if you want to be listed on the JSE and those figures have to be correct then you actually have to provide a lot of documentation, right. So, if the JSE is commissioning an independent research they have to provide the proper documentation to be analysed. But then this other research comes out after that with not even the proper frameworks for this catch you. But then the government comes out and tells the people that their research is more valid than the one that has all the data. So that's why we chose the alternative prosperity research.



[END OF TRANSCRIPTION]

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APPENDIX R

Plenary Session: Group Feedback for Olympic Ranking Task

Group 1

FEMALE: What we've basically done is, we applied maths when we decided we're going to work in terms of a points system. So, in our point system, we decided that for gold we're going to give five points. And then the silver we decided is going to be three points and then the bronze we decided is going to be one point. And then we said like for the first one, Switzerland – we said three times five because they have three gold medals but times by five points and then they got 15 for the gold medals. And then two times three for the silver because they got two silver and then they got six, and then they got two bronze and then we times that by one. So that was two. And then the total we got was 23. So, we continued that with all of it and then the outcomes were that Denmark came first because they had a total of 35. And then the ninth place was Argentina and they had a total of 18. South Africa came third with 30 points. The reason why we decided on a points system because obviously we don't know what weight gold carry in this given ranking system and we feel the current ranking system is not fair for example. when you look at Denmark, their ranking position is 28 in the given ranking system, but they came home with 15 medals. So, how can you rank a country that came home with more medals at position 28 and a country like Switzerland who's ranking position is 24 but they went home with 7 medals? For argument's sake Argentina went home with four medals and they were ranked higher. How is that possible? So, to make it like fair we then worked with the points system and Denmark came first and Argentina came ninth. But because they had more bronze medals, they actually came their ranking position is 28th which is wrong. That's basically it.

Group 2

MALE: Our model that we worked on was very similar to the previous groups. But we just had different allocations for the different medals. Like gold medals weighed for 3 points, silver medal 2 points and bronze weighed for 1 point. We

also noticed when there are ties, the number silver medals are taken into consideration first and then the bronze medals. But it seems quite flimsy when you consider the fact that you could just set up a point system to describe how many points a gold medal is, how many points a silver medal is and so forth. Okay, this is what this score is based upon. But like we didn't complete our calculation yet to order them into a rank.

Group 3

MALE: Okay. So, our group have basically the same system as the previous group. We gave 3 points for gold medal, 2 points for silver medal, 1 for bronze. We did distinguish though that if countries have the same amount of points then the rank will be determined by their overall total number of medals. Our weighting was 3:2:1 but I suppose there are a couple of ways to do it. We felt that if you've won more medals for example, if you've got 4 bronze, 2 silvers and 3 gold's and another country got three gold's they've got 1 more silver but 2 less bronze. They have got one less medal overall. But they have not played in as many events. So, the team or the country's got more medals have performed better overall or in more events because of that, we felt they deserved a little bit more recognition. Yes, and if they happen to have the same points and the same number of medals then we'll look at does one have more gold medals and they'll get ranked above but if they've all got the same medals in just in the sequel. So, basically in a nutshell. We didn't weight the gold and, we didn't weight it like the other group. We just look at the total and looked for ties and then through a process of elimination we got a different kind of ranking.

[END OF TRANSCRIPTION]

APPENDIX S

Plenary Session: Group Feedback for Soccer Ranking Task

Group 1

MALE: So, looking at those rankings and we were requested to just adjust what the score is. We took the table and we adjusted them. So, we took the totals that they have, according to the way it was set up. They said that they got like three points for a win and we add the loss and then we divide by two. Then we basically made a formula that adjusted the total score which we took the GDP of each province and divided it by the population of the province because, we went with the assumption that, if your – if they determining a specific GDP for a province then you need to compare it to itself in terms of population. Then we did that (divided the GDP by population size), multiplied by the total score and then we got our adjusted total. And now, even though they have these totals, they do represent the amount of games were won and drawn and lost, according to the old system, but they're given a new ranking that's adjusted according to their GDP and their population size.

Group 2

FEMALE : Okay so, what we did – we took the life expectancy and the Gross Domestic Profit of South Africa and we multiplied those two together and then we divided by the population of each province. Then we multiplied that by the total score. So, we also kept the points the same as in the SAFA table. Then, we worked it out for each province. Eventually what we realise is then, obviously we are going to come to a constant for the life expectancy times the Gross Domestic Profit. So then, we used that and we substituted everything and, this is how it was ranked originally from the article and then, when we did our calculations, it was a lot different. So, Gauteng was first in the SAFA table and Gauteng was last in our table and then, North West was sixth in the SAFA table and then they were fourth in our adjusted table. Hence, we called ours the socio-economic index.

Group 3

MALE 1 : We tried to economise for the sake of allowing for the mistakes if they were there. This part about the teaching strategy but, what we came up with ultimately is sort of a dual point system. So, we used the current log points and we put it through an equation so, our equation was their log points and that was over what we called the PGDPI. So, we used the populous, multiplied by the GDP – or the ratio of the populous, times GDP and then multiplied that by a hundred to get a new point's ... ja, sort of a weighted point system. And so, how that works is, once we got that – so for Gauteng, they had their thirty three log points and then got added another one point six five points on the weighted system which gave them – we added those two points together and gave you a total points of 34.65 log points – or total points, and then ranked them according to those total points.

[END OF TRANSCRIPTION]

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APPENDIX T:

Validation Summary Report

Johannesburg Stock Exchange Task

Codes for JSE Task	Example of quotation from data	Name of theme for collection of codes	Validator A	Validator B	Validator C
<ul style="list-style-type: none"> • Privileged few • Black economic empowerment • Black ownership 	<p>F3Gr2: “So, with the National Empowerment Fund (NEF), we found it highlights only a privileged few shareholder. So, it does not take everyone into account. Obviously, shares must be directly held by black individuals. And those are the only ones that they referred to in their results”.</p>	<p>Economic Empowerment</p>			
	<p>M1Gr3: “My group supports the Alternative Prosperity group. So, the reason why is because this article ultimately deals with like investments. There are two sets of research stating to where the funding and empowerment must go. So, they show the need for the research to happen, started doing the research. Presented their results but now the results actually show a positive increase in the amount of people – the amount of black ownership in the business sector and the companies listed on the JSE”.</p>				

Score (1—agree; 2—maybe; 3—disagree)			1	1	1
Alternate suggestion theme for disagreement			None	None	None
Codes <ul style="list-style-type: none"> • Neutrality • Interests • Competence • Integrity 	Example of quotation F1Gr3: “I have something we can discuss. So we know this is independent research that was done, so independent research according to me is based on like, you must be neutral, like it’s your being because it’s an independent thing, you come in and you do basic research So, the person’s name is Trevor Chandler, now he created Alternative Prosperity.... this is his company or the main thing of the JSE”.	Name of theme Authority of Research			
	F2Gr1: “Okay so are you raising that both the Alternative Prosperity and National Empowerment Fund, when they were doing their research, where they look at the same facts or at the same records”? M1Gr1: “They were using different methods though”. M2Gr1: “Different methods to do the research but they’re representing figures about the same thing”.				
Score (1—agree; 2—maybe; 3—disagree)			1	2	1

	F3Gr3: “Yes”. M1Gr3: “The AP just seems fair... like it takes a bigger amount of people into consideration”.				
Score (1—agree; 2—maybe; 3—disagree)			1	1	2
Alternate suggestion theme for disagreement			None	None	None
Codes for JSE Task	Example of quotation from data	Name of theme for collection of codes			
<ul style="list-style-type: none"> • Direct and indirect shares • Ownership 	F3Gr3: “And here they said the findings, they found that the black people are holding more shares in the JSE because they use their pension money. Now they want to know like usually, I wouldn’t – I don’t know, I’m speaking now in general like the white people would use, they will do part of the JSE companies and they do it throughout the years but whereas the black people are like on pension and then they invest in the JSE. And that is why”.	Shares Assignment Criteria			

	F1Gr3: “In the Alternative Prosperity, the AP, I think I heard them say the number of black South Africans holding shares on the JSE has overtaken the number of whites”.				
	F4Gr3: “Some of them mentioned, the only difference, between direct and indirect shares is of procedural, so the methodologies, they use are just different. The one sticks to strictly black people can invest and the other one is broader... multicultural. I mean any person can invest”. M1Gr3: “Well it says here that the NEF states - the shares must be held directly by black individuals”. M3Gr3: “But then those who are investing through pension funds or whatever else ...they’re indirectly owning shares”.				
Score (1—agree; 2—maybe; 3—disagree)			1	1	1
Alternate suggestion theme for disagreement			None	None	None

Soccer Ranking Task

Codes for Soccer ranking	Examples of quotation from data	Name of theme for collection of codes	Validator A	Validator B	Validator C
<ul style="list-style-type: none"> • Gross Domestic Product (GDP) • Life Expectancy • Fiscus 	<p>M3Gr2: “I suppose it has got to do with opportunity, so how much weight do we give to opportunity because obviously you get soccer maybe you look at whether it’s athletics or rugby or cricket or golf. But generally those provinces that have a higher GDP, are going to be playing those sports because you need money in order to, you know, succeed at it because you need equipment and if you can’t afford it, chances are you are not going to go anywhere with it. Soccer is a bit different.... I think you also need talent”.</p> <p>F1Gr2: “Compared to someone that is, look I can’t just say it like that but what I am saying is like someone who is academically smart, comes from usually better home, like where they are exposed to certain things”.</p> <p>F2Gr2: “Just open to more opportunities”.</p> <p>F1Gr2: “But whereas a sport is a talent, you can play it anywhere”.</p>	<p>Influence of economic power on outcomes</p>			

	<p>F2Gr1: “So, do you think we can compare a soccer player in the…….”</p> <p>F1Gr1: “Western Cape”.</p> <p>M3Gr1: “So now, comparing a soccer player in the Western Cape ... Comparing maybe a Gauteng player and an Eastern Cape player”.</p> <p>F1Gr1: “Or a Northern Cape player”.</p> <p>M2Gr1: “It said here, like you can still consider the amount of games won and lost. Do you know what I’m saying? Do you think we must somehow multiply it by a factor that includes the Fiscus?”</p> <p>M3Gr1: “We must include the GDP and the life expectancy as well”.</p>				
Score (1—agree; 2—maybe; 3—disagree)			1	1	1
Alternate suggestion theme for disagreement			None	None	None
Codes for Soccer Ranking Activity	Examples of quotation from data	Name of theme for collection of codes			
<ul style="list-style-type: none"> Population 	F2Gr3: “It’s the soccer. It’s the team over the population – it needs to be that ratio.”				

<ul style="list-style-type: none"> • Gross Domestic Product (GDP) • Life Expectancy 	<p>F1Gr3: "Remember, that needs to be the ratio. The team over the population."</p> <p>F3Gr3: "But how?"</p> <p>F1Gr3: "Because, not the whole population partakes in the thing."</p> <p>F1Gr3: "So, something needs to go over the population, right? So, it's obviously...."</p> <p>F2Gr3: "How can we add the totals there as well? Because we are adjusting the total now."</p> <p>F1Gr3: "What do you mean? What total?"</p> <p>F2Gr3: "These totals here (total on soccer league table)."</p> <p>F1Gr3: "No, we're not changing that total. That's just how many points they got while they played soccer."</p> <p>F2Gr3: "We need to change it."</p> <p>F1Gr3: "It's going to change after we do the calculation basically."</p>	<p>Search for elements and manner to combine them for an alternative model</p>			
	<p>F1Gr3: "We just all need to keep the population. We know where the population is."</p> <p>F1Gr3: "There. The population must be there. But then it needs to be the population times the GDP."</p> <p>F3Gr3: "Isn't it the life expectancy?"</p> <p>F1Gr3: "It needs to be the population times the GDP."</p> <p>F3Gr3: "Why times?"</p>				

	<p>F1Gr3: “Because the population is the total and the GDP is per person, so it needs to be the total times the population.”</p> <p>F3Gr3: “This is per person? Is that what you’re saying?”</p> <p>F3Gr3: “Ja.”</p> <p>F2Gr3: “So, this must be multiplied with the ...”</p> <p>F1Gr3: “The mid-year population.”</p>				
Score (1—agree; 2—maybe; 3—disagree)			1	1	2
Alternate suggestion theme for disagreement			None	None	None
Codes for Soccer Ranking Activity	Example of quotation from data	Name of theme for collection of codes			
<ul style="list-style-type: none"> • Population • Life expectancy • GDP 	<p>M1Gr3: “We tried to economise for the sake of allowing for the mistakes if they were there. This part about the teaching strategy but, what we came up with ultimately is sort of a dual point system. So, we used the current log points and we put it through an equation so, our equation was their log points and that was over what we called the PGDPI. So, we used the populous, multiplied by the GDP – or the</p>	<p>Presentation of different constructed models</p>			

	<p>ratio of the populous, times GDP and then multiplied that by a hundred to get a new point's ... ja, sort of a weighted point system. And so, how that works is, once we got that – so for Gauteng, they had their thirty three log points and then got added another one point six five points on the weighted system which gave them – we added those two points together and gave you a total points of 34.65 log points – or total points, and then ranked them according to those total points.”</p>				
	<p>F3Gr2: “Okay so, what we did – we took the life expectancy and the Gross Domestic Profit of South Africa and we multiplied those two together and then we divided by the population of each province. Then we multiplied that by the total score. So, we also kept the points the same as in the SAFA table. Then, we worked it out for each province. Eventually what we realise is then, obviously we are going to come to a constant for the life expectancy times the Gross Domestic Profit divided by the population of the province. So then, we used that (life expectancy times GDP divide by the population of the province) and we substituted everything into the formula and, this is how it was ranked originally from the soccer league table and then, when we did our calculations and it was a lot different. So, Gauteng was first in the SAFA table and Gauteng was last in our table and then, North West</p>				

	<p>was sixth in the SAFA table and then they were fourth in our adjusted table. And, we called ours the socio-economic index.”</p>				
	<p>M3Gr1: “So, looking at those rankings and we were requested to just adjust what the score is. We took the table and we adjusted them. So, we took the totals that they have, according to the way it was set up. They said that they got like three points for a win, one point for a drawn match and we add the loss and then we divide by two. Then we basically made a formula that adjusted the total score which we took the GDP of each province and divided it by the population of the province because, we went with the assumption that, if your – if they determining a specific GDP for a province then you need to compare it to itself in terms of population. Then we did that (divided the GDP by population size), multiplied by the total score and then we got our adjusted total. And now, even though they have these totals, they do represent the amount of games were won and drawn and lost, according to the old system, but they’re given a new ranking that’s adjusted according to their GDP and their population size.”</p>				
<p>Score (1—agree; 2—maybe; 3—disagree)</p>			1	1	1

Alternate suggestion theme for disagreement		None	None	None
Codes for Soccer Ranking Activity	Example of quotation from data	Name of theme for collection of codes		
<ul style="list-style-type: none"> • Log results • Mid-year population 	<p>F3Gr3: “We need to design a new ranking system.”</p> <p>F2 Gr3: “What are you looking at?”</p> <p>M1Gr3: “I want to look at the results on the log, so Gauteng had the most people and the most points. Mpumalanga is an outlier, meaning second on the log but sixth in population. Western Cape is third on log and third in population. KZN is second in population and fourth on log, so it is not far away. Free State is second last in population but fifth on log.”</p> <p>F3Gr3: “So, we’re saying that there is an impact?”</p> <p>M1Gr3: “So, Mpumalanga basically must be pushed out but how do we do it?”</p> <p>F3Gr3: “We can find a formula to exclude Mpumalanga.”</p> <p>M1Gr3: “So, these need to be put together in order to create a percentage that it is to going to apply by? So, what do we multiply population with? I suppose we can find out the total</p>	Deliberations in the mathematical modelling cycle		

	population of the country, find out the percentage of the population in each or the ratio of each, each province has, multiply that by the GDP and then find the square root.”			
Score (1—agree; 2—maybe; 3—disagree)		1	1	1
Alternate suggestion theme for disagreement		None	None	None



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