A Content Analysis of how Astronomy is Framed in Selected South African Online Newspapers

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A research report submitted to the faculty of Science, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Masters of Science by combination of coursework and research.

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ABSTRACT

The aims of the study were to provide an overview of how online newspapers portray astronomy news in terms of framing and tone. The "tone" is used as a way to analyse and reflect on the mood of the article, whether the journalist reports about positive or negative news. The study sought to understand what aspects of astronomy news are covered by South African online newspapers because using real world examples and stories as a way of learning has a magnetic attractiveness to the majority of students. This is one of the reasons why a newspaper is the perfect teaching and learning tool because it is regarded as a medium that can heighten students' knowledge, enhance students' vocabulary skills, conceptual understanding and encourage a positive attitude towards learning.

The study was underpinned by framing theory which suggests that presentation can influence the choices people make; it is a procedure where people improve a specific conceptualisation and change their perception about it. A mixed method was used since it combines both qualitative methods and quantitative methods to deal with different questions of the research study. A data collecting instrument was not required to conduct the study because the data was already available on the internet, however, the researcher developed and modified an instrument to analyse the available data. The Nisbet framework and a modified story analysis form were used as coding instruments. Newspapers articles were retrieved from the internet using search terms such as "SKA, astronomy, planets". The samples were two online newspapers, the Mail & Guardian and News24 from 1st January 2012 to 31st July 2015.

The quantitative results were divided into two, firstly for the Mail & Guardian and secondly for News24. Items that were analysed for each online newspaper were: news origin, news treatment, geographical focus, photos and graphics, framing techniques, the Nisbet framework, word average, and general reaction. The Mail & Guardian has longer news article lengths than News24. This might suggest that New24's news articles are better to use since they are shorter and the aim of using newspapers is to make teaching and learning science fun and productive. The qualitative results indicated that astronomy articles in newspapers are flooded with scientific terms that are not explained. Teachers need to assess and make students think about the content from the newspaper story and to recognise that stories in the newspaper are written differently from school textbooks.

The research study indicated that newspapers can be used and are useful in science class if they are used correctly and, at the same time, textbooks and other teaching materials are also used. The use of newspaper when teaching science is undoubtedly one of the effective ways of teaching science whether in an informal or formal learning context. Using newspapers increases students' knowledge and improves students' vocabulary skills to enhance conceptual understanding.

Key words

Astronomy, Mail & Guardian, News24, Story Analysis Form, Nisbet Framework, Informal Learning, formal learning and Science.

DECLARATION

I hereby declare that this research proposal is my own, unaided work. It is submitted for the degree of MSc (Science Education) at the University of Witwatersrand, Johannesburg. It has not been submitted for any other degree or examination in any other university, nor has it been prepared under the guidance or with the assistance of any other body or organization or person outside the University of Witwatersrand, Johannesburg. All phrases, sentences and paragraphs taken directly from other works have been cited and the references recorded in full in the reference list.

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Aviwe Sondlo

27th day of July in the year 2016

DEDICATION

I dedicate my research report to my family and to all my friends. An exceptional feeling of appreciation to my loving parents Nolulamo P. Sondlo & David M. Sondlo whose words of encouragement and push for persistence rang in my ears all the time. My siblings Noloyiso Matoto, Zamikhaya, Khanyisa, Nelisa and Banele Sondlo have never left my side and are very special.

I also dedicate this research report to my friends, those that I know and those I don't even know who were giving me words of support throughout the journey. I will always appreciate all they have done, in particular, Tshiamiso Makwela who was by my side throughout. To my friends who I was with from 1st year until now, Kabelo Sitole and Jacqueline Mphahlele, I hope our hard work will not go in vain.

Lastly, I dedicate this work and give a special thanks to all the current and upcoming academics who are dedicating their lives to research. I know that it is a very scary journey to take but keep it up and contribute to the world of research, as Ahmed Zewali (1999) said when he received his Nobel Prize in Chemistry:

> Preserving knowledge is easy. Transferring knowledge is also easy. But making new knowledge is neither easy nor profitable in the short term. Fundamental research proves profitable in the long run, and, as importantly, it is a force that enriches the culture of any society with reason and basic truth.

With these wise words, I encourage all of you to dig deep in this fertile soil and make your own contributions that will take the country forward and make education fashionable.

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LIST OF ABBREVIATIONS

AP	Associated Press
GHS	General Household Survey
M&G	Mail & Guardian
PCK	Pedagogical Content Knowledge
Reuters	This is an international news agency London and a division of Thomson Reuters.
SAPA	South African Press Association is the South African national news agency.

CHAPTER ONE: INTRODUCTION

Using real world examples and stories as a way of learning has a magnetic attractiveness for the majority of students. This is why a newspaper is a perfect teaching tool because it strengthens the knowledge of students in the classroom, enhances student's vocabulary skills, and advances an encouraging approach towards learning (Sanderson, 1999). While at the same time it is not the responsibility of journalists to impart science knowledge to students, but a responsibility of educational systems. The purposes of this chapter are to stipulate the study background by showing the benefits of using a newspaper in science classrooms. It will explain the importance of this study in South Africa by presenting reasons why there is a lack of interest in the media when it comes to science news. Lastly, it will stipulate a purpose, aim, objectives, research questions and the research study rationale.

1.1 Background

To some people, reading a newspaper on a daily basis is one of their habits. Nevertheless, this practice requires the time and aptitude to read with understanding then to take part in social discourse and impart knowledge to others. It is acknowledged that all forms of media play a vital part to circulate information about the different ways people appreciate the world in which they live (McQuail, 2005; and Lugalambi, Nyabuga & Wamala, 2011). The role/objectives of a newspaper include communicating its opinions and those of its readers, to entertain an audience in different ways, to persuade readers to buy a product or think in a certain way and to educate its audience using factual content. Another role of either newspapers or any form of media is to present issues by interpreting and evaluating them with the aim of making good judgment of the world and events for its audience (Sociology Central, 2011).

Newspapers were selected over other forms of media or communication such as YouTube, Phat animations, magazines, Television etc. because in South Africa newspapers are considered as a form of communication that most people have an access to (Van Rooyen, 2002). The Audit Bureau Circulations of South Africa released a statement on the 19th February 2015 that hard copy newspaper readership is declining at an alarming rate in South Africa and around the world. However, in South Africa newspapers are still amongst the favoured forms of media. The majority of people in Africa use their cell phones to access the Internet (Poushter & Oates, 2015). Therefore buying/using cell phone data bundles is still expensive to most South Africans to access information using YouTube by using their cell phones. Accessing newspapers whether hardcopy or online is still less expensive to people.

Formal science education is only out in the open to a small proportion of the South African population. The majority of people read about science discoveries/news in newspapers, magazines or digital communications such as social networks and online newspapers. The sources of information mentioned above are not accepted as formal learning approaches, but as informal learning, in view of the fact that, firstly, it is demanding to assess the level of learning through these media and secondly information in newspapers often disagrees with formal learning such as school science (Wellington, 1991). Science portrayed in newspapers is interpreted as factual and encompasses new and forthcoming breakthroughs that are not yet officially published (Turner, 2012). Awujobi et al. (2012), Dutt & Garg (2000) and Wellington (1991) support the claim that, if newspapers were to be used with awareness in science class by teachers, they could play an essential role because newspapers act as a link between formal science education and informal science education.

1.2 Context

In 2012, the General Household Survey conducted by Statistics South Africa released statistics that brought to light that ninety-two per cent of the South African population is literate, which means they can read and write simple English. In spite of this, some independent analysts and researchers warn that these generalised statistics may hide the real levels of literacy in South Africa (Pretorius, 2013). A fifteen-year-old who obtained grade seven is perceived as literate in South Africa because it is assumed he/she had acquired all the basic skills of reading and writing in lower grades. According to the survey, adults who obtained grade seven can read and write excellently, i.e. they can read newspapers, recipe books or magazines written in simple English. The survey also discloses the fact that, in South Africa, only 4.2 million adults have a qualification above grade twelve. More than 9 million people obtained grade twelve or may have dropped out from higher institutions such as colleges or universities without receiving diplomas or degrees. 19 million adults passed grade seven to grade eleven and 6 million people passed below grade seven. The overall results revealed that only seven per cent (3.6 million) adults are illiterate in South Africa (Pretorius, 2013). The above statistics are for people who can read simple English only.

In December 2014, the South African Audience Research Foundation (SAARF) released readership statistics for newspapers, magazines and other forms of printed media. It ascertained that 48.6% of the South African population over the age of sixteen read newspapers. This corresponds with the literacy levels released by GHS in 2012 showed that more than forty per cent (19 million) South Africans can read and write simple English texts if they obtained grade seven to eleven qualifications. The above findings only show that the minority of the South African population read newspapers, however, currently there are no statistics of people who buy newspapers, magazines or use digital communication such as social networks and online newspapers to read about science breakthroughs. Hence, it might be conceivable that people only read about science news in newspapers or find out

about science news when they see interesting science stories on twitter or Facebook and from friends if they are interested in science.

Newspapers are important because they can educate and impart knowledge to people who did not have the privilege to attend grade twelve or go beyond grade twelve for formal education. There is limited or no evidence available to show whether people buy a newspaper or read about science to learn something new about science or they are forced to read about science news because they are doing an assignment. Science presented in newspapers is problematic to assess and, because it might be in disagreement with formal learning, in this case school science, a reader cannot tell whether he/she has learnt something or not (Wellington, 1991). Science presented in newspapers is factual, it covers new and upcoming breakthroughs which are yet to be officially confirmed (Turner, 2008). In academic discourse, reading a newspaper is not recognised as a form of formal learning because newspapers set the agenda to awaken the interests of the public. As a result, people in general do not buy newspapers to learn something new, they buy newspapers when there is something interesting or disquieting in them. On the other hand, schools can instill a culture of reading newspapers as a form of informal learning which might be expedient to teachers who use newspapers for a different purpose, which is learning. In most cases, science stories in newspapers have already been published in educational journals and reviewed by other scientists. This suggests that science stories in newspapers are accurate and students can benefit because they are learning science side-by-side with their school textbooks.

Newspapers are a reliable resource because they tend to be permanent and authoritative (Dutt & Greig, 2000). Ola & Ojo (2007) suggest newspapers are among the most commonly-read periodicals within reach to the sizable number of people of all ages in any community. Newspapers assemble information in order to be easily accessible, for example, important stories are located on the front page, their headings are written in bold and graphics often appear next to the stories. Newspapers aim to reach different groups of people, for example, there may be a school section prior to exams to help both students and teachers with their school work (Awujobi & Adeokun, 2012).

This research study focused on the coverage of astronomy news using two South African online newspapers, the Mail & Guardian and News24 as alternative teaching resources that teachers can use at school. Even though News24 is not classified as an online newspaper, it is a network of popular digital publishing brands, online services, mobile applications and interactive television under the Media24 Company. For the purpose of this research, News24 was considered as an online newspaper. The reasons for using News24 as an online newspaper are explained under Section 3.7 Online newspapers can be used by students and teachers to access astronomy news but many people still rely on hard newspapers for science news because they are the oldest and most important channels of communication (Dutt & Greig, 2000).

Hard copy newspaper readership is declining at an alarming rate in South Africa and around the world. On Thursday, 19 February 2015, the Audit Bureau of Circulations of South Africa released statistics about circulation of newspapers for the period of October-December 2014. They showed that daily newspaper circulation fell from 1 600 667 to 1 537 302 in this reporting period while weekly newspaper readership went down from 632 934 to 594 431 (Manson, 2015). In contrast, online newspaper readership is growing fast among South Africans, for instance, most people own cellphones and they can access news on the internet through their cellphones.

In 1995, the world's population who had an internet connection was only 1% but it is estimated that currently at least 40% of the world's population can access internet daily. The number rose ten times between 1999 and 2013 and, in 2005, the number reached one billion. The second billion was reached in 2010, the third billion in 2014 and currently there are more than 3,279,902,848 people who are able to use or access internet around the world (http://www.internetlivestats.com/internet-users-by-country/).

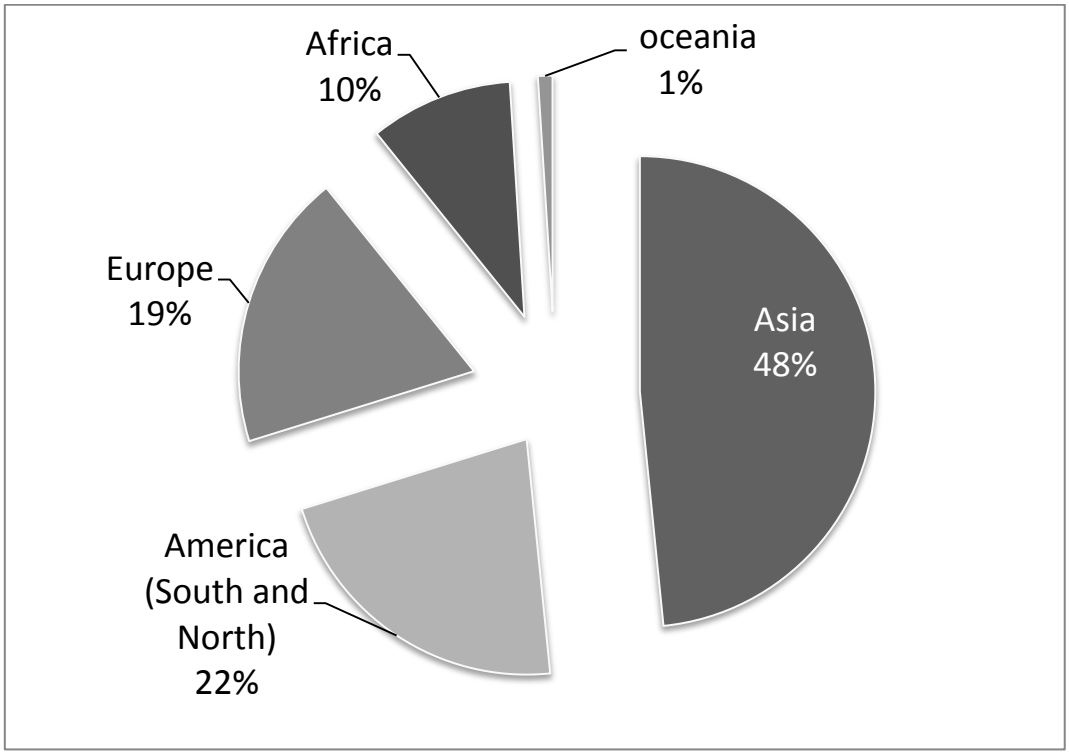

Figure 1.1 End of 2014 proportion of global internet users per country

Figure 1.1 shows the percentage of each continent internet access and it can be noted that Asia has the highest number of people who have an internet access around the world with at least 48% of its population. The reason for Asia to have the highest number of internet users is; it has the highest population around the world which is 4,361,416,312 in 2015 and both China and India contribute

more than 2 Billion people in Asia's population. The country with the least internet users is Oceania with at least 1% of its population can access internet. Africa is the second last continent with at least 10% of its population can access internet and in 2014, 24,909,854 people had internet access in South Africa. This was a 14% growth from the previous year which means that an additional 3,022,362 people had internet access in South Africa. At least 48% of the South African population can access internet either by using their mobile phones or personal computers (www.internetlivestats.com/internet-users-by-country/). These numbers include some schools that are accessing internet in South African and these schools can access online newspapers to create productive class activities for their students.

1.3 Science coverage

Newspapers around the world, including South Africa, are overwhelmed with politics, fashion, celebrity news and other things that are not science related depending on the status and geographic focus of the newspaper because journalists focus on what their readers are interested in (Van Rooyen, 2002). This raises questions of how many other stories are being covered in newspapers apart from science stories if most of the available space in the newspapers is devoted to politics and other trending news. Science and technology have very little news coverage in South African media. A study conducted by Van Rooyen (2002) found that less than 2% of editorial space in South Africa's top publications was devoted to science topics. A lack of communication between journalist, scientists and the society might be a possible reason for not producing much science news. People in science fields do not make their voice heard about what they want to read about given that most people do not have science backgrounds.

1.4 The importance of astronomy in our everyday life

Since from the beginning of time, people used look up to the sky in order for them to get directions to sail across the oceans, they used the environment to agree when to plant their crops and to answer some of the questions of how we got here and where we came from. Astronomy is a branch of learning that gives context about the universe and it shapes how we view the universe and has continuously had a meaningful influence on how we view the world at large (Rosenberg, Russo, Bladon, & Christensen, 2013).

As our understanding of the world grows, we discover more planets and other bodies in the universe. These discoveries make science interesting and people are becoming more curious about the cosmos. School children are fascinated by the bright attractive colors of the universe and some of them want to study astronomy (Renee, 2012). Therefore, teaching astronomy in the science classroom might increase the interest of students about astronomy. Venugopal (2015) mentions that youngsters seem to love space and astronomy and therefore school workshops use astronomy to inspire school children to

be interested in mathematics and science. Introducing astronomy to young children might answer questions in astronomy such as "How old are we?", "What is the fate of the Universe?" and certainly the most thought-provoking question, "How unique is the Universe, and could a slightly different Universe ever have supported life?"

Astronomy is breaking new records; there are new discoveries or advancements in this field. Currently, all eyes are on South Africa because of the Square Kilometer Array project and therefore primary and high school students want to know about astronomy as a career including the advancements that are taking place concerning the SKA project (Rosenberg et al., 2013). Exposing children at an early age and other science advancements is vital for our students.

We are experiencing many technologies on a daily that were originated from astronomical discoveries, for example,

- the wireless local area network (WLAN);
- a gas chromatograph for splitting and examining compounds which ware invented by astronomers for a Mars mission now are operated to check baggage for explosives and drugs in airports.
- a gamma-ray spectrometer was first used to examine lunar soil and now is used in a non-invasive way to probe structural weakening of historical buildings;
- The hand-held Chemical Oxygen Demand (COD) photometer that is used by police was developed by astronomers to measure light intensity and currently police are using it to check that car windows are transparent, as determined by the law (National Research Council, 2010).

I selected astronomy for this study in view of the fact that it is linked to our everyday lives and for students to realise that there is a future in astronomy. I decided to use newspapers because in South Africa newspapers still play a big role in terms of disseminating information around. At the moment people who are in science field need to encourage journalists to cover astronomy news and impart knowledge at the same time to students and other readers although this is not their responsibility. Newspapers are an important tool for students to use to learn new information while at the same time they are enjoying themselves.

1.5 Astronomy in South African schools: Curriculum and its visibility

Everything that has to do with space "astronomy" inspires youngsters to be interest in mathematics and science (Venugopal, 2015). Countries such as USA and England use astronomy as one of the ways to attract students to special events or workshops. South Africa also uses a similar approach where schools take their students to planetaria (e.g. the Johannesburg Wits planetarium) to show them artificial space that makes science interesting but there is no follow up after the workshops to sustain

children's interest in science and mathematics and these are the subjects that need to be appropriately concentrate on (Venugopal, 2015).

The South African government, in partnership with NRF is investigating new ways to make learning breathtaking. They have already recognized priority areas, which includes astronomy, among others. This subject has the potential to create a thought-provoking learning environment and it can introduce new ways of learning that make the learning process exciting, spellbinding and able to grab the attention of the students (Venugopal, 2015). Using newspapers in a science classroom can benefit students by giving them exciting and stimulating images and techniques and generating educational materials that are relevant to the school syllabus.

In the late 1990s to early 2000s, the South African school curriculum was revised and astronomy was shifted from the geography syllabus into the natural sciences. The current education system introduces astronomy into the curriculum as an entity designed to attract students to learn about science. In primary school, from grades 4 to 9, astronomy topics account for 11% of the curriculum while from grades 10 to 12 astronomy topics in physical sciences account for only 4% (Lelliott, 2012). This is a very low percentage for students who want to select astronomy when they go to university. In physical sciences, there is no separate astronomy section and these topics are embedded within other physics concepts.

In the grades 10 to 12 physical science curriculum, topics such as big bang theory, cosmology, stars and galaxies are not covered while online newspapers frequently cover such topics. In South Africa, particularly in grades 4 to 9, basic astronomy topics are introduced. They cover planets, season changes and the universe among others. In these grades, teachers can use resources such as online newspapers as an alternative teaching tool to assist with the comprehension of science concepts. Teachers in South African schools need to be encouraged to use online newspapers to supplement their teaching resources. If newspapers can be used in a science context, students can have a chance to integrate what they are learning formally at school with the science in newspapers.

However, newspapers are not textbooks, they report news. They cover these topics when there are new discoveries or innovations, and they focus on the news angle, not the science behind the story. Currently, South African National Department of Basic Education and the Gauteng Department of Education are introducing pilot studies to use tablets. These tablets are currently used by grade 12 students to access information and learn better. In astronomy these tablets can be used by students to obtain first-hand information about current experiments and innovations that are taking place in astronomy. Teachers also need to be trained on how to download newspapers and other materials to achieve effective teaching using computers.

1.6 Problem statement

It is not the responsibility of journalists to communicate science knowledge, but an educational system has a responsibility to educate people. However, the current educational system is not fulfilling this responsibility. In South Africa, according to the General Household Survey (GHS) of 2012 performed by Statistics South Africa, 19 million adults had a level of education between grades seven and eleven and 6 million adults had a level of education below grade seven (Pretorius, 2013). Many people leave school before they complete grade twelve, which means that they do not receive formal science learning after they drop out from school. The public can use science journalism and newspapers to close the communication gap. The study focused on the coverage of astronomy news in South African online newspapers for several reasons.

Many children have an interest in astronomy which leads to an interest in the sciences (Lelliott, 2007). Astronomy, more than any other science field of research, has attracted funding and media coverage all over the world (Reid, 2014). In 2012, South Africa was chosen to be the site for the Square Kilometer Array (SKA) project. The study sought to explore what aspects of astronomy news South African online newspapers cover. Its primary focus was to understand how the selected online newspapers cover astronomy news in a rapidly changing world of science and technology and whether the newspaper articles are suitable to be used in science classrooms (Jarman & McClune, 2002).

1.7 Aims of the study and research question

The aims of the study are to provide an overview of how online newspapers portray astronomy news in terms of framing and tone. In the study, "tone" is used as a way to analyses and reflect on the mood of the article, whether the journalist reports about positive or negative news. Framing in media is the approach where information is presented to the audience. It suggests that the way that a story is presented can influence the choices people make (Kalvas, Vane, Stiplcova, & Kreidl, 2011). The study sought to answer the following research questions:

i. How much coverage does astronomy news receive in selected South African online newspapers?
ii. In what ways is the coverage of astronomy news portrayed in terms of framing and tone?
iii. How, if at all, can astronomy articles be used in science classrooms?

1.8 Rationale

This study is concerned with how journalists frame astronomy news in South African online newspapers and how their coverage can help science students and teachers access information and use online newspapers as an alternative form of teaching.

Conducting a research study about astronomy coverage by online newspapers is one of the ways to show the importance of informal learning in science education using newspapers. It will show the public, educators and journalists that online newspapers can play an important part in science teaching. There is already an abundance of information when it comes to astronomy which is being distributed by organizations such as the National Aeronautics and Space Administration (NASA), European Southern Observatory (ESO), and other organisations. Teachers who are willing to bring astronomy to life in their classrooms have an option to select online newspapers as one of the alternative resources used in teaching. Any material a person reads, whether for pleasure or learning, shapes perceptions about his or her surroundings. Too many people only know about science through the media, especially newspapers (Dutt & Garg, 2000). Therefore, teachers can take this opportunity to use newspapers and make students change their perceptions about astronomy or science.

If people want to learn about science, and if the culture of reading newspapers can become a habit, it can improve scientific literacy levels. It is important for citizens to be science literate since many decisions made by the government require knowledge of science and technology (Hobson, 2003). Scientific literacy is a minimum science knowledge required to participate in science discourses (Driver, Newton & Osborne, 1997). Having scientific literacy means an individual has the capability to portray, envisage and explain natural phenomena. When an individual is scientifically literate he/she can read and comprehend science articles in the popular press, can engage in social dialogue that involve science and can form valid arguments and conclusions in a particular context (http://www.literacynet.org/science/standards3.html#terms). If an individual can develop a minimum scientific literacy, he/she can understand and participate in decision-making or government policy implementation. South Africa can reduce some of the challenges the country is facing if the majority of citizens are scientifically literate. People could then participate in public debates that need opinions, for example, whether to use nuclear power and debates on whether to legalize euthanasia. If reading newspapers or online newspapers can become a habit, scientific literacy can improve formal science learnt at school (Wellington, 1991).

1.9 Conclusion

If teachers and students can be encouraged to read and use newspapers as an alternative teaching and learning method, students will learn science at the same time learn vocabulary. The objectives of this chapter were to provide a background to the study showing the benefits of using newspapers in science classrooms. It explained the importance of the study in South Africa by giving reasons why there is a lack of interest in science news. Lastly, it provided the purpose, aim, purposes, research questions and the rationale of the study.

1.10 Chapter summary and structure of the research report

Chapter Two provides a literature review of sources relevant to the study by listing some of the influential research conducted in other countries. It will then give an explanation of what a newspaper is, how it was used in the past, how to use a newspaper as a teaching tool in a science context and the benefits of reading a newspaper. Further, it will explain the meaning of the terms science, science communication, science journalism, astronomy, science communication in science education and it will explain how science news is portrayed in different newspapers around the world.

Chapter Three discusses the methodology used for the study and how it is going to reply to the research questions. It will explain the research paradigm, research approach, coding instrument, a "story analysis form" and how it was developed, the Nisbet framework and Flesch readability analysis tool. Lastly, this chapter will explain content analysis, the sample used and the reasons for the selection of newspapers.

Chapter Four provides statistical evidence for the first research question, "How much coverage does astronomy news receive in selected South African online newspapers?" The conclusions drawn from this chapter will inform the results of qualitative research in Chapter Five where the remaining research questions will be answered. The research study only describes a small percentage of online astronomy newspaper articles that appeared from 1 January 2012 to 31 July 2015 and it does not try to make any generalisations about astronomy news coverage of other online newspapers in South Africa or other periods.

Chapter Five provides an in-depth analysis on how astronomy is covered in selected South African online newspapers. It will provide a background to the method of analysis using newspaper articles to justify the claims. Further, Chapter Five will provide a short comparison showing the differences between the two newspapers using the categories of content, level of details, vocabulary, language complexity and use of technical jargon. Fairhurst & Sarr framing techniques and the Nisbet frameworks will be used for further analysis. Lastly, it will explain why one particular newspaper is recommended for use by teachers in science classes.

Chapter Six answers the research questions using literature and episodes from the analysed newspapers. It will then address the limitations, make suggestions and recommendations about how teachers can use newspapers to teach science.

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

When conducting research, it is important to locate your research within a body of theory. This can be achieved by reading the relevant literature. This chapter provides relevant literature about how newspapers have portrayed science news in the past. This will be achieved by listing some of the major or influential research conducted in other countries. It will then give a definition of a newspaper, how it was used in the past, how to use a newspaper as a teaching tool in science context and the possible benefits of reading a newspaper. Further, it will explain the meaning of science, science communication, science journalism, and astronomy, the importance of science communication in science education and the portrayal of science news in different newspapers around the world.

Some authors have suggested that science, as presented in newspapers, can be valuable when it is used in formal science education wisely (Turner, 2008; Wellington, 1991). Currently, it is time to test whether online newspapers can replace hard copy newspapers as a form of learning and teaching at school, although hard copy newspapers still play a big role in our communities it is important to test other methods in order to be in the same standard as the world. Awujobi & Adeokun (2012), Dutt et al. (2012) and Hijmans, Pleijter, & Wester (2003) conclude that newspapers are not considered by some scientists to be suitable to disseminate science information neither is science coverage in newspapers prioritised by journalists. Lugalambi et al. (2011) assert that scientists believe it is easy to access scientific research information and its implications in newspapers, but, in reality, this is not the case as people do not access science news in newspapers like other subjects such as politics and celebrity news. Scientists tend to have a trust those working in scientific cliques while the public primarily trusts the media and this results in disputes about who to trust.

Journalists do not give precedence to science news since there are other news stories competing for the same space. It is the responsibility of either the educational system or the scientific community to make science news accessible to the public using different types of media. Newspapers offer up-to-date information on national, provincial and local issues. Newspapers are among the most commonly read publications that are accessible and nearby to most people of all ages (Dutt et al., 2000). Science in newspapers can be one of the ways to expose learners to science. Unlike science portrayed in textbooks, science presented in newspapers often involves new findings which may be controversial, for example, climate change and genetically modified food. Some of science concepts appearing in newspapers are not taught in school curriculum, which means if students do not read newspapers, they will not access the information. Journalists in newspapers often simplify terminology for the public and they not fully understand these terms because the meaning of words used in science is different from the meaning of the same words used in everyday language. For example, the word “concentration” has two different meanings, a scientific meaning that is the mass per unit volume, and

an everyday meaning, which is the action or power of focusing all one's attention on something. This shows that the use of terms can create confusion for both journalists and readers.

2.2 What is a newspaper?

A newspaper is known as a periodical that is distributed daily or weekly, depending on the nature of the newspaper. Traditionally a newspaper comprises of international and local news, sports bulletin, and opinions from the public, television listings, advertisements, cartoons, and announcements. It is used to let the public know about what is taking place in their communities and other parts of the world. With the advancement of computer technology, online newspapers persist to be an important feature of peoples' everyday lives. A hard copy newspaper's front page contains important news of the day. Each news bulletin has its own "headline" and a "by-line" giving the name of the news reporter (Abcteach.com, 2008).

Online newspapers have become popular while readership of hard copy newspapers is declining (http://www.nla.gov.au/content/what-is-a-newspaper). A digital newspaper is a type of a newspaper produced digitally and is obtainable from online by using an internet. The public is able to access digital newspapers on mobile device applications. They are in the form of an integration of resources, with new material being added while older content is removed or they may be ongoing publications. Digital newspapers comprise of files or news that were used for the production and editions of hard-copy newspapers. Online newspapers have a continuous stream of content and updates incorporating multimedia such as video, audio and other dynamic material which may be locally produced, syndicated or third party produced. This includes applications and reader or user-produced content.

2.3 Benefits of reading and using newspapers in science context

A modern newspaper is a record and an encyclopaedia. It records events that have taken place and events that are currently taking place. Newspapers seek not only to inform but to excite and stimulate the reader and they keep us informed of what is taking place around us. Reading a newspaper gives a person deeper insight into events which television news cannot cover in the short time it has to report on them. For example, although there is 24 hour news channels, stories are cut to fit allocated time slots making them superficial. When reading a newspaper, a person can choose to spend time reading a story. Newspapers cover a lot of topics, for example, international and local stories, movies and jobs and you can read them anywhere. It is important for both ordinary citizens and students to read newspapers for them to keep up with the rapidly changing environment.

In any teaching context teachers can introduce a newspaper's reading culture in their classrooms in different ways. For example, in language classrooms teachers use newspapers as an alternative method when teaching; in science class the same method can be used as they bring real life situations

to students. Activities engage students in interesting and enjoyable learning, and encourage students to further read at their leisure time (Laureta, 2009).

Teachers can use newspapers as a prompt to introduce a topic by starting a class discussion about the topic. This can be done in class by showing students a graphic or phrase in the newspaper to stimulate conversation and this can be done even when using textbooks. If your aim as a teacher is to assess discussions and speaking skills, in that case using a newspaper is an appropriate way; you can give students a newspaper article and they can skim through and report back to the class. The best way is to split the class into groups and provide each group with a different newspaper article then ask each one to read something from the newspaper and explain what science message is being communicated and you can ask other questions through the debate (Laureta, 2009).

2.4 Science definition

Usually people assume they understand what science is. However, as one might expect, upon further discussion, it quickly becomes apparent that they cannot define science or they can only give a partial explanation. Forje (1985) defined science as what society has accepted as being worthwhile and is also meaningful to a scientist. This is considered as a broad definition of science because one cannot comprehend what is really worthwhile to the society and people have different views about what is worthwhile to them. Feynman (1998) argues that science is often regarded as a method of finding things out. In other instances, science is referred to as the body of knowledge and sometimes science is viewed as a type of technology, i.e., it develops things to be used. However, to me, these definitions do not clearly explain science in a manner that a lay person can understand. I believe that science is a hands-on action carried out by individuals; it is intended to come across or collect information about the world and become aware of ways in which this information can be organised into significant patterns. A principal objective of science is to gather evidences (Gottlieb, 1997). Science is fun; it helps you to understand the world around you and to appreciate its complexities. Many people think that Physical Science is the only science studied, ignoring the fact that we have other sciences, such as Life Science, Earth Science, Geo Science and other sciences.

2.5 Science communication

If a person understands a concept, he/she tends to create analogies that will make it appealing to a variety of people. Teachers use this special knowledge to create analogies that will make a concept easy to understand. This form of knowledge is known as Pedagogical Content Knowledge (PCK) which is a kind of content knowledge that is more than just simply the comprehension of subject matter to a deeper understanding which allows teachers to teach it (Kind, 2009; Shulman, 1987; Shulman, 1986, p. 9). Both teachers and journalists need to have this knowledge so that they can

communicate with people and provide explanations that are understandable for students and other non-experts.

It is appropriate that science communicators and teachers simplify science jargon in the classroom or in newspapers and other public platforms. The skill of science communication is to explain something as complicated as quantum mechanics, evolution, astronomy and other science topics in a way that is not only debatable but believable (Grossman, 2014). Science concepts or topics need to be debated because they may contain controversial issues which can challenge beliefs and values. Evidence or findings can be falsified and therefore disputes, disagreements, and inconsistencies can occur (Kuhn, 1962). For example, Copernicus disproved Aristotle's theory that stars were isolated heavenly bodies positioned according to the earth's solar system. Copernicus challenged this view by introducing a new theory that was not proven until later by Galileo's extensive telescopic observations of the universe showed that the universe was not made from a perfect, unchanging substance, but that the Earth was just another planet and the stars are located outside of our galaxy (Leveilee, 2011).

Science communication refers to professional scientists explaining science-related topics to non-experts. It focuses on dialogue, engagement, respecting the audience, the context of science and how it matters to society. Science communication relies on the use of images, maps, photos, tables, figures, video clips and conceptual diagrams to make content simpler (Goh, Pomsagun, Le Tissier, Dennison, Kremer & Weichselgartner, 2000). These are known as the basic principles of science communication. Grossman (2014) argues the public has an acquisitive desire for knowledge therefore science communicators have a duty to get both the message and science right. Science communication does not encourage dumbing down content, but its objective is to write unambiguously. Scientists and journalists need to understand that the majority of readers or audience may have very little prior knowledge of a particular scientific topic but they need to assume that readers are intelligent and knowledgeable (Goh et al., 2000). To accomplish this, journalists need to reduce science jargon when covering science stories, the use of acronyms and definitions need to be clear and science terms need to be explained in each newspaper article.

2.6 Science journalism

Around the early 1990s, the terms "science communication" and "science journalism" were used interchangeably. Science journalism differs from science communication in how it is used and in which context. Science journalism is the science information disseminated by the journalist to the public whereas Science communication refers to scientists being the direct agents reporting science information to non-experts. The relationship between media and scientists can influence the way science advances are made known to ordinary people (Cook, 2007).

Wormer (2006) as cited in Summ & Volpers (2015) introduced two categories of science journalism these categories are traditional science journalism and classic science journalism. Traditional science journalism comprises technology, natural sciences and medicine. These fields, in a general form, can appear in any newspaper, magazine or television program and a journalist drives the content. Classic science journalism, on the other hand, covers scientific findings, conferences and projects. In this context, scientists decide the content of science news that appears in the science sections, in selected science magazines, newspapers, science programs on TV, or radio (Summ & Volpers, 2015).

2.7 Use of newspapers in the science classroom

Newspapers are vital teaching and learning resources to develop a context for general scientific literacy among students which includes communication skills, research, science for citizenship, critical thinking skills in science, and lifelong learning (Jarman & McClune, 2002). Achebe (1988) asked, "What kind of science students could learn in the absence of basic language competence when it comes to reading and understanding scientific terms?" In a science context, teachers need to use newspapers in different ways for teaching. Variety is key and therefore teachers need to be creative in their teaching whilst, at the same time, achieving the goals and the objectives of the curriculum. In a science lesson, a teacher can use an online newspaper as an alternative tool to make students interested in science. This will create awareness in students that all science concepts in the curriculum are applicable or relevant to their lives. Newsprints can be used in science context to show and explain the nature of science, especially science in the making (Jarman & McClune, 2002).

2.8 The importance of science communication in science education

Before 1994, science was inaccessible to the majority of South Africans and the government of the time did not publicise science news and innovations. People were ignorant about the importance of science in their daily lives and how it can impacts socio-economic factors (Joubert, 2001). They were not exposed to scientific inventions, discoveries, implications and policies that may have put their lives and environment in danger or, on the other hand, saved their lives. At school level, only a minority of students were allowed to study science, particular physical science. Black students were mostly not allowed to study physical science and mathematics. After 1994, things changed and all students are now allowed to study any subject of their choice. The media is free to publish any news and practices freedom of speech. Science coverage is now used in the media to close the gap between science communication and society.

Science communication creates respectable science journalists who are experts to make up complex news understandable to the average person while obeying scientific accurateness and not dumbing down content. Scientists send their work to science journals or present their work in science conferences and journalists who cover the conferences have to simplify the information for the

general public. When science communication is practised by science teachers in their classes, it stimulates exchanges of ideas between teachers and learners in the inclusive language of science discourse (Stocklmayer, 2001). Science communication brings to mind the excitement of discovery and the disseminating of research results that embraces everyone in science including high school students. Science communication can assist students to understand that doing science means to investigate the undiscovered and acquiring indispensable skills of rationalising natural phenomena in terms of the proof tested using scientific procedures. Science communication persuades science students to adopt the style of writing that people in the field of science use and to be able to report in a manner that the general public can comprehend (Strauss, Shope , & Terebey, 2005).

Many journalists think they have to dumb down their writing for the non-scientific public. They are doing themselves and their readers a disservice for the reason that important information may be distorted in the effort to simplify the language of science. They tend to use non-technical terms in a science context resulting in the loss of meaning. Non-technical terms are everyday words that are used in science concepts such as “sensitive” and “disintegrate”. The use of non-technical by journalists when reporting is the main reason for miscommunication in science reporting as they do not clearly explain their meaning in science context (Oyoo, 2011). While scientists play a main role to disseminate science news to journalists and, ultimately, to the public, it is usually the journalists who are to blame for miscommunicating this information. But the reality is that scientists do not establish avenues to disseminate science information or discoveries to the public (Brownell, Price, & Steinman, 2013). It is the responsibility of a newspaper to entertain and inform its readers. For them to do this, journalists must publish accurate information. Journalists need to report about the increasingly complex world we live in which includes informing the public about scientific knowledge. People are often faced with difficult decisions to make for themselves and their environment and accurate scientific knowledge can help them make these choices.

Table 2.1 Examples of the terms that have both every day and scientific meanings taken from the newspapers analysed

Common Definition	Scientific Definition
1. **System:** Is a set of principles or procedures according to which something is done; an organised scheme or method.	1. **System:** Is the portion of the universe that is being researched.
2. **Concentration:** the action or power of focusing all one's attention	2. **Concentration:** is a substance quantity per defined space and it is generally conveyed in terms of mass per volume.
3. **Dissociation:** the action of disconnecting or separating or the state of being disconnected.	3. **Dissociation:** The separation of an electrolyte into ions of opposite charge.
4. **Heat:** the quality of being hot; high temperature.	4. **Heat:** is a type of energy that emerges between two samples of matter due to their temperature difference.
5. **Matter:** a subject or situation under consideration.	5. **Matter:** is anything that has mass and volume (occupies space).
6. **Solution:** a means of solving a problem or dealing with a difficult situation.	6. **Solution:** is a similar mixture constituted of only one phase.

Table 2.1 indicates that some of the words are either used in everyday language and science language interchangeably. People who are not familiar with these terms in science may have an incorrect understanding when these terms are used.

In newspapers, the coverage of science has been criticised. Some of the critics say that the quality of science news coverage is below standard because journalists do not have specialised scientific knowledge (Lugalambi, 2011). This, as has been explained above, is due to the lack of collaboration between scientists and journalists (Brownell, Price, & Steinman, 2013). Science communication in South Africa needs to be vitalised and if journalists prioritise science news, students and teachers are going to use newspapers in their teaching and learning.

2.9 Portrayal of science news in different newspapers around the world

In Africa, including South Africa, there is no extensive published research about science coverage in newspapers. Most of the research found was conducted in American and in some European countries. In countries where research was conducted, the focus was on controversial subjects like climate change and global warming.

Awujobi et al. (2012) conducted a content analysis study about agricultural matters that are reported in two Nigerian daily newspapers. Their study used two widely read Nigerian newspapers, Punch and

Guardian, to assess the extent of daily newspapers' involvement in disseminating agricultural information. They found that space allocation and types of agricultural issues featured in newspapers did not play any role in the improvement of agricultural production in Nigeria. Newspapers were not considered as the primary source of information by farmers. That means that farmers were not buying newspapers to get information concerning farming, but they relied on other publications. Therefore, if farmers were not interested in farming news in the newspapers, that meant that the majority of people who were buying these newspapers were not interested in agricultural news but were buying them for other reasons.

Hijmans, Pleijter, & Wester (2003), in a study conducted in the Netherlands, claim that science pages seem to be less important than other supplements in either regional or popular newspapers. Dutt & Greig (2000), in their study about which science stories dominate Indian newspapers, found that the greatest proportion of newspaper space for science issues was dedicated to nuclear science and technology, lag behind by defence, space research and astronomy. They also came to the conclusion that some of the news stories are granted more extensive attention than others. These sentiments were also expressed by Lugalambi et al. (2011) in their study *Media coverage of science and technology in Africa*. Lugalambi et al. (2011) mentioned that there are various external factors which lead to biased news coverage. For example, politics and news that is relevant to the public receive more coverage than science news. Science and technology are provided very little coverage or they are overlooked or mentioned surrounded by "juicier" matters of politics or other more attractive news (Lugalambi et al., 2011).

The agendas of scientists and journalists sometime is in opposite direction as journalism is guided by human interest, while scientists focus on facts, media create their own reality by employing biased selection criteria on what is popular and how it needs to be portrayed (Lugalambi et al., 2011). Two different newspapers can cover similar stories but portray them differently depending on the external factors. On the 12th August 2015, Oscar Pistorius and Thandi Maqhubela appeared in different courts for bail appeals at the same time. Each was accus ed of killing a partner. Two different South African online newspapers had the same headlines for each accused, the first headline was "Oscar Pistorius back in court" and the second headline was "Husband killer Maqhubela back in court". A person who is unfamiliar with these two different cases might conclude from these two headlines that Maqhubela is a killer and therefore a bad person while Oscar Pistorius was arrested for a minor crime that did not include murder. Also, in science news, journalists cover science stories differently. Science news is often covered in the political news because politics are more interesting to the public (Lugalambi et al., 2011). In most cases, scientific matters only receive extensive media attention when they affect politicians or politics.

The assertion above can be illustrated by another recent event that took place in South Africa. Siyabulela Xuza was honoured when a celestial body, a "dwarf planet", was named after him by the MIT Lincoln Laboratory in 2013. The announcement received a limited coverage around the country because Xuza was not well known. However, this news received extensive news coverage when Siyabulela Xuza was honoured by the United States of America's first lady, Mrs Michelle Obama who advised him to return to South Africa after completing his studies so that he could impart the knowledge he received at Harvard to other young scientists. After the invitation, Xuza received coverage around the world and Total garage South Africa made him their ambassador.

Zamith, Pinto & Villar (2012) examined and compared the interpretation of climate change in four different national newspapers from Brazil, Colombia Argentina and USA. They looked at how climate change assertions are unpacked, interpreted or, contrariwise, withdrawn from public view and whether these claims are likely to involve societal sympathetic and responses to climate change.

From January 2009 to the end of the third quarter of 2009, most newspapers covered the issue of climate change during the build up to a conference that was held in December that year. In December 2010, the coverage of climate change was once more visible in newspapers as the Copenhagen summit was about to commence. Most newspapers throughout this period reported about climate change in terms of public accountability and governance. They said that it was the responsibility of the public to reduce carbon emissions and that the government ought to instigate stringent policies to control carbon emissions in the atmosphere. Their newspaper coverage of climate change news was not constant across the four newspapers investigated even though all four newspapers blamed their respective governments' policies for carbon emission (Zamith et al, 2012).

Hijmans et al. (2003) and Yun, Ku, Park, & Han (2012) conducted a content analysis around Netherlands and Korea respectively, focusing on different fields of science. They concluded that people viewed climate change as a fabricated environmental issue. The presentation of this depended on whether the newspaper was a business newspaper or a conservative newspaper. Business newspapers presented the story as an economic issue describing how the problem will affect the economy of the country while conservative newspapers had a trend to portray climate change as a favourable occurrence and covered debates about issues that relates to development as more important than environmental concerns. This took place in countries where the study was conducted including South Africa, they have noted that science news received little coverage in newspapers and science news was placed in sections that were less important to readers, for example, at the bottom corner in the last page (Van Rooyen, 2002). In India, Dutt & Garg (2000) found that the space allocation of science and technology items across prominent English newspapers wide-ranging from 1.4-2.1%. This means that, in many countries, science news is not a priority. Van Rooyen's (2002) study found

that science topics were given less than 2% of editorial space in top South African publications. One reason for this is the poor relationship between the media and scientists (Van Rooyen, 2002).

2.10 The definition, history and developments of astronomy

Possible if you take a trip to a place faraway from city lights, it is estimated that you can be able to notice about 3000 stars on a clear night. When using a telescope, this number can grow to billions depending on the power of the telescope. It the past, the word “astronomy” was a usual expression used to describe science of the planets, stars, sun, moons and other objects in space. Astronomy was the study of anything outside the earth (NASA, 2001). Even though this term is still pertinent and accepted in science discourses, astronomy has been subdivided into many specialties. Geology and planetary atmosphere studies were consigned to the study of planets; the study of fields in space and particles was separated into magnetosphere physics, ionosphere physics, and cosmic and hemispheric physics; the sun had its own solar physics discipline; and the beginning and evolution of the universe is the falls under cosmology. These changes are still taking place and the latest versions of textbooks in astronomy or astrophysics introduce new discoveries and new terms.

Morison (2008) and Moulton (2010) argue that astronomy is probably the oldest of all the sciences disciplines. The astronomer observes what he/she sees in the universe and tests whether his/her observations fit theories that have been previously advanced. One of the fascinating things about astronomy is that, in the universe, there are many states of matter which are impossible to create on Earth and this allows astronomers to create genuine tests for key theories (Moulton, 2010).

2.11 Reasons for selecting astronomy for the current study

Why do we have changes of seasons on earth? Why does time differ in other countries? These are some of the questions children ask themselves. Most students, if they do have an idea, erroneously predict that seasons are the result of the earth's distance itself from the sun and this differs throughout the year. Students know that the earth revolves to present us day and night and also the earth revolves about the sun each year to complete its circle. However, this knowledge does not inevitably lead to the comprehension of seasons. The literature generally compatible that changes of seasons is the least well comprehended topic in astronomy and majority of students experience challenges to explain cause of season changes (Todd & Hotan, 2008). Astronomy was selected to create awareness in either teachers or students about difficult concepts because the misconceptions that were identified in the literature are also visible in South African schools.

I selected astronomy for this study since it is a science on its own. The astronomer observes what he/she sees in the universe and checks whether his/her observations fit existing theories. Astronomy is a topic which shows up student misconceptions and explores strategies that foster scientific understanding. Some teachers do not like to teach astronomy as they believe they have a limited

knowledge about this field but I believe students are interested in astronomy and are willing to find out more about as it inspires students to develop an interest in science (Venugopal, 2015). The education system needs to come up with ways to sustain children's interest in science and online newspapers can be used as first step alternative resources to achieve this goal.

2.12 Theoretical framework

No matter what research questions are being investigated, there are always significant primary norms related to the study which are founded in logic and theory. Simon & Goes (2011) assert there are two spheres in research which are theory and observation. They describe theory as that which a researcher is thinking about, whereas observation is what going on in the real world, i.e., when collecting data. Wilkinson (1991) defines a theoretical framework as an explanation of a trend or an abstract overview that scientifically explains particular phenomena for the purposes of predicting and controlling such phenomena while Eisenhart (1991, p. 205) defines it as a construct that influences a research by being certain about a theory that is assembled by using an recognised, rational elucidation of a certain observable fact and their relationships. A theoretical framework consists of theories that appear to be interrelated. It guides a research and is used to evaluate whether questions are structured in agreement with the theory or not (Chong & Druckman, 2007).

This research study was a content analysis of how astronomy news is framed in selected South African online newspapers therefore it was appropriate to select a theoretical framework that was related to the study, i.e., a theoretical framework that addressed issues of how the media, in particular newspapers, portrayed science stories to their readers. The appropriate theoretical framework used was framing theory which is perceived from diverse angles and can have implications for multiple values.

Erving Goffman refers to framing as a theory in his book published in 1974 *Frame analysis: An essay on the organization of experience*. Goffman used the idea of frames to label schemata. Goffman's framing concept evolved from his work that was made available in 1959, *The Presentation of Self in Everyday Life*, a commentary on the management of impressions. Goffman (1974) in Cissel (2012, p 68) defined framing theory as

> A schema of interpretation, that enables individuals to locate, perceive, identify and label occurrences or life experiences. Framing is used to represent the communication aspect which leads to the people's preference by accepting one meaning to another.

Kalvas, Vane, Stiplcova, & Kreidl (2011) defined framing as a way in which information is presented to the audience. It suggests how something presented can influence the choices people make. It is a process where people acquire a specific conceptualisation about a topic and later change their

thinking. Framing inspires decision-making practices by emphasising a specific aspects and reject others, for example, newspapers frame the news from a certain perspective (Cissel, 2012). Often framing can influence the audience's perceptions and meaning making. Fairhurst & Sarr (1996) maintain that framing is made up of three fundamentals which are thought, language and forethought. They claim that language can transform ways in which we look at our surroundings. To use language, people reflect on their own informational frameworks and of others (Fairhurst & Sarr, 1996). Fairhurst and Sarr (1996) explain that framing techniques used when conducting a newspaper analysis or any written works are: metaphor, spin, jargon, and contrast.

Table 2.2 framing techniques

Framing techniques	**Definition**	**Examples**
Metaphor	Is a figure of speech where an expression or phrase normally labels one thing is used to labels another, consequently making an understood relationship, which gives an idea or program a new meaning.	The Earth is like a **"Ball"** when you are looking at it from space.
Jargon	Jargons are particular expressions or terms used by writers in a specific circumstances, trade or profession. These specialised expressions are used to communicate hidden meanings accepted and comprehended in that particular field (http://literarydevices.net/jargon/).	There was a bang, we think, a **singularity**. This energy **coalesced** into **subatomic particles,** the particles merged into atoms and our **cosmic primordial soup** of universe congealed into something more tangible, but the universe was opaque. It was so dense that light kept bumping into other particles and could not find a way out: **a cosmic Dark Age.**
Contrast	Contrast is used to describe a subject in terms of what it is or not.	The Karoo is a great window for the telescope because it has bad/dry weather.
Spin	This means when you talk about an idea so as to provide it with a negative or positive nuance	The SKA site bid manager for South Africa, outlined to Parliament the **advantages South Africa enjoyed over Australia**. These included the **extreme quiet** of the Karoo and the lack of **radio signals** in the area. The sensitivity of the equipment means there can be no local signals such as from cell phones and terrestrial television. The Karoo also provided

		"the best window on the planet out of which to gaze upon the universe"

Language, in particular in the framing techniques, helps readers to recall what was portrayed in the newspapers. These framing techniques are convenient tools for analysis because they allow us to picture a particular frame that people use when examining a particular issue. If we comprehend and appreciate various frames that writers use to differentiate significant from insignificant information, then we can attain a better understanding of why people take the positions they do, and we can learn about why and how people react as they do when interpreting a particular situation from a newspaper or any other text.

2.13 Conclusion

Chapter 2 offered a relevant literature review for the study. This was achieved by listing some of the major or influential research studies conducted in other countries. It then gave a definitions of a newspaper, how it is/was used, how to use a newspaper as a teaching tool in a science context and the possible benefits of reading a newspaper. Further, it explained the meaning of science, science communication, science journalism, and astronomy, the importance of science communication in science education and the portrayal of science news in different newspapers around the world.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The aims of the study were to provide an overview of how online newspapers portray astronomy news in terms of framing and tone. In the study "tone" is used as a way to analyse and reflect on the mood of the article, whether the journalist reports about positive or negative news. Chapter three discusses methodology and shows how the methodology relates to the theoretical framework and the research questions. Further, it explains the research paradigm, research approach, coding instrument "story analysis form" how it was developed, the Nisbet framework and Flesch readability analysis tool. Lastly, this chapter will explain content analysis, the sample used and the rationale for newspaper selection.

3.2 Methodology research paradigm

People, including researchers have diverse principles and ways to interpret and interact with their environment. There are specific criterions and regulations that influence a researcher's actions. We refer to such standards as paradigms. A paradigm is a principle or theory that influences the way people act, or how people ceremoniously inaugurate a set of practices (Hatch, 2002). Kuhn (1962) defines a paradigm as a cohesive collection of principal variables, concepts and problems accompanying the consistent organisational tactics and tools. According to him, the word "paradigm" is a philosophy of research containing a series of values, beliefs, and postulations that any society of researchers share concerning the complexion and how to handle research.

A paradigm hence infers a pattern, structure and system of academic ideas and scientific, assumptions and values (Thomas, 2010). Lather (1986, p. 259) asserts that research paradigms naturally replicate our principles about our world and the world we desire to live in. Based on this belief, Gephart (1999) characterised research paradigms into three logically well-defined classes; interpretivism, positivism, and critical postmodernism. However, this study will use an interpretive research paradigm which is a type of paradigm showing or telling us how things really are and how they work (Anderson, 2013). Walsham (2006) asserts, in the interpretive practice there are no approved or erroneous philosophies. Nevertheless, these philosophies need to be evaluated on how "interesting" they are to the researcher or to people who are closely involved in the same area. It further claims that anything that exists between conscious minds is communal to more than one conscious mind and is developed whether socially or experientially (Walsham, 2006).

In simple terms, there are countless certainties and realities, not all people have similar needs, perceptions and experiences. Therefore, how I interpret the data from the analysed online newspapers might be different from someone else who analyses the same data. It depends on the motives of each

person and how he/she views the story. Reeves and Hedberg (2003) notice the interpretive paradigm emphases the necessity to locate analysis in context, people's prior experiences differ and their analyses will differ. An interpretive paradigm is connected with qualitative research since it is used to attain a comprehension of the world from an individual's perspectives and the data is used for social change. The above mentioned statement validates why the researcher carefully selected the interpretive paradigm since it is descriptive, explanatory and uses contextual words from interview data, in this case, ways in which I analyse the selected online newspapers. The study used a content analysis form and the episodes from analysed newspapers to accomplish the demands of interpretive paradigm.

3.3 Research method

A research method is a process used to assemble information for the objective of making decisions (Myers, 2009). The most common grouping of research methods is either qualitative or quantitative research methods. These two are the most frequently used research methods in academic research. They are objective methods that are observable and verifiable for testing. They explore issues, understand phenomena and answer questions by examining and making logic of them in different ways (Crosby, DiClemente, 2006).

In this study, a mixed method was used as it combines both quantitative methods and qualitative methods to address different questions of the study (Johnson & Onwuegbuzie, 2004). In the past two decades, the mixed method became popular and was recognised as the third research approach. The mixed method includes assumptions, principles, and combines both qualitative and quantitative methods to obtain a full picture and deeper understanding of a phenomenon (Johnson, Onwuegbuzie & Turner, 2007). Using both quantitative and qualitative methods ensures the researcher is not restrained to a particular method, therefore, in this study I used the strengths of qualitative method to overcome the weaknesses of the quantitative method (Creswell 2003). The mixed method approach has the benefits of both the qualitative methods and quantitative methods, as it permits for more affluent explanation, understandings and a broader range of study questions (Johnson & Onwuegbuzie, 2004). The disadvantages of using mixed method is to find ways to analyse qualitative and quantitative data without favouring one over the other, and how to interpret conflicting results. Usually it is problematic for a single researcher to carry out both qualitative research and quantitative research simultaneously (Johnson & Onwuegbuzie, 2004). In this research, qualitative and quantitative methods were not used concurrently. The quantitative method was used first then the results obtained from quantitative method were used to supplement qualitative approach.

I decided to use a mixed method due to the nature of the research questions as they required both qualitative and quantitative approaches to be answered fully. To answer the first research question, a

quantitative method was used since the question required statistics to gather information on how much coverage does astronomy news receive in South African online newspapers. The question required gathering facts leading towards a general understanding of the question. A quantitative method is a method that emphasises the objectives of measurements and statistics or a numerical analysis of data collected through questionnaires, surveys, or by using content analysis and generalising results across groups of people to explain a particular phenomenon (Creswell 2003). A quantitative method reduces complex problems to a regulated number of variables, it ignores the importance of subjectivity of the researcher and it is less detailed compared to the qualitative method (Zawawi, 2007). Research question one needed this kind of analysis, to come up with a different way of showing how much coverage of astronomy news is in South African online newspapers. This was accomplished by using a story analysis form explained in section 3.4 below.

A qualitative method was used to acquire a profound understanding of the generalised facts from the quantitative method to answer the second and third research questions. Mack, Woodsong, MacQueen, Guest & Namey (2011) claim that qualitative research is used to acquire a multifaceted understanding of a particular event, rather than a superficial explanation of a large population sample. It provides an explicit rendering of an explanation. There are different methods that are common when using qualitative approach including participant observation, direct observation, case study, unstructured interviews content analysis and others. Crosby and DiClemente (2006) argue that qualitative research uses objective methods that are observable and verifiable for testing; it is about investigating problems, comprehending phenomena and responding to questions by investigating and making sense of them in different ways (Crosby, & DiClemente, 2006). A qualitative method was used as a way to make sense of how journalists portray astronomy news. This was accomplished by taking episodes from the online newspapers' articles and analysing them using both the Microsoft Word Flesch readability and the Nisbet framework.

3.4 Coding instruments

A data collecting instrument was not required to conduct the study as the data was already available on the internet, however, the researcher developed and modified an instrument to analyse the available data. A framework developed by Nisbet (2009) and a modified story analysis form were used as coding instruments. A story analysis form is an instrument used by coders when conducting a content analysis of newspapers or any other texts. It has categories and sub-categories which include: the origin, news treatment and geographical focus, among others. The benefits of using a story analysis form is that it is not a standardised instrument and a researcher can modify the instrument to suit his/her research study, however, a coder follows similar coding instructions when collecting or analysing data (Lynch & Peer, 2002). The Nisbet frameworks or typologies were used to determine

the different ways that climate news was portrayed by journalists in newspapers. The functions of these coding instruments and how they were used are explained in section 3.5 below.

Since this study was a content analysis, it involved findings and quantifying concepts which were selected for examination (Opie, 2004). A content analysis is usually used to investigate a comprehensive range of texts from records of interviews and conversations in social research and in clinical research to the description, editorial and advertising content of essay, pamphlets, books, speeches, news articles, and other text materials by using quantitative methods where the results are numbers and percentages (Macnamara, 2005). An advantage of using a content analysis is that it focuses on the actual content and permits the researcher to make inferences about the comprehensiveness of the content covered (Opie, 2004). Content analysis allows a researcher to disclose dissimilarities in content and identify omissions in content made by the journalist. A major benefit of content analysis is that it is systematic and reliable; it forms quantitative components of research to describe who, when and how astronomy was portrayed in the press over a specific period of time (Mayring, 2014). These benefits were also applicable in this study.

In this study, content analysis was vital because it made it easy for me to answer research question one "how much coverage of astronomy news there was in South African online newspapers". It provided a detailed analysis of the amount of astronomy news coverage and how the coverage of astronomy was presented in these online newspapers. Content analysis is divided into many categories. This study focused on media content analysis which is regarded as a specialised subsection of content analysis (Macnamara, 2005). I preferred content analysis over other types of analysis because it combined both quantitative and qualitative research methods. It provided quantitative statistics and a qualitative in-depth explanation for all research questions and I was able to describe how astronomy articles in the newspapers can be used at schools.

3.5 Data collection

Ahead of using the content analysis instruments mentioned above, the Nisbet framework and the story analysis form, a researcher had to retrieve newspaper articles that were going to be analysed online. The sample was made up of news stories retrieved from two South African online newspapers, the Mail & Guardian and News24. Forty newspaper articles were retrieved, twenty from the Mail & Guardian and twenty from News24. The process of retrieving newspapers was straightforward a researcher had to read the headlines of each newspaper article to ensure whether the articles were relevant to astronomy news or not and he retrieved the available articles related to astronomy. To achieve this researcher logged on to the newspapers' websites and searched using the words "astronomy" or "SKA". The newspaper articles were copied into a Microsoft word document to assist with word count, and then converted into Portable Document Format (PDF) files to prevent faults

such as paragraph shifts when scrolling or any other fault that may occur during this crucial time of reading and analysis. I spent more than three to four months reading and analysing the selected articles before I gave five newspaper articles from each online newspaper to a colleague to perform an independent analysis in order to test whether my analysis instrument was valid.

3.6 Sample

Two South African online newspapers, the Mail & Guardian and News24, were selected for the research study from 1 January 2012 to 31 July 2015. The period was selected because on the 25th May 2012, members of the SKA organization declared Australia and South Africa as the hosts of the SKA telescope, with a bigger part of the telescope was intended to be assembled in South Africa. This marked a change in how astronomy news was portrayed by newspapers in South Africa because people began to develop an interest in SKA and astronomy. They started to ask questions about where the SKA project was going to be situated and how long would it take to complete building these giant telescopes. Forty online newspaper articles were analysed and twenty articles for each newspaper were selected. The number of articles was due to two reasons, firstly, because both newspapers were reporting similar stories and, secondly, before 2013 there were not many reports about astronomy in either of the newspapers selected.

3.7 Reasons for selecting Mail & Guardian and News24 online newspapers

These two online newspapers were selected based on their content which is robust and critically interrogative of all topics. The Mail & Guardian online newspaper was inaugurated in 1994 and it was Africa's leading online newspaper. Even now, it continues to offer subject matter that is comprehensive and astute on digitally innovative platforms. The Mail & Guardian is one of the few newspapers in South Africa that has a science editor and journalist and their news is regarded as trustworthy and reliable. The Mail & Guardian is predominantly read by middle class citizens who are educated people and their journalists try to write news that is accurate and reliable. News24, on the other hand, is not a traditional newspaper like the Mail & Guardian. It is an amalgamation of various online newspapers and some reporters from other associated newspapers use News24 as an alternative platform to express their views. News24 is under Media24 which owns Laduma, City Press, Beeld, Die Burger and other newspapers. For the purpose of the study, News24 was selected since it is one of the few Southern Africa and Africa's online news resource that covers news 24 hours a day that bring local and international news as they take place. The main news sections on News24 are world, Africa, South Africa, Sport, entertainment and Science-Technology. Almost all cell-phones have a News24 app and News24 is accessible from DStv.

Both the Mail & Guardian and News24 Apps are available on android, iPhone Operative System (IoS), Blackberry and Windows devices which are widely used in South Africa. These online

newspapers have received numerous awards for their online work and they reach close to seven million South Africans combined. These online newspapers have around-the-clock coverage of local and international news. According to the South African Audience Research Foundation (SAARF), the Mail & Guardian hard copy circulation is 50 230 and current readership is 535 000 every week while News24 has a daily circulation of over 500 000 and more than 4.6 million people are able to access their website weekly (Media Club South Africa, 2015).

3.8 Designing story analysis form

A story analysis form is an instrument that is used when coding newspapers during content analysis. Coding is a procedure where numerical values, letters or colours are allocated to texts to identify them (Saldana, 2008). When reading the newspaper article, a coder highlights important sentences using a PDF highlighter and, at the same time, does a formative check to ensure the coding trustworthiness and makes an on-going response of the analysis available as data analysis progresses (Hanna, & Dettemer, 2004). After reading the newspaper a couple of times, a modified story analysis form was used to analyse the story.

The story analysis form is divided into categories and sub-categories, for example, origin of the story, geographic focus, article readability, and the Nisbet framework, among others. When using this instrument, a researcher decides how the information is going to be used, which portions are to be analysed in what arrangement and what situations need to be gained for coding to be approved (Lynch & Peer, 2002). I decided to follow the above format to analyse my data and I omitted other questions from the original tool/instrument to suit my study.

Table 3.1 Story analysis of categories and sub-categories

Category and definition	Sub-category and definition
Story ID is the article number or label for example story number 2 or 10. Next to it there is a space for a newspaper date, title and lastly a coder is required to write number of words on the space provided below article title.	
Graphics. Here I am looking at the number of photos used in each newspaper article. These can be charts or any non-photograph illustrations that are used to articulate a story. Graphics are usually photographs, but there are other kinds of graphics such as drawings, paintings, and other graphic work (Ingram & Henshall, 2008).	
Origin indicates where the newspaper article originates it has three sub-categories	1. News service is the source of the stories whether the story is taken from AP, Reuters, SAPA or any other news agency, or whether the story is taken from other local newspapers such as Sowetan, City Press etc. 2. The second sub-category is the newspaper journalist; this is the selected person who reports on specific events and news, 3. Last sub-category is unknown; the story is not indicated (Lynch & Peer, 2002).
News treatment is a different way a story is written. News treatment has four sub-categories	1. General News; any story which emphasises realities of a current event, and it is time and again straight news. 2. The second sub-category is feature; it is lengthier, more philosophical tone, usually entertaining or humorous, occasionally it can be about a serious subject nonetheless attempts to tell a story rather than just repeating a succession of facts. 3. The third sub-category is commentary/criticism; any narrative that presents a first-person view or stated view of a newspaper such as editorial, view or recommendation pieces, art, music and entertainment criticism. 4. The forth sub-category is unknown (Lynch & Peer, 2002).
Geographic focus refers to the location of the story, why is it interesting in that particular place. Geographic focus has three sub-categories;	1. National means that the story is about local news i.e. focusing on South Africa, in this case. 2. International, does the story have an international interest or from other countries including African countries. 3. Unspecified these are stories which are not indicated their geographic focus.

3.9 The Nisbet framework

Content analysis was time-consuming as it involved reading and re-reading the newspaper articles. Then the researcher defined units of analysis and categories made up of specific words and phrases. In an evaluation of science-related frameworks, I decided to use the Nisbet framework. Nisbet classified 8 frames that are pertinent to climate change and, with modifications, to other science related fields. The eight Nisbet framework typologies are: Morality and ethics, scientific and technical uncertainty, Economic development and competitiveness, Pandora's box/runaway science, social progress, middle way/alternative path, public accountability and governance, and conflict and strategy (Nisbet, 2009, p. 18). He described these frames as follows:

Table 3.2 The Nisbet framework

Frames	**Defines science-related issue as …**
Economic development and competitiveness	An economic investment is risk or market benefit or a point of global, national or local competitiveness.
Social progress	A means of cultivating an attribute of life or solving problems.
Conflict and strategies	A game among cream of the crop, such as who is triumphant or losing the debate.
Pandora's box/Frankenstein's monster/runaway science	A necessity for safety measure or action in face of likely devastation and out-of-control outcomes.
Morality and ethics	A matter of wrong or right or of appreciates or disregard for boundaries, limits, or thresholds.
Middle way/alternative path	A third way between contradictory or differentiated options or views.
Scientific and technical uncertainty	A matter of specialist understanding or debating over what is accepted versus mysterious.
Public accountability and governance	Policy or research of either serving special interests or public interest or deliberation over correct use of science and know-how in decision making.

Before coding, a coder again had to perform an all-inclusive reading of a newspaper article in advance of coding against the Nisbet frameworks. I read the frames a couple of times to decide which the suitable Nisbet framework for a particular article was. The typologies allowed the coder to determine whether the journalists framed the news story in terms of progress, positive or negative.

3.10 Flesch-Kincaid readability statistics

Flesch-Kincaid readability statistics is the relative ease with which a manuscript or text can be read. The Flesch Reading Ease formula is a method that is used to evaluate text grade level. Primarily it is used to test the complexity of a written English passage (Redish, 2000). Williamson (2008) defined Flesch-Kincaid as a tool used to check grammar that simultaneously provides the readability of the content. These formulae on average consist of factors such as syllable count, difficult vocabulary, and sentence length. Flesch-Kincaid readability statistics are grounded on mathematical formulae that are designed to independently assess the appropriateness of reading materials or texts for students to a precise age or grade level. The Flesch-Kincaid readability statistics includes: word counts, number of words, paragraphs, sentences and characters.

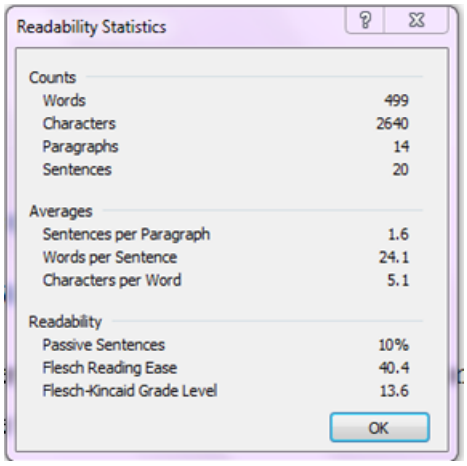

Figure 3.1 example of a Readability statistics from MS Word

Figure 3.1 above indicates some of the features that are found in the Readability Statistics from MS word. For example Readability statistics includes; words per sentence, characters per word and average sentences per paragraph. Lastly, it calculates the Flesch Reading Ease score, Flesch-Kincaid Grade Level and the passive sentences percentage. This study only used the word count, Flesch Reading Ease and the Flesch-Kincaid Grade level. These three tools were used to answer both question one and question two. Question one asked "How much coverage does astronomy news receive in selected South African online newspapers?" To answer this question, the word count was required to determine the length of science news stories in the selected online newspapers. Question two was: "In what ways is the coverage of astronomy news portrayed in terms of framing and tone?" Here the question required a determination of whether the story can be read and understood by students at that particular level, and whether it was difficult to read or not and a grade level was used to determine and respond to question 2.

Table 3.3 Flesch Readability Ease Score, Level and Grade

Flesch Reading Ease Score	Levels	School Grades
90-100	Very Easy	Grades 4 and 5
80-89	Easy	Grade 5
70-79	Fairly Easy	Grade 6
60-69	Standard	Grades 8 and 9
50-59	Fairly Difficult	Grades 10 to 12
30-49	Difficult	Grade 12 or college
0-29	Very Confusing	University

Table 3.3 above shows scores that are used by Microsoft word to determine the difficulty and grade level of a document or text. Scores between 90 and 100 are considered to be very easy to understand and an average grade five students can read and understand the text. Scores between 60 and 70 are considered fairly easy and can be read by a grade eight or nine student. Scores between 0 and 29 are considered to be very confusing and can be understood by college/university graduates. Looking at the table it is noted that scores between 60 and 69 is considered acceptable in terms of Microsoft word and possible to the American educational system as these results/levels may not be accurate or in line with the South African context or educational system. Therefore, there may be a need to use a different rating/grading for a broader research. This study will use the available Microsoft word grading since it is a small study and only analysing two South African online newspapers. Below are the current South African schools achievement levels produced by the Basic Education department (Department of education, 2013).

I. **Level 6**: 80 - 100% (very easy)
II. **Level 5**: 70 - 79% (Easy)
III. **Level 4**: 50 - 69% (Difficult)
IV. **Level 3**: 40 - 49% (Partially difficult)
V. **Level 2**: 30 - 39% (very difficult)
VI. **Level 1**: 0 - 29% (Extremely Difficult - Fail)

These levels of achievements are used to assess students in all subjects and all these subjects are taken on the same level. The official pass grade currently in South Africa is 40% and this might mean a newspaper article ranging from 50-69% is acceptable for secondary school students. The mean mark in any subject is usually about 55. Therefore, in South African context it is important to use these levels of achievements when determining newspaper level of difficulty using the Flesch Readability Ease Score.

3.11 Conclusion

Chapter three discussed methodology and showed how the methodology relates to the theoretical framework and the research questions. Further, it explained the research paradigm, research approach, the coding instrument “story analysis form”, how it was developed, the Nisbet framework and Flesch readability analysis tool. Lastly this chapter explained content analysis, the sample used and the rationale for newspaper selection.

CHAPTER FOUR: QUANTITATIVE RESULTS

4.1 Introduction

Teachers and students are instinctively attracted to texts that are not produced for the purpose of language learning or formal learning (Roberts, 2014). To use a newspaper as a way of teaching and learning enables students to read more confidently and extensively outside the classroom if the lessons are planned correctly by their teachers. Cook (2005) mentions that teachers need to consider whether the text they select for students from a newspaper is too complex or not. If they want to use newspapers in science class, teachers must check how often newspapers publish science news.

Chapter 4 outlines key findings from the quantitative research, i.e., the content analysis of how online newspapers portrayed astronomy news from 1 January 2012 to 31 July 2015. Forty (40) online newspaper articles were analysed, twenty articles for each online newspaper, News24 and the Mail & Guardian. In this study, the term "science" refers to astronomy or astronomy related subjects. Chapter 4 gives statistical evidence for the first research question "How much coverage does astronomy news receive in selected South African online newspapers?" These findings will inform qualitative research in chapter 5 which will respond to the remaining research questions.

The research study only describes a small percentage of online astronomy newspaper articles from 1st January 2012 to 31st July 2015 from the Mail & Guardian and News24 online newspapers. The results from News24 and the Mail & Guardian are going to be combined to develop a general impression of the status of South African press for only these two online newspapers.

4.2 Data Presentation and discussion

4.2.1 Story analysis form

A story analysis form is a tool that is often used in the newspaper content analysis. It was adapted from Lynch & Peer (2002) and modified to suit the current research study. In the next sections, I provide an explanation of each category that was used in the story analysis form and, at the same time, I do a statistical analysis for each category. The story analysis form has the following categories: origin, geographic focus, and treatment, the Nisbet framework, framing techniques, article id, date, article title and general reactions.

4.3 Total number of words

The word average refers to a number articulating an innermost value in an arrangement of figures; specifically it's the median, mean, or mode which can be calculated by dividing the sum total of the values in the arrangement by their number. I will estimate the mean number of words each newspaper uses. Figures 4.1 and 4.2 shows the number of words in each analysed article for each newspaper.

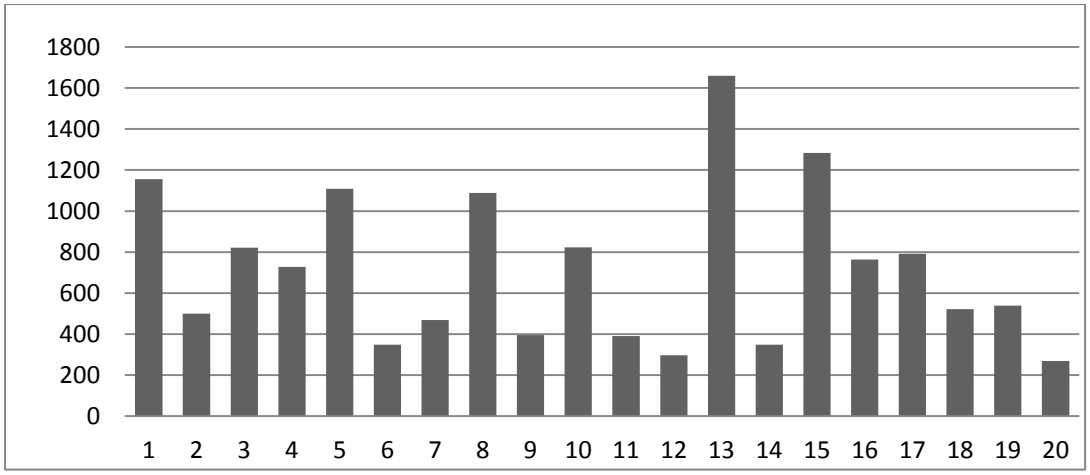

Figure 4.1The Mail & Guardian total number of words per article

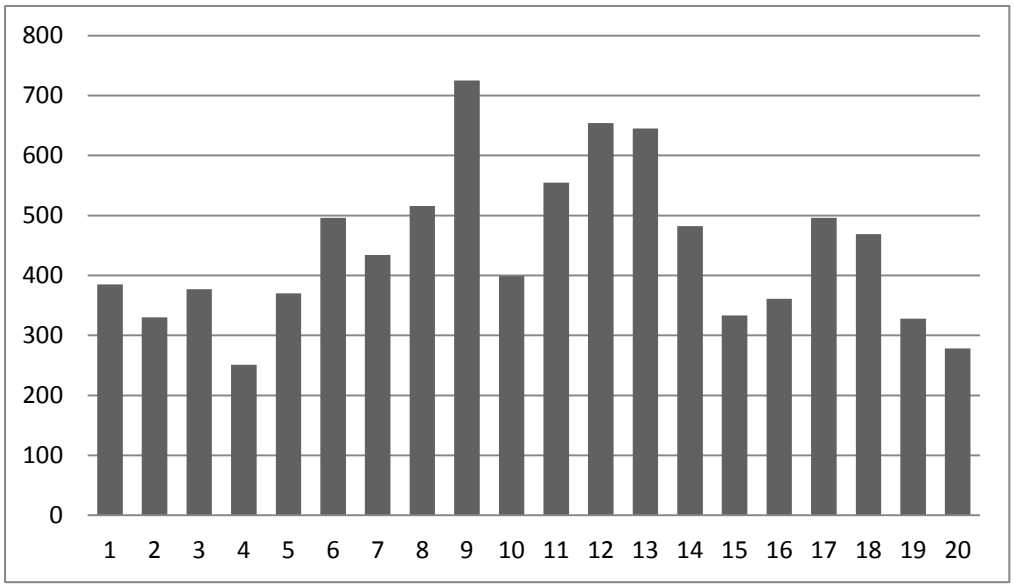

Figure 4.2 News24 total number of words per article

Total number of words includes the heading, date, name of the author and the body. Figure 4.1 indicates that the total number of words in the Mail & Guardian articles is often close to 300 words, the shortest news article has 269 words and the longest article has 1660 words. Figure 4.2 shows that the shortest article in News24 has less than 255 words and the longest article has 782 words. Therefore, the word average for Mail & Guardian is approximately 715 words while News24 has a word average of approximately 444 words.

For the purpose of the study, a newspaper article that has less than 350 words is considered as a short article and a long article has more than 650 words. I established these restrictions based on the claims suggested by Josh Schwartz, a data scientist, who studied how many times people scroll down when reading online articles. The study shows that online readers struggle to remain attentive when they are online. The longer the article, the greater the chances for them to lose focus. When they log on to a

story, it is unlikely for them to even make it all the way down the last page if the story is too long. Schwartz's data indicates, often readers find it tedious to scroll down to the end in particular if they are trafficked by pop-outs or adverts (Manjoo, 2013). A newspaper article with less than 350 words with no image fits the average personal computer screen and for the reader there is no need to scroll down many times. Therefore, this is one of the reasons three hundred and fifty words was selected as the appropriate number of words for an online newspaper article for this study. The other reason is, according to a study conducted by Microsoft, they concluded that the typical human concentration time has dropped from 12 seconds in 2000 to 8 seconds in 2013, especially for those who use social media. A concentration time/span is the amount of time a person concentrates on a particular task without being distracted (Brenner, 2014). If an article is longer than half a page, a person's concentration span would decrease. This can be caused by external stimuli such as the content marketing on the websites, especially the adverts that appear on the sides of the laptop, cell phone or iPad screens (Brenner, 2014). If a newspaper can convey its message using 350 words or less, people might read science news articles for pleasure.

4.4 Origin of the newspaper article

A newspaper article originates from one of three sub-categories. The first sub-category is a news service such as AP, Reuters, SAPA or any other news agency, or the story may be from other local newspapers such as the Sowetan or City Press. The second sub-category is the newspaper journalists who report on particular events and news. The last sub-category is unknown which means that the source of the story is not indicated (Lynch & Peer, 2002).

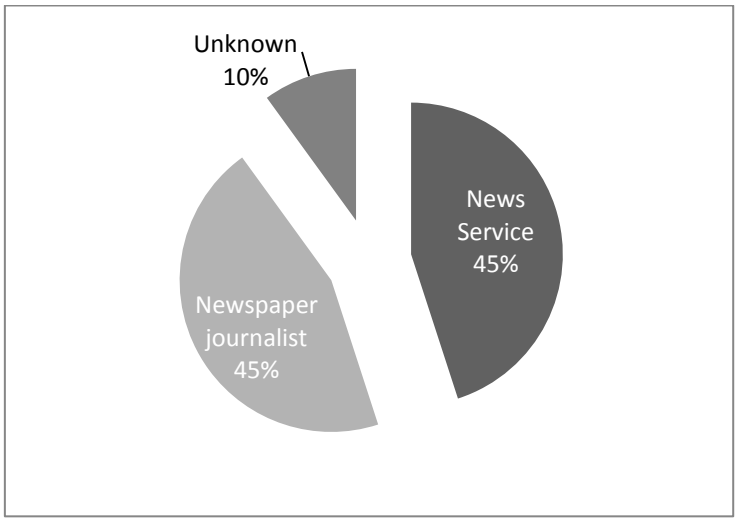

Figure 4.3 The Mail & Guardian news origin

Figure 4.3 above shows the origin of the Mail & Guardian newspaper articles. The Mail & Guardian is one of the few traditional newspapers in South Africa that has a journalist responsible for science news. 45% of the articles analysed were written by newspaper journalists meaning they were not

taken from other news agencies. Another 45% of the news was taken from news agencies. The sources of the remaining 10% of the articles are unknown.

During the research study, the Mail and Guardian had a science journalist specialising in reporting science news. She was knowledgeable about science and wrote most of the science articles. However, in the late stages of this research study, she left the company.

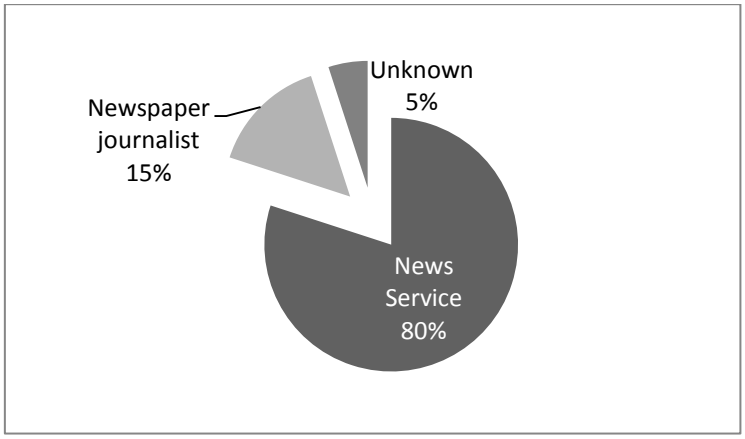

Figure 4.4 News24 news origin

News24 science stories are often taken from other news agencies as is indicated by the pie chart above. 80% of the analysed stories were taken from SAPA, Reuters or other online news agencies. Most of the News24 stories were from other countries. Only 15% of the stories were written by News24 newspaper journalists and they were mostly about SKA developments in South Africa since it is the biggest science and engineering project to be built here. Local journalists wrote about how this project is going to contribute to astronomy, science and to the development of the country. This included articles such as "*SKA looking for extra-terrestrials*" and "*SKA to spur science, maths interest*". Only 5% of the origins of the articles were unknown.

The Mail & Guardian stories were originally written by their journalists but News24 had a limited number of stories that were written by their own journalists. The stories analysed from the Mail & Guardian reported both international and local news from primary or secondary sources. The articles from News24, on the other hand, were based mainly on secondary source.

4.5 News treatment

News treatment is a different ways a story is written. It has four sub-categories as shown in Table 4-1 below.

Table 4.1 News treatment definition and sub-categories

Sub-categories	Definition
General News	Is any piece of an article that stresses evidences of a recent event that is regularly straight news?
Features	A long story with more reflective tone, and usually it is a serious subject nonetheless attempts to tell a story more accurately than repeating a chain of proofs.
Commentary/criticism	Is any piece of an article that presents first-person views or newspapers editorials views?
Unknown	It is not stated.

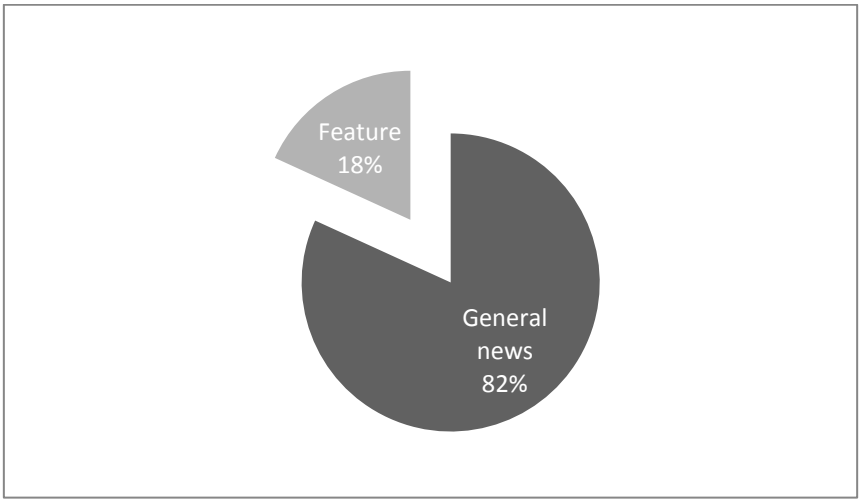

Figure 4.5 The Mail & Guardian news treatment

Figure 4.5 above indicates that 82% of the Mail & Guardian news treatments are general news where journalists of the Mail & Guardian newspaper report about facts of recent events/stories such as "*Star wars as SA battles for SKA*" that explains the advantages South Africa possesses over Australia to host the SKA site. These include the extreme quiet of the Karoo in the Northern Cape Province and the absence of radio signals; these are the main things that help the sensitive SKA equipment's to work effectively. There is no pollution in the atmosphere and, at night, it is completely dark, therefore the visibility is good.

The remaining 18% of the Mail & Guardian news featured stories that had a more reflective tone. For example, an article, "*We'll need two planets by 2030*", where the author wrote about the fact that because the earth is becoming overpopulated and natural resources are being depleted, other planets will be required in the future to meet the next generations' needs. The tone of the article was more reflective and the author presented possible solutions.

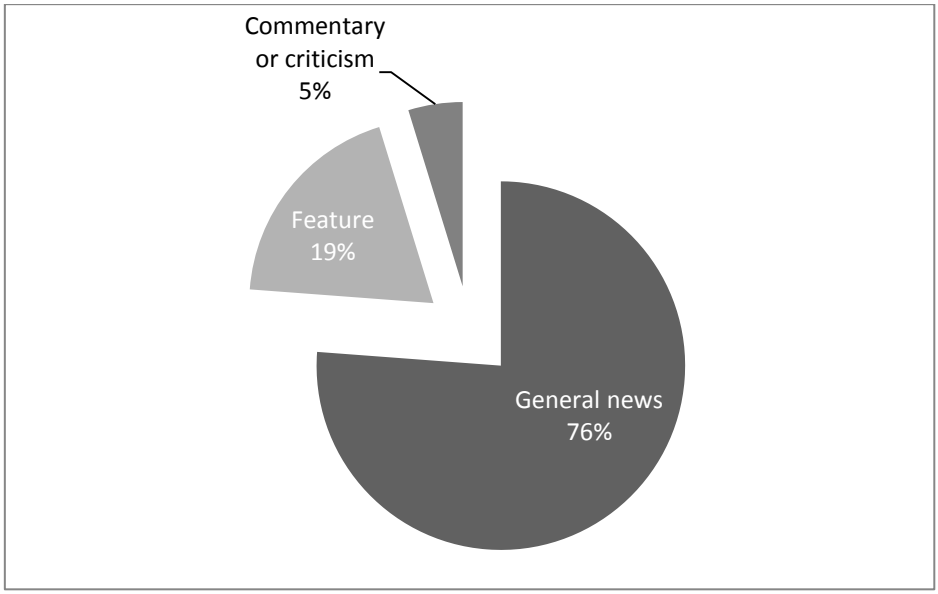

Figure 4.6 News24 news treatment

Figure 4.6 indicates that News24 is slightly different from the Mail & Guardian in terms of news treatment. Only 5% of News24 stories are commentary or criticisms. A story such as "*SKA to spur science and Maths interest*" reported the views of the Sci-Bono Discovery Centre chief director about the state of education, particularly mathematics, in relation to the concern that arose about the number of qualified astronomers and engineers to work on the SKA project. Only 19% of the stories were featured news and 76% was general news. Other stories from both newspapers fell under the category of general news and these stories corresponds with science main focus or objectives that includes producing facts whether from empirical evidence or theoretical evidence as Gottlieb (1997) defined science as the hands-on action taken out by humans, intended to determine or collect more information about the humankind and the environments we are living in and to learn ways in which this information can be structured into profound patterns. These online newspapers are covering stories that are in line with a science definition presented by Gottlieb (1997) where journalists are covering news that are informing their readers about new science innovations.

4.6 Geographic focus

Geographic focus is about the location of a story, for example, why it is situated in a particular place. The purpose of geographic focus is to investigate whether the story is local or relates to provincial, regional, national or international readers. Geographic focus has three sub-categories which are: national which are stories from South Africa in this case, international which are stories from other countries including African countries, and lastly, unspecified, which stories which do not indicate their geographic focus are. Figure 4-6 shows the percentage of the geographic focus.

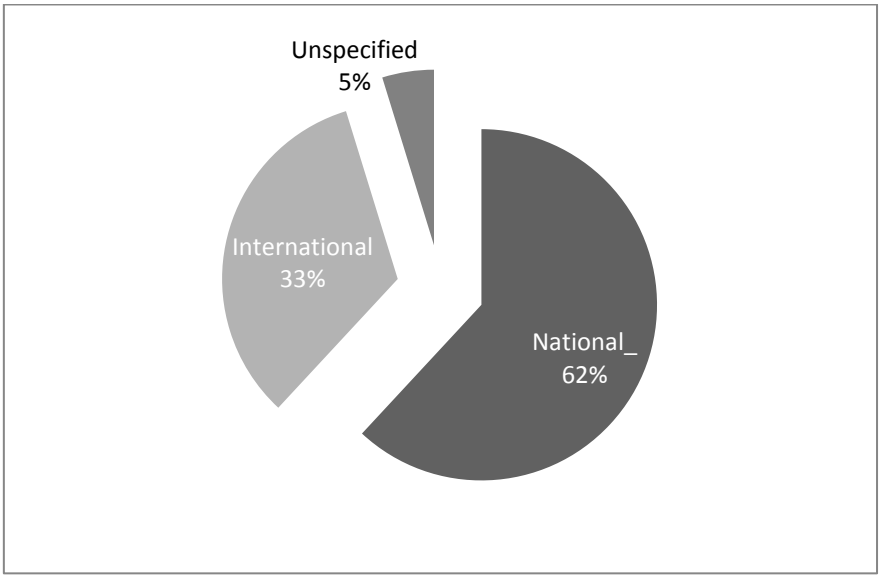

Figure 4.7 The Mail & Guardian geographic focus

Figure 4.7 above indicates that most of the Mail & Guardian stories were nationally based with 62% of these stories reporting about events that took place in South Africa, in this case, the SKA project developments in the Northen Cape area. 33% of the Mail & Guardian news is international news such as "*Map produced of the universe after Big Bang*" that was published in London and the Mail & Guardian sourced it from AP. The remaining 5% of the stories were not specified, either the name of the journalist or the geographic focus were not stated.

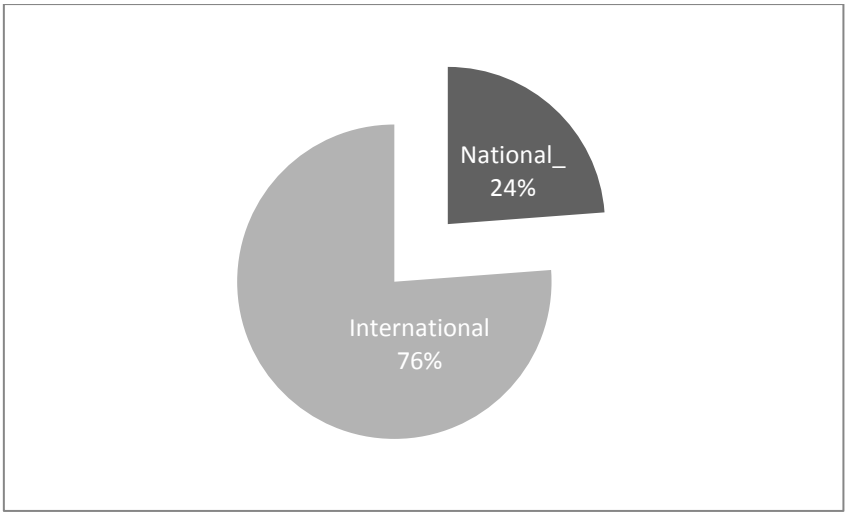

Figure 4.8 News24 geographic focus

Figure 4.8 above indicates that 76% of News24 stories were international news sourced from news agencies such as SAPA, AP among others. 24% of News24 stories were national stories mainly about the developments on the SKA project, such as "*SKA funding model unsure, Pandor solicits Brics*". News24 reports about events concerning astronomy that are taking place around the world.

Looking at differences between the newspapers, there is a huge difference between national and international articles. The Mail & Guardian relied more on local news and News24 relied on international news. The Mail & Guardian reports about local news as its objective is to make the newspaper relevant to South Africans and it has its own qualified science journalist, therefore there is no need to frequently publish stories from other news agencies on their website. News24 relies on international stories or journalists because they want to make the newspaper relevant to both national and international audience.

4.7 Graphics

The focus of this section is the number of illustrations used in each newspaper article. These can be photographs, charts or any other visual material such as drawings, paintings and other graphic work (Ingram & Henshall, 2008). The Mail & Guardian places its graphics either at the top or in the middle of the story, while News24 places its graphics on the right side of the story next to the advertisements. Only three newpaper articles had more than one graphic and they were all long stories from the Mail & Guardian. The author/journalist used more than one graphic to keep the reader interested in a long story.

Graphics are important in newspapers or magazines to illustrate a story and make it easier to understand. A newspaper with no graphics does not look interesting and it does not attract readers. At school, students are more likely to read a passage with a graphics in it than one that does not have any

graphics (Ingram & Henshall, 2008). This is also true for ordinary newspaper readers since graphics make the texts look more interesting.

4.8 Framing techniques

Fairhurst and Sarr (1996) explain that framing techniques that are most likely to be used when conducting a newspaper content analysis are: metaphors, spin, slogans, jargon and contrast. A metaphor is a figure of speech where an expression or phrase normally labels one thing is used to labels another, consequently making an understood relationship, which gives an idea or program a new meaning. The second technique is jargon which is a specific phrase or word that is used by authors in a specific profession, circumstances or trade. These specialised expressions are used to communicate meanings that are appreciated in that field (http://literarydevices.net/jargon/). The third framing technique is contrast which is used to describe a subject in terms of what it is or is not. The last framing technique is spin which is to describe a concept by giving it a positive or negative stance. These terms are explained in chapter three and in chapter five. In this chapter, I will only provide the statistical analysis while a more in-depth analysis is in chapter five. Figures 4.9 and 4.10 show the number of framing techniques used by each newspaper.

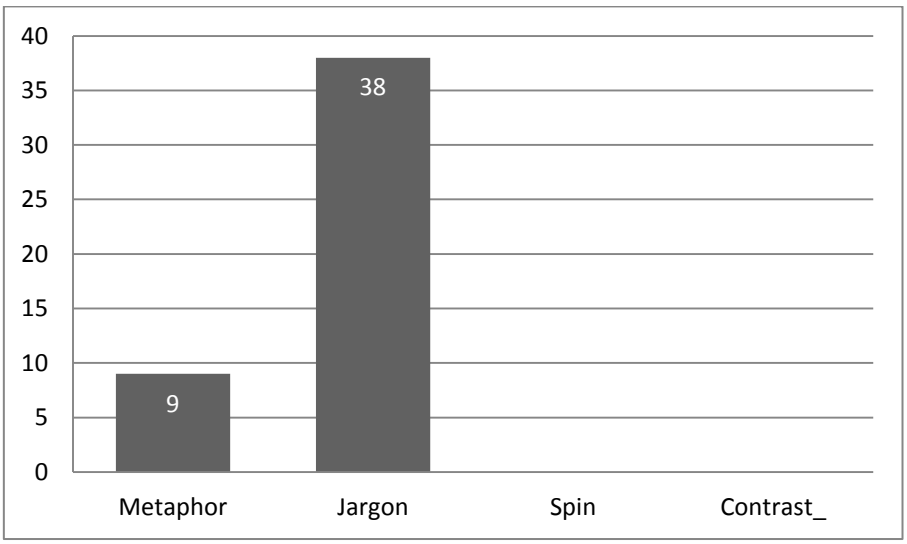

Figure 4.9 The Mail & Guardian framing techniques

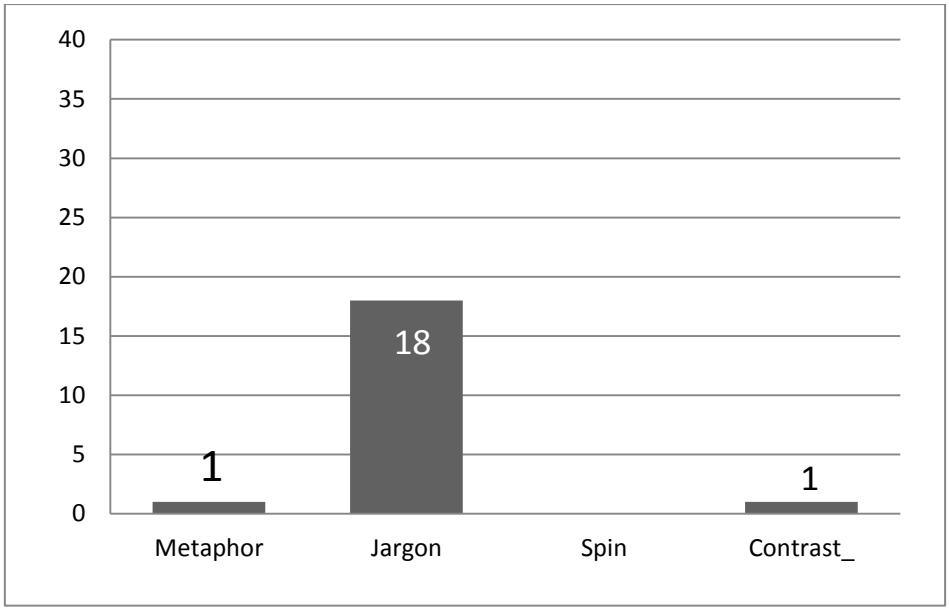

Figure 4.10 News24 framing techniques

Figures 4.9 and 4.10 above indicate that both of the analysed newspapers contained jargon. 81% of the analysed stories from the Mail & Guardian contained jargon whereas 90% of the analysed stories from News24 had jargon terms and abbreviations which were not explained. Terms such as "light year" and "AU" were not explained or written in full. This might confuse their readers. The Mail & Guardian contained 15% metaphors while News24 had 5% metaphors in the analysed stories. Science newspapers use metaphors for different reasons, however, it is rare to find metaphors in science stories. News24 stories are taken from science journals or science seminar presentations where there is very little use of metaphors. The Mail & Guardian stories, on the other hand, are usually written by journalists who understand their audience and the way they prefer science stories to be presented. The above results shows many science stories in newspapers use terms that are not clearly explained for readers, especially those who are not familiar with technical science terms.

4.9 The Nisbet framework

The Nisbet framework is a framing form/tool that looks at ways that journalists portray climate news in different newspapers. Newspaper stories are portrayed differently against the Nisbet framework depending on the nature of the story. Nisbet (2009, p. 18) listed and described eight framework typologies that were originally for climate news which are: Pandora's box/runaway science, morality and ethics, Economic development and competitiveness, conflict and strategy, public accountability and governance, scientific and technical uncertainty, social progress and middle way or alternative path. The abovementioned frames are reviewed in chapter three, section 3.10

Here, the Nisbet framework examines different ways these newspaper articles are presenting astronomy news. An in-depth analysis is in chapter five. Figure 4.11 shows the Mail & Guardian Nisbet framework.

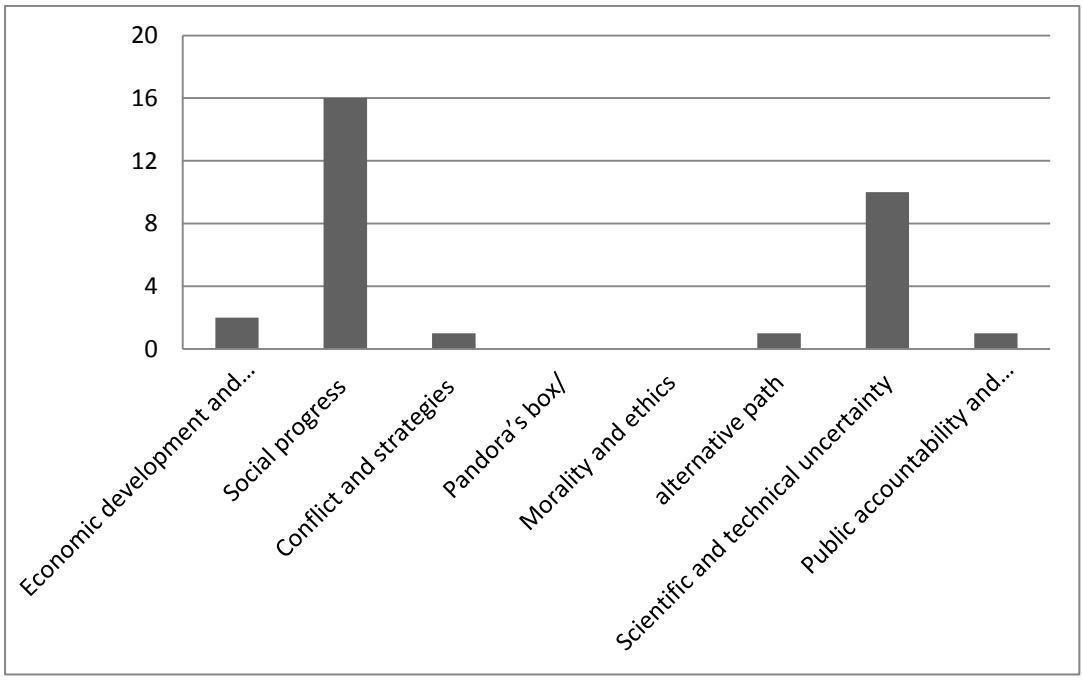

Figure 4.11 The Mail & Guardian Nisbet Frameworks

Figure 4.11 shows sixteen out of twenty Mail & Guardian stories that were analysed. All sixteen of them fell under social progress in the Nisbet framework. In previous section, it was stated that the majority of the Mail & Guardian stories were based on SKA developments and were written by South African journalists.

Social progress is a means of advancing the attribute of life or resolving problems concerning astronomy (Nisbet, 2009). Half of the analysed stories from the Mail & Guardian came under "scientific and technical uncertainty". This is where specialists discuss over what is accepted versus the unheard of. On the story analysis form, a coder had an option to select two of the Nisbet frameworks for the same story he/she was analysing, hence, some of the stories had two Nisbet frameworks others had only one Nisbet framework. In the Mail & Guardian, there were stories that relied more on the views of the experts than the journalists. In these cases, a journalist cited different experts or the story was written by a scientist or was taken from science journals.

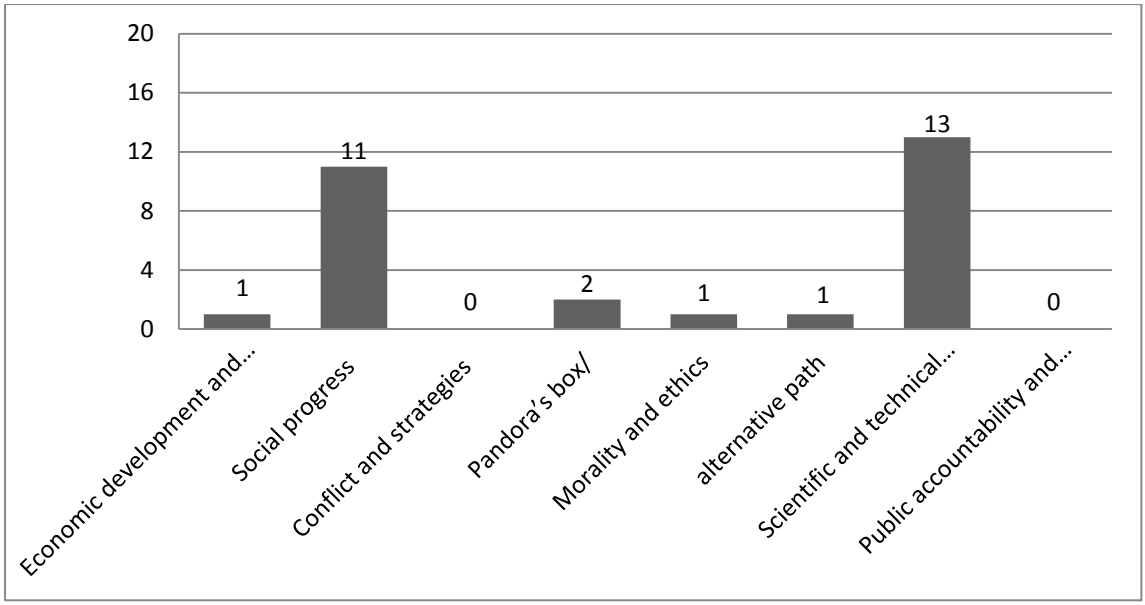

Figure 4.12 News24 Nisbet frameworks

Figure 4.12 indicates that News24 has more than twelve stories that are "scientific and technical uncertainty" against the Nisbet framework and ten of the twenty analysed newspapers are rated as "social progress" against the Nisbet framework. The reasons for this could be that News24 stories are often taken from science journals, seminar presentations and may be written by journalists from the news agencies. The main focus of a journalist writing a report about a seminar presentation is facts and results that are being presented by the researcher. Journalists who do not understand what is being presented may report about the facts, dangers or controversies that are surrounding the story. Only two News24 stories were "Pandora's Box" or "Frankenstein's monster/runaway science" against the Nisbet framework.

4.10 Conclusion

The purpose of chapter 4 was to offer a synopsis of the quantitative research findings. The findings were divided into two, for the Mail & Guardian and for News24. Items that were analysed for each online newspaper were the origin of the news, news treatment, geographical focus, photos and graphics, framing techniques, the Nisbet framework, word average, and general reaction. From the findings, it is noted that the Mail &Guardian news articles are longer than the News24 news articles. This suggests that News24 articles are more appropriate for classrooms as the aim of using newspapers is to make teaching and learning science fun and productive.

The Mail & Guardian stories are written by the newspaper's journalists, while News24 has limited stories written by their journalists. At school this might be problematic because science teachers want to make science accessible to students by using examples that are familiar to them and the Mail & Guardian provides this opportunity. However, the science presented in this newspaper is not in line

with school science because it reports about the SKA project frequently while News24 covers science news on subjects that are taught in school. The results that were obtained from this chapter do not represent the entire spectrum of science coverage because it portrays astronomy news from only two selected South African online newspapers. More research still needs to be done for all the South African online and hard copy newspapers.

CHAPTER FIVE: QUALITATIVE RESULTS

5.1 Introduction

Reading is a fundamental process when teaching and learning science, however, newspapers are not frequently used resources in the classroom. Newspapers make available the central sources of scientific information for the majority of adults (Jarman & McClune, 2002). To use newspapers as a teaching tool teacher need to be aware of the false opinions bluntly made by journalists or authors. These opinions are based on scientific knowledge that is not supported by research and at the same time a reader need to know and understand this information in order to make critical analysis in their discussions as this information often persuades what people believe, how they behave and that is the reason people need to have a skill to evaluate media reports in science (Oliveras, Márquez & Sanmartí, 2013). Science written in newspapers is very different to the science written in an academic context and the aim of scientific news in the newspapers and other form of media is to communicate science, not to teach science, which is the responsibility of the educational system.

Chapter 5 describes how astronomy is framed in selected South African online newspapers. It provides an in-depth analysis of how astronomy is covered by newspapers. The previous chapter used the quantitative research findings to show how astronomy is portrayed by online South African newspapers and how teachers can use these newspapers for teaching purposes. To achieve the above, chapter five will use excerpts from the newspaper articles to justify how journalists portray astronomy news and how teachers can use them for teaching. Further, this chapter will give a short comparison of the differences between the two newspapers using the following categories: content and detail of the article, in other words, what extra details does one newspaper offer over the other?; vocabulary/complexity of language, how complex is the language of each article?; and is there any technical jargon? Fairhurst & Sarr framing techniques and the Nisbet frameworks are used for further analysis. Lastly, it will explain which newspaper I prefer to be used by teachers in science classes. This will be achieved by showing how entertaining, informative and clear the newspaper is in terms of its content and whether it can be used as a teaching tool in the science context.

5.2 Qualitative analysis

This chapter analyses newspaper articles using a qualitative research methodology which explores issues, understands phenomena, and answers questions (Crosby, DiClemente, 2006). It tries to find to comprehend a particular research problem from the standpoint of the population it comprises of (Creswell 2003). Chapter 3 will use a qualitative approach to make an in-depth analysis about the claims I made in the quantitative analysis by citing episodes from the newspapers substantiated by the relevant literature.

5.3 Methods of analysis

The study is underpinned by a content analysis which is a method used to describe a systematically spoken, written or visual exchange of ideas. Sometimes content analysis is used to examine novel material documented by researchers, and it catalogue open-ended answers to survey questions or interview questions (Mayring, 2014). Here I used a content analysis through a story analysis form adapted from a Lynch and Peer (2002) study. A story analysis form is designed to capture both quantitative and qualitative results for both online newspapers (an example/template of story analysis form is in Appendix A). To complete a story analysis form, I read each news article several times. I summarised each news article using the questions in section 5.1 as a guide. The questions that were used to summarise each article are modified questions taken from other similar studies. The main focus of the summary was to justify the Nisbet frameworks that were selected in each newspaper article and the Flesch-Kincaid readability statistics from Microsoft Word.

5.4 Data Presentation: Flesch-Kincaid

The Flesch-Kincaid is an instrument used to check grammar while, at the same time, it provides an idea of the content readability. These formulas normally comprise factors such as syllable count, difficult vocabulary and sentence length (Williamson, 2008). The Flesch-Kincaid readability statistics provide a Flesch-Kincaid grade level which is the least possible reading grade level needed to understand a particular text. These are explained in detailed in chapter three. Table 5.1 below indicates the Readability Ease and Grade levels of each newspaper article used.

Table 5.1Readability Ease

Flesch Reading Ease Score	**Levels**	**Frequency (Readability Ease in %)**	**Frequency (Readability Ease in %)**	**Grades**
		Mail & Guardian	News24	
90-100	Very Easy	0	0	Grade 4 and 5
80-89	Easy	0	0	Grade 5
70-79	Fairly Easy	0	0	Grade 6
60-69	Standard	15	0	Grade 8 and 9
50-59	Fairly Difficult	10	10	Grade 10-12
30-49	Difficult	65	85	Grade 12 or 1st year college
0-29	Very Confusing	10	5	University
Totals in %		100	100	

The results in table 5.1 above indicate the difficulty levels of newspaper articles comparing them to the South African school curriculum and content understanding standards. The results show that the readability ease of most of the newspaper articles for both newspapers was around 30-49 which is considered as "difficult" to read and comprehend. At least 65% of the Mail & Guardian news articles had a readability ease in the 30-49 range and a 42.85 average readability ease when all the newspaper articles were combined. While News24 had at least 85% readability ease of its articles between the ranges of 30-49, the average readability ease was 41.2 when all the analysed News24 news articles were combined. One of the possible reasons that News24 had more articles that are considered difficult to read might be because News24 articles had a lot of technical/science terms that were difficult to understand. However, to impose a grade level requirement or readability ease of the text can do more harm than expected. To make a news article keep to a score at a lower grade level, a journalist needs to make sentences shorter for them to meet the standards of lower grade levels in terms of Flesch-Kincaid readability statistics. While this improves ease of reading, it can direct to edits that lessen the ease of reading. For example, writers usually eliminate well-known words because they are too long (Redish, 2000).

5.5 Summarised newspaper articles

Table 5.2 List and some information of summarised newspaper articles

Title	Newspaper	The Nisbet framework	Flesch-Kincaid readability	Grade level
Stars Wars as SA battles for SKA	M&G	conflicts and strategies against	44.9	grade 12 or college students
The SKA sets universities abuzz	M&G	scientific and technical uncertainties	27.4	grade 12 or college students
SKA telescope on the lookout for aliens	M&G	social progress	52.2	Grade 10-12
Trio of black holes marks the spot for gravitational waves	M&G	Economic development and competitiveness and social progress	40	Grade 12 and university
South Africa eyes SKA telescope with bated breath	M&G	social progress	43	Grade 12 and university

Dust cloud, aurora detected around Mars	News24	social progress and scientific and technological uncertainty	41	Grade 12
Astronomers find oldest known star	News24	scientific and technological uncertainty	47.1	Grade 12
Astronomers see "glue" of the universe	News24	Scientific and technology	40	Grade 12
SKA to spur science, math's interest	News24	social progress	35.3	University students
Saturn moon may have "life-friendly" ocean	News24	scientific and technological uncertainty	43	Grade 12 and university

5.6 The Mail & Guardian articles

In this section, I will provide a summary of only ten newspaper articles, five articles from each online newspaper. These newspaper articles were selected based on their catchy or interesting headings and content. After selecting twenty articles from each publication, I decided to select or explore five (25%) articles in greater detail on how they portray science news. The number of explored newspaper articles is based on the nature of the research as I was only interested in finding out if there is a trend on how online newspapers portray astronomy news. The first five newspaper articles were taken from the Mail & Guardian. Newspaper article number one is "*Stars wars as SA battles for SKA*" where the journalist explained the exchange of words between the South African and the Australian science departments over which country has suitable conditions to be the site for SKA radio telescopes. "*Stars wars as SA battles for SKA*" falls under "conflicts and strategies" in the Nisbet framework. This newspaper article was driven by journalists' interpretation as the journalist claimed that there were leaked results in one Australian newspaper, the Sydney Morning Herald, since the newspaper circulated what people and the newspaper alleged were findings from the statement which disclosed the South African proposal was better than the Australian proposal. Thenceforward, people on both sides questioned the legitimacy of this disclosure, but then again it has set the agenda and show the way the debates between these countries is taking. Another example,

> The media, and politicians have been kicking insults across the Indian Ocean over the hosting of one of the world's largest and most important scientific endeavors—the R16-billion Square Kilometer Array (SKA) radio telescope, which will rank alongside the Large Hadron Collider as one of the world's biggest scientific projects.

In the above episode, the journalist was directing the public opinion about the upcoming announcement about which country was going to host the SKA. It also discussed what is known versus what is unknown, and there were reviews about the advantages of hosting SKA telescopes in both countries.

"*Stars wars as SA battles for SKA*" is a long article as it comprised 822 words, including technical terms which might be difficult to understand. The Flesch-Kincaid grade level of this article is 44.9 which means that it is suitable for grade 12 or college students as this rating is regarded as "difficult".

The second article from the Mail & Guardian is "*The SKA sets universities abuzz*". This is a very difficult article to comprehend with a Flesch reading ease of 27.4 which is "very confusing" and a Flesch-Kincaid grade level of 15.6 which means it is suitable to be read by students who are in the last year of undergraduate level. It is a very long article with 1109 words and people who do not have a science background might experience difficulties comprehending the science concepts that are presented in this article. The article uses many scientific terms and references. Against the Nisbet framework, the article falls under "scientific and technical uncertainties" because it is about experts from different universities who are debating over what is known versus the unknown concerning the possibilities and opportunities SKA might bring to South Africa. This article to falls under "scientific and technical uncertainties" because the main purpose of the article was to gather the views of university professors about the advantages and disadvantages of SKA in South Africa and to identify the role that would be played by South Africans and African university graduates.

The third Mail & Guardian article that was summarised is "*SKA telescope on the lookout for aliens*". This article has a catchy heading which might attract readers who are interested in the existence of aliens on other planets. It is very short and it does not have many science terms that might be difficult for readers to comprehend apart from the excerpt that says:

> We want to look for organic molecules, the molecules of life out in space and, of course, we want to look for extra-terrestrial intelligence.

The phrase that needs an explanation is "organic molecules" which is a science term and might be confused with inorganic molecules. The primary dissimilarity between an inorganic molecule and an organic molecule is an organic molecule at all times contains carbon whereas most inorganic molecules do not have carbon (Silberberg, 2009).

The article contains 496 words, its Flesch reading ease is 52.2 which is "Fairly Difficult" and suitable for students who are in grades 10-12. That means teachers in these grades can use this article to create class activities for their lessons. "*SKA telescope on the lookout for aliens*" falls under social progress

in the Nisbet framework as its aim is to find out whether there are aliens or other forms of life in other planets and gather more information about our galaxy and other galaxies.

The article, "*Trio of black holes marks the spot for gravitational waves*", makes the public aware of the developments in astronomy. It falls under "Economic development and competitiveness" and "social progress" in the Nisbet framework. It highlights the benefits of SKA in South Africa and in Africa by comparing the benefits of using both the SKA and Very Long Based Interferometry (VLBI) in Southern Africa. The article can be understood by grade 12 or college students as its readability grade level is 13.6 and it is 40 which are "difficult" in the Flesch reading ease score because it contains a lot of science jargon. However, the story has the means to improve the quality of life or to solve problems in astronomy.

"*South Africa eyes SKA telescope with bated breath"* is an average article that has 727 words. It has a score of 43.4 which is a "difficult" Flesch reading ease and a score of 13.3 Flesch-Kincaid grade levels which is equivalent to grade 12 and college in South Africa. The title of the article "*South Africa eyes SKA telescope with bated breath*" catches the reader's attention. In the Nisbet framework, it falls under "social progress" as it provides evidence on how the construction of SKA can benefit South Africa.

5.7 News24 articles

"*Dust cloud, aurora detected around Mars*", is a short article which includes unexplained scientific terms or names of the instruments that were used to conduct the research such as Mars Atmosphere and Volatile Evolution. The excerpt, "Aurora are seen when geomagnetic storms unleashed by eruptions on the sun cause energetic particles like electrons to crash into the atmosphere, causing the gas to glow" comprises many unexplained terms or science jargon such as energetic particles, electrons, atmosphere and geomagnetic, however, students who have done physical science will be familiar with these terms as they are often used in their subjects but there is no proof whether they understand them. Teachers can use this story as a classroom activity although, according to Microsoft Word, its Flesch-Kincaid grade level is grade 12, but grade 9 or 10 students can understand the content of the article. The terms that are used are not foreign to most students. The article has a 41.1 Flesch reading ease which is "difficult". Against the Nisbet framework, the article falls under "social progress" and "scientific and technological uncertainty" since experts or astronomers are reaching consensus about the issues raised in the article.

The second article from News24, "*Astronomers find oldest known star*", is a short article that falls under "scientific and technological uncertainty" on the Nisbet framework. Astronomers are developing theories that can explain how these old stars were formed or died in our solar system. Most of the technical terms are not explained, such as "light year" which is a confusing term to people

who do not have a science background in physics or astronomy. Frequently people assume a light year is the time taken by a light to reach a certain destination while it is actually a component of astronomical distance equal to the distance light travels in a year and it is represented by 9.4607×1012 Km.

The article is equivalent to grade 12 or first-year undergraduate students and its Flesch read ease is 47.1 which is regarded as "difficult". A person with no science background can read the article but may not fully understand everything written as it uses scientific terminology taken from a science journal.

"*Astronomers see 'glue' of the universe*" is the third article taken from News24. The headline is interesting and it is a very short article that is a summary from a journal article in a "Nature's Journal" and consists of 251 words. The article uses simple language that even a layman can understand and most of the terms are explained. "Scientific and technological uncertainty" is an appropriate framework under the Nisbet framework since it is controversial on whether matter between galaxies is distributed in a network of strands known as the "cosmic web". Its Flesch reading ease is 40.1, regarded as "difficult", and its Grade level is 13.6 which mean that it can be used as an activity for grade 12 or university students.

The fourth article from News24 is "*SKA to spur science, math's interest*". This is a review of the state of education in South Africa and it provides details about the 2012 grade nine pass rate nationally in mathematics which was, at that time, only 13%. In the same year, only a few matriculants achieved 65% or higher for mathematics and science subjects. Against the Nisbet framework, the article falls under "social progress" as its aim was to improve the science skills of the current generation. The newspaper source mentioned that "the current generation of learners will reach higher education or employment in the technical economy just as the SKA approaches operational maturity around 2020". "*SKA to spur science, maths interest*" is an average article that consists of 434 words, its Flesch read ease is 35.3 "difficult" and its Flesch grade level is 13.3 which are suitable for first-year university students. This is not an article that can be used at school for activities since it is a review of the current educational situation in South Africa.

"*Saturn moon may have 'life-friendly' ocean*" is a dull article. It does not provide any background that can assist a reader to use as a reference, much information is missing and the jargon used is hard to comprehend. Under the Nisbet framework, it is "scientific and technological uncertainty". Experts are providing facts and therefore it is not suitable for any grade at school as it is aimed at people who already have a firm background in space science. Its readability ease is 43 which are regarded as being "difficult".

5.8 Discussion

The first five newspaper article summaries were taken from the Mail & Guardian. Most of these articles were very long as, according to this study, an article is regarded long if it has more than 600 words. Therefore, for a person who is not interested in science news, it might be very difficult to read the entire article. However, the Mail & Guardian articles report about what is happening in South Africa and this makes the readers own, criticise, or add views about what is written in the article because they are familiar with the context. The last five articles were taken from News24. Most of these articles were short consisting of less than 400 words which appeals to many people. Often News24 articles are from different science journal summaries or press briefings from the scientists who conduct research in astronomy. Against the Nisbet framework, astronomy articles often fall under "scientific and technological uncertainty" while of most of the Mail & Guardian astronomy articles fall under "social progress" in the Nisbet framework. These online newspapers are not reporting on the same issues because the Mail & Guardian has a tradition of reporting about stories that are taking place in South Africa. Joubert (2001) mentioned in a country like South Africa, science communication tries to alleviate the number of people who wants to know more about science-related topics, which means that it informs society about science related discoveries that are taking place in South Africa and other local science news to allow people to take informed decisions. I believe that this is the goal of the Mail & Guardian since it often reports about local science news and covers stories about SKA, MeerKat and other stories relating to science in order to meet the abovementioned suggestions by Joubert (2001). Most of the Mail & Guardian articles provide a background for the reader to understand what happened before. For example, the article "*Suddenly Africa is looking up*" provides a history or idea of why people are interested about what is happening in the universe and it gives an example that through boredom or a person can come up with an breakthrough when he/she least expect like Albert Einstein who was pushing paper in a copyright office when he established his general theory of relativity, which totally transformed the foundations of physics.

On the other hand, News24 science reporting is straightforward and does not provide any science background. Most of the News24 articles do not report local news as 75% of the News24 stories analyzed are international stories. One of the possible reasons for this could be that News24 is not an online newspaper but a network online newspaper, i.e., a form of a news agency that reports or receives news from other news agencies therefore it tends to buy news of international interest. Astronomy events find their way into News24 for the reason that reporters are interested in stories and events that will boost revenues or sales. News24 receives many comments from readers compared to the Mail & Guardian. These news articles were retrieved from News24 before the management decided to close comments on its website from Friday, 11 September 2015. This was done because editor-in-Chief, Andrew Trench, believes that the comments sections on their news websites do not add a noteworthy value to subject matter they are offering and to user experience.

Both newspapers had catchy headlines. The Mail & Guardian had headlines such as "*Stars wars as SA battles for SKA*", "*God did not create the universe, says Hawking*" which attracted readers to read the whole story as a result of curiosity about the headline. News24's headlines were "*Saturn moon may have 'life-friendly' ocean*", "*Astronomers see 'glue' of the universe*" and "*Lunar eclipse turns moon blood red*". These headlines also were attractive to the readers and may have caused people to read the whole article.

5.9 Framing techniques

The research study was underpinned by framing theory that propose, how a story is portrayed can influence the choices people make and their opinions about that particular issue (Kalvas et al., 2011). Framing theory is perceived from diverse viewpoints and has consequences for multiple considerations or values. Framing intensifies decision-making practices by emphasizing specific aspects and by rejecting others. A newspaper frames news from a specific standpoint and, in this way; it regulates an audience's perceptions and understanding (Cissel, 2012). This study used both Fairhurst & Sarr (1996) framing techniques and the Nisbet frameworks. The Fairhurst & Sarr framework consists of four framing techniques which are metaphor, jargon, contrast, and spin.

Table 5.3 The number of framing techniques that are used from both newspapers

Framing techniques (Format)	Frequencies	Percentages (%)
Metaphor	10	14
Jargon	56	84
Spin	0	0
Contrast	1	2
Total	67	100

The results in table 5.3 indicate that newspaper journalists often use jargon terms which are special words used by a profession that are difficult for others to understand. At least 84% of the framing techniques found in the analysed newspapers was jargon words that are only used in a science context (Martinez & Torregrosa, 2015). Technical terms comprise things such as physical concepts (force, mass), minerals, processes, chemical elements, process words (agitate, filtrate). Most of the readers are not familiar with this scientific vocabulary even though many of these terms are introduced in secondary school level from grade ten where students opt either to do physical science or life science.

A survey by General Household 2012 revealed that 19 million adults in South Africa obtained grades seven to eleven level and six million people obtained a qualification below grade seven (Pretorius, 2013). These statistics indicate that, among 19 million people who obtained grades 7 to 11, not all of them did science subjects which would allow them to understand the content presented in the newspapers. Postman & Weingartner (1971 as cited in Oyoo, 2011) assert that whatever we know or understand is attached to language where knowledge is organised. All forms of language are the building blocks that constitute learning in class. To obtain knowledge, a person needs to understand the language used. In some of the newspaper articles, this might be difficult to achieve.

Only 14% of the framing techniques were metaphors and most of the metaphors were used in headlines, for example, "*Stars wars as SA battles for SKA*", the metaphor suggests there is a tension between South Africa and Australian governments officials over which country will be the home of the SKA. "*World reaches for the stars in SA*", this suggests that the world will now access what is happening in the universe through the SKA telescopes that are going to be placed in South Africa. "*Suddenly Africa is looking up*" this metaphors explains now it is time for Africa and South Africa specifically as they are going to be the main sites for the SKA telescopes to observe what is happening in the universe and "*Astronomers see 'glue' of the universe*" This means astronomers discovered an isolated quasars, these are very isolated matters in our universe. They are away from our galaxy; they are extremely bright masses of energy and light and can be observed (Robberto, 2006). These quasar Illuminate an enormous nebula this is a cloud of gasses from which our own Solar system formed (Disney, 1998). These nebulas reveal parts of the network of threads believed to connect galaxies in a cosmic web. The scientists noticed the fluorescent luminosity of hydrogen gas follow-on or after its illumination by a powerful radiation starting the quasar. That is why they headline states Astronomers see 'glue' of the universe because it appears as the glue under the telescope.

Newspaper writing has been recognised as a source that naturally uses metaphors to create curiosity in the readers' minds (Krennmayr, 2011). For the purpose of this research study, I used a common description of a metaphor and I identified them using this definition stated above. As a result, there is a limited use of metaphors in science articles as they often report about events that are taking place or recent discoveries. Using metaphors might alter the message they are intending to disseminate to the public or to their peers in the same field or a different field of science. None of the newspaper articles used spin in their writing and there was only one contrast technique in all the analysed articles. The possible reason for this could be that the aim of science news is to convey the information to the relevant people and the message therefore needs to be crafted for people in that particular field. Contrast or spin might dilute the intended message.

5.10 The Nisbet framework

In an evaluation of science-related frames, I decided to use the Nisbet framework. Nisbet (2009) ascertained 8 frameworks that are appropriate to climate change. I consider these frames applicable, with modifications, to other science related fields. The eight Nisbet framework typologies are: morality and ethics, conflict and strategy, Economic development and competitiveness, social progress, Pandora's box/Frankenstein's monster/runaway science, middle way/alternative path, scientific and technical uncertainty, and public accountability and governance Nisbet (2009, p. 18). The above mentioned frameworks are discussed in chapter 3, section 3.9

The Nisbet framework shows the different ways these newspaper articles portray science stories. Figure 5.1 below shows the results of the Nisbet framework when the selected newspapers are combined.

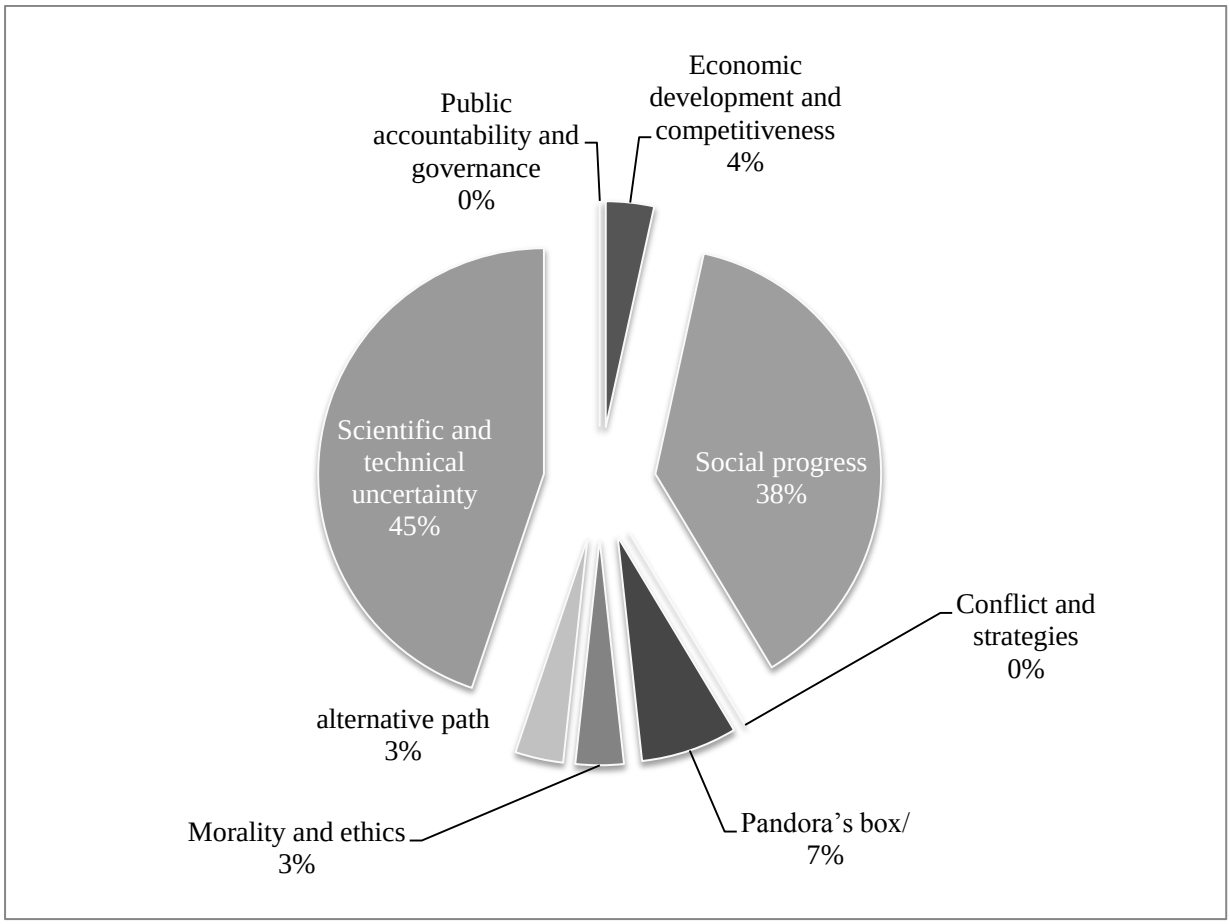

Figure 5-1 The Nisbet frameworks

Figure 5.1 above shows a graph of newspaper articles that are categorised into various Nisbet frames. Some of the newspaper articles were categorised in more than one of the Nisbet frames due to the nature of the story that was reported. Most of the articles which were categorised more than once were from News24. Figure 5.1 shows that most of the news stories were classified under "scientific and

technical uncertainty" followed by "social progress" on the Nisbet framework. Other Nisbet framework categories have less than four articles classified under them. This shows that astronomy news focuses on coming up with new evidence to support the claims about space science.

"Social progress" is a way of advancing the value of life and answering problems. 38% of the articles fell under "social progress" and 45% of the articles fell under "scientific and technological uncertainty" which is where experts reach a consensus or debate over what is known versus what is unknown. Some of the reasons could be that News24 reported mainly about astronomy discoveries and most of the articles were based on science journal articles. Astronomy news is not always controversial, its main aim is to create new ways to view the universe therefore most of the stories will fall under these two categories. Astronomers study extra about universe; they collect information about the physical appearance of the moon, stars, planets and other substances they use computer programs and telescopes. Astronomers work out and test scientific theories, analyse data, and spend time writing scientific journal articles and present their findings to their peers in the field (Morison, 2008). For example, in the past decades, many spaceships were sent to space to gather more information about what is happening in our solar system and beyond.

"Pandora's Box", "Morality and ethics", "Middle way path" and "Economic development and competitiveness" are the least used frameworks from the analysed articles. These four frameworks accounted for about 7%, 4%, 4% and 4% respectively. The SKA project does influence some people's wellbeing which is why "scientific and technological uncertainty" or "social progress" is used by the Mail & Guardian and News24 since most of its reports were about SKA and how it will improve the lives of South Africans. For example, there was an article in the Mail & Guardian reporting about the environmental hazards that might occur when the current Minister of Energy, Tina Joemat-Pettersson suggested in 2014 that it is possible to have an alternative electricity source (gas) in South Africa.

Out of all the eight Nisbet frameworks used to analyse science newspapers, Figure 5.1 indicates that science stories are likely to be portrayed in terms of "scientific and technological uncertainty" or "social progress". These two frameworks are the highest in terms of percentage when compared to other frames. The online newspaper I prefer to use or I can advise other teachers to use in their classrooms to create activities, is News24. The reporting in News24 is balanced and there is a limited bias in terms of content. News24 reports about astronomers' findings or science journal reports. Most of their published stories are taken from news agencies. However, I understand the bias conveyed by the Mail & Guardian articles since they are promoting the SKA project and trying to show the advantages of allowing the majority of SKA telescopes to be located in South Africa.

5.11 Conclusion

Content in the newspaper needs to be explained to students since it has been revealed by the findings of this study that most of the astronomy newspapers had scientific terms that are not explained by journalists. Teachers need to assess and reflect on the contents from the newspaper articles and to recognise that newspaper articles are written differently from school textbooks. This chapter provided a background interpretation of qualitative analysis then it made an in-depth analysis of how astronomy is covered by the two selected newspapers. This was achieved by using episodes from the analysed newspapers to justify claims. Further, this chapter used a short analysis to illustrate the differences between the two newspapers using content and detail, i.e., what extra details does one newspaper offer over the other? Vocabulary/complexity of language, how complex is the language of each article? Is there any technical jargon? Fairhurst & Sarr framing techniques and the Nisbet frameworks were used for further analysis. Lastly, I explained which newspaper I preferred and gave reasons.

CHAPTER SIX: DISCUSSION

6.1 Introduction

Sanderson (1999) asserts that a newspaper can act as a tool when teaching science given that it is regarded as material that can heighten students' knowledge, enhances students' vocabulary skills and encourages a positive attitude towards learning. Right the way through this research study I went into details concerning ways of using newspapers to benefit pupils, teachers and ordinary people. The literature and quotes from selected analysed newspapers are used to substantiate the findings. Chapter 6 will discuss and respond to the research questions using literature and episodes from the analysed newspapers. It will then address the limitations, make suggestions and recommendations on how teachers can use newspapers when teaching science.

6.2 Reinstating research questions

The purpose of the current study were to provide an synopsis of how online newspapers portray astronomy news in terms of framing and tone and enhance public interested to astronomy and science as general. This chapter will respond to the following research questions using findings from chapter 4 and 5. A content analysis form, the Nisbet framework and Fair & Sarr (2006) framing techniques were used to respond to the bellow questions.

6.2.1 The study sought to answer the following research questions:

I. How much coverage does astronomy news receive in selected South African online newspapers?
II. In what ways is the coverage of astronomy news portrayed, in terms of framing and tone?
III. How, if at all, can astronomy articles be used in science classroom?

The goals of the study are to provide an overview of how online newspapers portray astronomy news in terms of framing and tone. "Tone" is a way to analyse and reflect the mood of the article whether a journalist reports about positive or negative news. The study aim is to scrutinise how journalists frame astronomy news in South African online newspapers and how their coverage can assist science students and teachers to access information and use online newspapers as an alternative way of informal learning.

Conducting a research study about astronomy coverage in newspapers is one of the ways to contribute and make possible suggestions about the importance of informal learning in science education. If teachers want to introduce an informal learning to her/his science class they need to know that there is already an abundance of information when it comes to astronomy. The information is being distributed by other organizations such as the ESO, NASA and other organizations. Teachers who are

willing to bring astronomy to living in their classroom have a choice of selecting online newspapers and some of the above mentioned platforms as their alternatives in their teaching.

6.3 Question one: How much coverage does astronomy news receive in selected South African online newspapers?

Research question number one was answered through a quantitative method as it required numerical values. Complete statistics are discussed in chapter four. The newspapers that were analysed are the Mail & Guardian and News24 these are online newspapers and are amongst the highest dissemination and are persuasive to their readers. To respond to question one "how much is the coverage of astronomy news in South Africa", forty online newspaper articles were selected, twenty articles from each newspaper. Origin of the story, geographic focus, and news treatment were used to further respond.

6.3.1 News vs. feature

There are no major differences between The Mail & Guardian and News24 news treatment. News treatment is a different way a story is written. News treatment has four sub-categories, however, only News and feature to answer question one. Their characteristics and distinctions are straight forward, often newspapers use either news or feature in their coverage and it is relatively easy to pick them out. General News is any piece of an article stresses evidences of recent events and is regularly portray news straightforward. Featured news is a long story, it has a more reflective tone, sometimes it is humorous and it can be on a serious subject but tries to tell a story rather than just regurgitate a series of facts (Lynch & Peer, 2002). Out of all the analysed newspapers 82% of the Mail & Guardian stories was predominantly general news whereas only 76% of News24 stories were general news. These statistics indicate that most of the science news is general news seeing that they are more likely to be covered by journalists if they are perceived as newsworthy or if they are blended with political news (Lugalambi et al., 2011). Mail & Guardian reports about astronomy news when there are new advances relating to SKA or if political leaders had visited the SKA project site. For example, they often quote high profiled people like the current science and technology minister Mrs Naledi Pandor or university professors. Almost 70% of the analysed articles were reporting about the SKA project, either about new developments, threats that may occur or ways of fundraising for the project.

While on the other side featured news was limited from both online newspapers. Featured news is a long story with more reflective tone, and usually it is a serious subject nonetheless attempts to tell a story more accurately than repeating a chain of proofs. By taking more time to tell a story means more space is used in the newspaper this is why the featured news is customarily not favoured by journalists or news editors though not always. In the Mail & Guardian only 19% of the stories were featured news despite the fact that News24 had only 18% of featured news. Journalists write featured stories to make a reader keen with news sense or to create an awareness of human interests and a healthy

curiosity. For example, one of the Mail & Guardian featured story was about creating an awareness regarding dangers we might possibly draw against if we are not taking care of our planet. It suggests that by 2030 we will need two more planets to relocate in order to meet our needs and to survive.

6.3.2 Local vs. foreign news

If you are a person who is enthusiastic about news whether international or local news, reading newspapers is one of the central ways we can learn about and understand our world. News interposes immensely on how we understand the place we are leaving in and politics that are contributing to our daily lives. This study examined geographic focus whether the analysed stories had a national or international interest. Geographic focus refers to the location where the story focuses on and why it has a particular interest in that region? Geographic focus sub-categories are; national news, these are stories that have an interests about South Africans in this case, whereas international news is stories that have an international interest (Lynch & Peer, 2002).

The variation was visible on how these two online newspapers portrayed astronomy news. In the Mail & Guardian only 62% of its news is national news and 33% is international news while News24 only 24% of its news is national news and 72% of news is international news. As a result, the study can put forward that the Mail & Guardian journalists are the main reporters of science news given that the majority of their coverage is about SKA occurrences. The Mail & Guardian journalists are able to bring the local news to the people for them to take part in the discussion as their stories possess national interest while News24 local journalists are not involved to report about South African science news nevertheless they buy stories from other news agencies. The News24 custom to buy stories from other news agencies might be advantageous or disadvantageous to the newspaper. The advantage is they are exposing their readers to other science news that are trending around the world while at the same time it disadvantage their journalists abilities to write about science and be recognised around the global stage.

Before conducting the study, it was anticipated that astronomy stories from any newspapers could be based on SKA improvements in South Africa inasmuch as the aim was to determine how the media portray astronomy news from the year 2012 to 2015. The findings indicate that News24 prefer to report about international news or news that have an international interest. The Mail & Guardian on the other side prefers local based stories and quotes people that are familiar with the South African context to make its readers relate to stories they are reporting about and to the newspaper as a whole because it is updating the nation about what is happening around them on a weekly basis. This resonates with Van Rooyen (2012) assertion that often the audience usually prefers to read about what they understand or what they can relate for them to make contributions about the story. This means geographical relevance needs to be a priority when selecting a science story in class.

The coverage of astronomy news from the selected South African online newspapers is still limited. The number of astronomy news article between 2012 to 2015 from both the Mail & Guardian and News24 is still limited on each newspaper website. There is still a lot need to be done to make science news fashionable to journalists in order for them to report about astronomy stories daily or weekly. Van Rooyen (2002) mentioned in her research study that generally science news in South Africa is limited, in her research, only 2% news was science news in the newspapers she analysed at that time. One of the reasons she came up with was the poor relationship between newspaper journalists and scientists. Alternatively Lugalambi, et al. (2011) proposed there are positive signs that the relationship between scientists and newspaper journalists is currently growing faster than expected for the reason that, most of the scientists they interviewed and asked the question "which, if any, would you say the non-specialist public uses to obtain information about scientific research and its social and ethical implications". Most of the interviewed scientists believed public depend on newspapers to obtain scientific research and news. In spite of this, their research maintains that the public still relies on doctors, teachers and nurses when it comes to public trust.

As a result of this claim teachers need to be more knowledgeable than the public, they can accomplish this by reading more newspapers and astronomy news that is relevant. Reading newspapers is going to provide teachers with an upper hand to disseminate reliable information that is trustworthy in their class since they are considered by the public as the reliable sources of information. Teachers can be encouraged to use newspapers in their science class in different ways whether during teacher workshops teachers can be advised by facilitators to use more newspapers. Facilitators can bring example on each workshop on how to use a newspaper using different science topics. Encourage teachers that using newspapers can tie together the difference between classroom learning and real-life this can be shown in a long term or after numerous workshops. If teachers are using newspapers now and then they help to care for global consciousness and understanding of local problems, and they creates informed citizens for future.

To conclude, the coverage of astronomy news is still very limited in South Africa although I do not have full statistics. The research study's objective was not to come up with statistics of how limited is the coverage of astronomy news. There is still an obvious bias on how often political news is favoured in newspapers than science news.

6.4 Question two: In what ways is the coverage of astronomy news portrayed, in terms of framing and tone?

Coverage of science news depends on the writing style a journalist is familiar with; however, often it is argued that both journalists and public tend to interpret science news coverage in terms of advantages and disadvantages or risks and benefits. In other cases, science news is portrayed as controversial, apart from the fact that they are difficult to comprehend. Before the relationship of

working together between journalist and scientist, journalists and newspaper editors had a belief that science news might not be appealing to common people (Lugalambi et al., 2011). As a result, controversial coverage was considered as an appropriate way to report science news in order to have an appeal even to a lay person on the street in view of the fact that media also competes in terms of revenue or sales. News editors did not favour to include science news in their newspapers science they were taking space for stories that might sell the paper. In astronomy news the trend of using controversy to portray news is not fashionable, often astronomy news is about progress or new discoveries that are either taking science or the public forward. Nevertheless, there were one or two articles that were controversial. For example "Stars wars as SA battles for SKA" article combine together a controversial coverage about which country will win the rights of hosting or be the home of SKA project.

"The fierce battles between South Africa and Australia normally reserved for the rugby field and cricket pitch has spilled over into the realm of science. With the national teams resting, the media and politicians have been kicking insults across the Indian Ocean over the hosting of one of the world's largest and most important scientific endeavours—the R16-billion Square Kilometre Array (SKA) radio telescope, which will rank alongside the Large Hadron Collider as one of the world's biggest scientific projects".

When a person reads this episode he/she might become interested about what will transpire as the days unfold towards the announcement from the SKA organising committee. The coverage was intended to cover science advancement in South Africa and in Australia in spite of this the news is amalgamated with political news and controversies that might strengthen sales. For that reason, controversy is beneficial in science coverage because media is about business and revenues (Lugalambi et al., 2011).

Astronomy news is portrayed reasonable by both newspapers. Reports or tone about astronomy was not uniform across the two newspapers. The Mail & Guardian vastly covered SKA occurrences although News24 covered international news that is concerned with new improvements in astronomy. The approach that was used by these two newspapers is different; the Mail & Guardian presents their stories by quoting officials or experts to back up their claims whereas News24 presents their stories in a direct approach i.e. they took what was presented by the speaker or what is written in the science journal and did not put forward their views. News24 does not state their views in a story since they are buying news from other news agencies and they do not have science dedicated journalists. Zamith, Pinto, & Villar (2011) assertion was, newspapers when covering climate change usually present the issues in terms of either blaming the public for not being accountable or there are no governance structures that are dedicated to deal with the problem. The Mail & Guardian and News24 are not blaming any person or organisation in their coverage, but then again they are using people's views to

make their points valid in particular the Mail & Guardian is quoting government officials to make their statements trustworthy or grabbing reader's attentions.

When analysing the newspapers using framing techniques it is evident that often newspaper journalists use jargon terms, these are special words used by a professionals that are difficult for others to understand. At least 84% of the framing techniques that were found are jargon. Most of the jargon terms that are used are science technical terms these are words that are only used in science field (Martinez & Torregrosa, 2015). Most of these terms are new to the readers, are difficult to spell or pronounce and are complex, this results to people not reading science stories if these terms and abbreviations are not explained in some newspapers. All the times journalists need to explain the science terms they are using for readers to understand.

In a review of science-related frame typologies, I decided to use the Nisbet framework. The Nisbet framework is merely examining different ways these newspaper articles are presenting their stories. Most of the stories are classified under scientific and technical uncertainty then followed by social progress against the Nisbet framework. This shows that astronomy news is about developing the world and scientists in this field are coming up with new evidence to support their claims.

In terms of the Nisbet framework, social progress is a way of advancing the value of life or answering problems that are surrounding astronomy. From the analysed articles only 38% of the articles are social progress. These articles are exposing the astronomy advancements to the public as astronomy is the most funded science around the world so it is expected to have numerous advancements than other sciences. On the other hand, only 45% of the analysed articles are scientific and technological uncertainty. Scientific and technological uncertainty is a matter of specialist understanding or reaching an agreement over what is acknowledged versus unheard of. Some of the newspapers articles are reporting about news scientists are still speculating about. Often the newspaper that reports about scientific and technological uncertainty is News24 as they mainly report about astronomy discoveries and most of the articles are from science journal articles. While the Mail & Guardian is reporting about social progress articles and it can be concluded that astronomy news are portrayed in terms of progress or advancements, there are few controversial news.

6.5 Question three: How, if at all, can astronomy articles be used in a science classroom?

In language classrooms teachers use newspapers as an alternative method when teaching, this means that in science classroom newspapers are used or can be used as they bring real life situations to students. Newspaper activities engage students in interesting and enjoyable learning and encourage students to further read at their leisure time as they store vast information (Laureta, 2009). With electronic newspapers a teacher can select pages they find interesting then print, these printed newspapers can be marked, cut, pasted and coloured-which makes it useful for young children even

before they learn how to read. Using newspapers in the classroom creates an active learning instead of passive learning. There are various ways teachers can create an active classroom environment using newspapers as an alternative method for learning and teaching (Laureta, 2009). In South African many schools do not have resources that can aid learning. Most of the schools may not even have an access to hardcopy newspapers that a teacher can use. In Schools where they can't access newspapers or internet such as farms or rural schools, parents can be asked by the school governing body to donate newspapers if they can and the district can donate or ask newspapers companies to donate old newspapers.

Teachers can use newspapers as a prompt to introduce a topic by starting a tough class discussion about a topic. This can be done in class by showing students a graphic or phrase in the newspaper to stimulate conversation and this can be done even when using textbooks. If your aim as a teacher is to assess discussions and speaking skills, in that case using a newspaper is an appropriate way, you can give students a newspaper article and they can skim through and report back to the class. The best way is to make small groups and provides each group with a different newspaper article then ask each group to read something from the newspaper and explain what science message is being communicated and you can ask other questions through the debate (Laureta, 2009).

Teachers who believe in any teaching style can easily use newspapers. For example Piaget (1964) Cognitive Development theory proposes children are unexpectedly making conceptions and they are not restricted to attain knowledge from their teachers. He argues learning is a practice that transpires in the human mind, children actively create their own knowledge and they identify their surrounding by only experiencing it (Wood, Smith, & Grossniklaus, 2001). This is what newspapers can assist to do since it is a form of informal learning, students will have a chance to experience science on their own without or with little help from their teacher. Student's mental processes such as reasoning, remembering, and perceiving are can be enhanced if students are reading newspapers often. Cognitive theory recognised learning as an unambiguous content taking place in the course of discovery learning. Children learn best by exploring and working out, learning happens within person's minds. At this juncture children learn best through the use of natural world. Therefore, newspapers are real and expose students' too real life situations. However, Cognitive theory is based on maturation and stages, and concept of readiness is important because teachers need to introduce students to concepts that are within their capabilities. Teachers need to understand when and how to introduce new concept to children (Cook, 2005). When using newspapers it needs to be recognised that here we are looking at the relationship between context and content to teacher's role. When using newspapers as teaching tool teachers have to evaluate student's improvement and they must not presume what is quantifiable is important to be tested as it is difficult to assess informal learning. Some experts in education have a belief that education must be learner centred and if they wat their goal to be achieved an active

discovery learning need to be introduced where teacher's role is to facilitate learning, rather than continuous teaching (McLeod, 2009). Newspapers provide all the above mentioned claims from the Cognitive theory.

Using newspapers in science context applies if a teacher believes in Vygotsky (1978) socio-culture theory. Socio-culture theory describes learning as a social process where human intelligence begins in society and interaction plays an important part in cognitive growth. Communicating with other people is one of the best ways to learn (Vygotsky, 1978). Teachers can use classroom presentations or discussions to foster this form of learning and teaching. Vygotsky (1978) asserts social interaction and culture are vital locations for learning to take place. The context of learning happen from extrinsic to intrinsic, meaning the environment affects the child through development and learning. Here a teacher acts as a mediator i.e. his/her responsibility is to assist students to reach the next level in their learning. In this case he/she models manners for students. This is co-operative communication for example a child pursues to comprehend instructions delivered by the teacher, he/she is going mull over the material and use it to standardise his/her routine.

The relationship between content, context and teacher is the act of enabling/mediating to scaffold learning. Mediation include decide on which preparations to present to students, selecting how to communicate with them, and assisting students to recognise their practicality e.g. when presenting Newton's laws in the beginning to grade tens, using a story as an introduction will make them to look forward to learn more (Cook, 2005). Therefore using newspapers before or after you have already introduced the topic might help as they are going to realise that these theories are applicable in real life.

In lower grades in particular grade 4, 5 and 6 Natural Science teachers can cut out graphics from the newspaper of recent news items which are relevant or interesting. A teacher needs to group students into small groups or in pairs and give each group/pair a unique graphic then ask the following questions or modify the following questions; describe what is in the graphic? Why is it important to know about it and how can we use it in South Africa. When each group or pair had answered then they can exchange graphics with other group/pair and do the same thing using a different graphic. Throughout this process, students need to write their answers on a separate piece of paper. To make things interesting, a teacher can collect all the captions and graphics then redistribute only captions to students, he/she can paste graphics on the wall or on the board, students are supposed to find the graphic to match the caption (Clandfield & Foord, 2013).

To higher grades such as grade 10-12 science teachers can use a similar approach when they are planning to use astronomy or science newspaper article s in their teaching. Veneu-Lumb & Costa

(2010) came up with some activities and questions a teacher can ask students to answer in a science classroom when using newspaper. Some of the questions are;

a. What is the story about for example is this a story that can be help South Africa or not? In your own opinion is this information important to you? Give reasons?
b. Name the place where the story is from or what is the name of the organisation writing this article?
c. Identify people that were quoted by the journalist e.g. politicians, scientists or a normal citizen? What is their involvement?
d. Did you know anything about the matter before reading about it? If yes, is the content containing new information that you did not know? If yes what is it and does it is in disagreements with what you thought before?
e. Does this text written for researchers, teachers, students or anyone who can read and why you think like that?
f. What was the purpose of the journalist to publish this article? Is there a hidden motivation, such as fear-monger, a political intention, or is about sale?
g. If possible, students can be requested to find a same story from other newspapers, compare them and determine whether that helps them to respond to some of the previous questions?

Before online newspapers were introduced and after they were popular scientists were/are still finding faults about the accuracy of scientific information provided by media in general. This is one of the reasons some science teachers are still reluctant to use newspapers in their classrooms. Nevertheless, I still continue to encourage teachers to use newspapers since in recent years media houses including newspapers houses have taken a decision to hire science news journalists who are focusing only on science news, as a result there are well-brought-up and precise science news whether in hardcopy and online newspapers. However, through the advancement of technology the quality of science news in depreciating again since there is Wikipedia. Wikipedia is a free online encyclopaedia that is written by the individuals who frequently use it. It is a type of website intended to make co-operative essays, were people in particular field like astronomy; they contribute by writing their ideas and rectifying them at the same time. Any person can write on Wikipedia and individuals are continuously refining Wikipedia, making changes on hourly base. Social media like Facebook, twitter, Badoo etc. also play a big role in disseminating false science news. This is what makes teachers to be reluctant to trust newspapers when it comes to science news. Fake news is all over the internet in particular Facebook and Twitter often this news seems real, like quotes from politician's suit our predetermined philosophies of what we believe need to say in a given situation.

In south Africa there is another issue of a lack or limited local science news, this is caused by many issues such as lack of qualified science journalists, online newspapers etc. In recent years have a

researcher such as Filistrucchi (2005) in Italy noted newspaper companies open/start a website to broadcast some of its news experienced a negative influence both on company newspaper sales and from its rivals? Online newspapers provide news for free the exact articles published on paper and, some newspaper companies tend to retrench its own journalists since the company is making loose. This might be the reason News24 buys science stories from other news agencies because they do not have journalists who can write about science news.

However, if teachers are reluctant to use newspapers because of fake/untrue news, teachers can take this opportunity and use newspapers in their science classroom to look for mistakes. This can be appropriate for grade 11 and 12 science students considering they are more matured and have been introduced to most of the science concepts through their schooling years. Actually, this can be the starting point for any classroom activity. Newspapers reflect the changes in science language, using newspapers may help students and teachers keep up a pace with such language changes (Laureta, 2009). Students might have an opportunity to experience how newspapers are different from textbooks in-term of presenting science news or writing in general and introducing new terms that are being used in a science field.

A study by Sullivan (2002) cited by Veneu-Lumb & Costa (2010) compared test scores of students who were using newspapers in their lessons with those who were not using newspapers in their lessons. Students who were using newspapers had better scored on a regulated reading test than those who were not using newspapers and Second English language speakers' students showed the greatest achievements. It shows using newspapers in teaching can be advantageous; nevertheless, teachers need to know what interest their students and sometimes allow students to select an article that interests them for a particular topic. A teachers need to be clear about the aims, and tell students whether he/she is looking for reading or speaking skills or both? And get students to read outside class as much as possible. Teachers need to make tasks as real and think about what people do when reading a newspaper in their own language and try to create questions that will relate to students age (Veneu-Lumb & Costa, 2010). As a result, yes newspapers can be used in science class/context, a teacher need to find or create ways he/she can use newspapers, at least, create activities that include newspapers twice a term.

6.6 Ethical consideration

The study did not involve any human or animal participants. For that reason, I did not impinge upon any research ethical issues. I only used the internet when collecting and analysing data. The attention of this study was on the material that is/was available to everyone on the internet and these materials can be used by everyone without signing any forms or asking for permission.

6.7 Validity and reliability

To ensure reliability and validity of this research study I was working with some of my research colleagues who are doing a similar research study, we started with inter-coder reliability. Inter-coder reliability is the uniformity of coding between coders (Bell, 1993). We used a story analysis form as a rubric to assists us to code. At that juncture, each coder was supposed to code at least 3-5 articles then give another coder to do the same to make sure whether we are using similar ways to code or not. The idea was that any person "trained or not!" reading the newspaper ought to become aware of the same content and categorise it in a similar way. It was expected coders to have at least 85% similarities in their coding. If coders did not agree about certain issue a meeting was called for other coders to discuss and reach consensus at the end. Bell (1993) claims that reliability is an extent where a technique created yields analogous results under identical circumstances. Hence, my coding results were similar to my fellow colleagues. Most of our coding was the same apart from one or two articles where we did not agree about where the article fall against the Nisbet framework, however, in our discussion we reached an agreement.

Validity in content analysis is achieved through an introductory reading of a subset of pertinent content, and cautious collection of the sample of media content to be examined. To certify the validity of the research coding method, I used an external audit, in other words, peer checking with my research colleagues (Creswell, 2012). Hence, the content analysis form of this study is legitimate as it was verified then modified as a result it was relevant to this study.

6.8 Limitations

There were few limitations in this study. Firstly, the limitations of the study are; Five to six months' time is not satisfactory to get hold of a general idea of how astronomy is portrayed by online newspapers. The study was restricted only to two online newspapers, the Mail & Guardian and News24 articles. A framing theory is based on subjective route (Gordon et al. 2010). A person has a right to think the way they want to about each newspaper article they are reading, so there are lots of differences in this theory. Lastly, newspaper article were randomly selected not considering the year or whether the topic is relevant to school curriculum or not.

6.9 Recommendations

The findings from the research study indicate that teachers in science need to get to the idea of using newspapers as one of the Way to make science interesting. This can be done by either universities or districts through workshops, methodology courses in junior degrees. Teachers should be aware of the problems science terms presents when used and not explained whether in newspapers or during teaching. This type of a research need to be conducted in a larger scale where at least 80% of the South Africa online newspapers and hard copy newspapers need to be analysed to determine whether

the findings are similar or they reveal more and it need to be repeated at regular intervals (Joubert, 2002).

All the research questions need to be further examined using the same theoretical framework and methodological framework to make an in depth analysis of the present study. In future researchers need to interview both teachers and journalists to know their views. If possible a research needs to design a classroom activity using newspapers articles for different grades and contexts to determine whether it is possible to use newspapers in different South African contexts.

6.10 Implications

The entire rationale for the current study is an effort to bring together the advantages of using online newspapers in science contexts because using real-life examples or context is encouraged by South Africa educational system and it started long time ago and to use particular form of science problems based on newspaper articles provide real life experience. If teachers are using newspapers in science classroom, they are not only teaching science but teaching language and reading skills. A study by Sullivan (2002) shows that students who were using newspapers scored better on a standardized reading test than those who were not using newspapers and Second English language speakers' students showed the greatest achievements. It shows using newspapers in teaching is good, nevertheless, teachers need to know what interest their students and sometimes allow students to select an article that interests them for a particular topic.

Using newspapers as a teaching tool cannot only be use in astronomy but in other sciences too such as chemistry, life sciences and others as reading newspapers broaden and provide high self-esteem to a person. I think this line of thought as significant in order to increase further the applicability and practicability of newspapers in science context.

6.11 Conclusion

Yes, teachers can use newspapers they are useful in a science classroom if they are used and supplemented with textbooks and other teaching materials. The use of newspaper in teaching and learning of science is undoubtedly one of the effective ways of teaching science whether in an informal or formal learning and teaching context. Using newspapers increase students' knowledge, and improves student's vocabulary skills to enhance conceptual understanding. Using newspapers in science classroom agrees with Feyerabend (1975) assertion that "anything goes" in the absence of a prescribed method of teaching and learning, science has methods and the choice of these methods ultimately impact on the learners; therefore being different at times might bring positive results. This chapter made conclusions by answering the research questions with evidence from both literature and from the results in chapter four and five. It then addressed the limitations of the study and it made few recommendations on how newspapers can be incorporated in our South African science curriculum.

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APPENDICES

Appendix A: An example of a modified Story analysis form used in content analysis

Story Analysis Form

Article ID___ Date____

Article title: _____

_____

Total number of words_____

Origin

News Service___

Newspaper journalist__

Unknown__

Treatment:

General news____

Feature_____

Commentary or criticism____

Other____

Photos & Graphics

# of Graphics___

# of Photographs___

General Reaction:

(1 = negative…..10 = positive)

How interesting was the story?

1 2 3 4 5 6 7 8 9 10

Geographic focus:

National___

International___

Unspecified

Nisbet Frame code (2009) used

_____

4.1 Nisbet Sub frame code

_____

How clear and understandable was the writing?

1 2 3 4 5 6 7 8 9 10

Is this a story you would *choose* to read or use as a class activity/assessment?

1 2 3 4 5 6 7 8 9 10

Use of Fairhurst and Sarr (1996) Framing Techniques

Metaphor_ Slogans__

Jargon__ Catchphrases_

Spin_ Contrast_

Appendix B: Instructions on how to display Flesch Reading Ease Readability Score on Microsoft Word

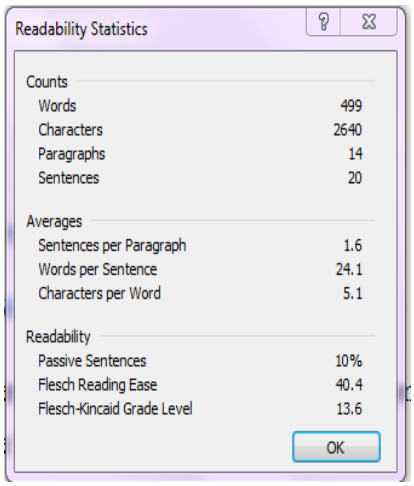
Microsoft Word is considered as an influential word workstation that offers a reader with a integral instrument to reveal Flesch Reading Ease score, as well as other statistics that you may need:

On your Microsoft document, go to the Tools menu or file top left, click Options at the bottom, and then click proofing.

Go and click the box next to it written show readability statistics, then click OK. The information is displayed after Word has come to an end inspecting grammar and spelling about the reading level of the document.

In order to skip correction procedures, you will have to press the "Ignore All" button positioned in the higher right part of the suggestion box, then after the scores box will appear. Word count appears in the 1st position; Flesch Reading Ease score appears in 9th place, grade level is in 10th position.

8.2.1 An example of a Readability statistics as it appears on Microsoft word 2010.



Appendix C: South African Audience Research Foundation (SAARF) average readership of newspapers in South Africa released in June 2014

AVERAGE ISSUE READERSHIP OF NEWSPAPERS / MAGAZINES

	AMPS Dec '13 ^				AMPS Jun '14 ^				AMPS Dec '14 ^				AMPS Jun '15 ^			
	TOTAL	TOTAL			TOTAL	TOTAL			TOTAL	TOTAL			TOTAL	TOTAL		
INFORMANTS	25444	25444			25510	25510			25584	25584			25584	25584		
POPULATION ('000)	37214	37214			37665	37665			37665	37665			38259	38259		
	'000s	%	± %	± '000	'000s	%	± %	± '000	'000s	%	± %	± '000	'000s	%	± %	± '000
WEEKLY NEWSPAPERS																
CITY PRESS (SUN)	1996	5.4	0.28	103	1821	4.8	0.26	99	1738	4.6	0.26	97	1761	4.6	0.26	98
ILANGA LANGESONTO (SUN)	874	2.3	0.18	69	788	2.1	0.18	66	730	1.9	0.17	63	745	1.9	0.17	64
INDEPENDENT ON SATURDAY	173	0.5	0.09	32	145	0.4	0.08	29	107	0.3	0.07	25	92	0.2	0.05	21
ISOLEZWE NGESONTO (SUN)	732	2.0	0.17	64	733	1.9	0.17	63	732	1.9	0.17	63	755	2.0	0.17	66
ISOLEZWE NGOMGQIBELO (SAT)	545	1.5	0.15	56	511	1.4	0.14	54	438	1.2	0.13	50	432	1.1	0.13	49
MAIL & GUARDIAN (FRI)	504	1.4	0.14	54	535	1.4	0.14	54	534	1.4	0.14	54	555	1.5	0.15	57
POST (WED)	299	0.8	0.11	41	274	0.7	0.10	39	244	0.6	0.09	36	234	0.6	0.09	36
RAPPORT (SUN)	1338	3.6	0.23	85	1270	3.4	0.22	84	1242	3.3	0.22	82	1065	2.8	# 0.20	77
SATURDAY CITIZEN	44	0.1	0.04	14	47	0.1	0.04	15	73	0.2	0.05	21	111	0.3	0.07	26
SATURDAY DISPATCH	119	0.3	0.07	25	102	0.3	0.07	25	101	0.3	0.07	25	102	0.3	0.07	26
SATURDAY STAR	227	0.6	0.09	35	209	0.6	0.09	36	219	0.6	0.09	36	249	0.7	0.10	39
SOCCER LADUMA (WED)	3185	8.6	0.34	128	3221	8.6	0.34	130	3316	8.8	0.35	131	3380	8.8	0.35	133
SON OP SONDAG	416	1.1	0.13	48	393	1.0	0.12	46	472	1.3	0.14	52	373	1.0	# 0.12	47
SUNDAY INDEPENDENT	64	0.2	0.05	20	74	0.2	0.05	21	87	0.2	0.05	21	68	0.2	0.05	21
SUNDAY SUN	2579	6.9	0.31	116	2481	6.6	0.30	115	2403	6.4	0.30	113	2413	6.3	0.30	114
SUNDAY TIMES	3658	9.8	0.37	136	3436	9.1	0.35	133	3489	9.3	0.36	134	3738	9.8	0.36	139
SUNDAY TRIBUNE	435	1.2	0.13	50	401	1.1	0.13	48	337	0.9	0.12	44	289	0.8	0.11	42
SUNDAYWORLD	1531	4.1	0.24	91	1419	3.8	0.23	88	1469	3.9	0.24	89	1526	4.0	0.24	92
WEEKEND ARGUS SATURDAY	141	0.4	0.08	29	123	0.3	0.07	25	104	0.3	0.07	25	108	0.3	0.07	26
WEEKEND ARGUS SUNDAY	114	0.3	0.07	25	127	0.3	0.07	25	196	0.5	0.09	33	169	0.4	0.08	30
WEEKENDPOST (SAT)	155	0.4	0.08	29	133	0.4	0.08	29	156	0.4	0.08	29	152	0.4	0.08	30
WEEKEND WITNESS (SAT)	100	0.3	0.07	25	67	0.2	0.05	21	57	0.2	0.05	21	59	0.2	0.05	21
THE ZIMBABWEAN (THURS) $$	46	0.1	0.04	14	52	0.1	0.04	15	73	0.2	0.05	21	69	0.2	0.05	21
ANY "AMPS" WEEKLY NEWSPAPER	11745	31.6	0.57	213	11393	30.2	0.56	212	11334	30.1	0.56	212	11244	29.4	0.56	214

KEY:- + = Significant increase
= Significant decrease

** = frequency change
$$ = not released - less than 40 respondents / Does not qualify
@@ = Name Change
= No longer on AMPS/Not Comparable
^^ = Combination of 5 + 6-Day measure - not comparable to previous surveys - Please refer to Technical Report

The Mail & Guardian articles

Appendix D: Stars wars as SA battles for SKA

26 Apr 2012 19:38 Sipho Kings

Science and Technology Minister Naledi Pandor says there is no need for an African sympathy vote to bring the telescope to the Karoo.

The fierce battles between South Africa and Australia normally reserved for the rugby field and cricket pitch have spilled over into the realm of science.

With the national teams resting, the media and politicians have been kicking insults across the Indian Ocean over the hosting of one of the world's largest and most important scientific endeavours—the R16-billion Square Kilometre Array (SKA) radio telescope, which will rank alongside the Large Hadron Collider as one of the world's biggest scientific projects.

South Africa, with eight other African countries, is competing against Australia and New Zealand to host the 3 000 radio dishes that will make up the telescope. Bidding started in 2006 and was supposed to end in an announcement this month. But this was delayed until mid-May to investigate the possibility of a compromise since both sides had invested so much in the project.

The local bid runs to 25000 pages and rests in the hands of the non-profit SKA Organisation. Although it has seven founding members, only four (China, Italy, the Netherlands and the United Kingdom) can vote on the site as the other three (Australia, New Zealand and South Africa) are bidding. It will take the support of three to win. Should South Africa's bid be successful, work can then start on a remote site outside Carnavon in the Northern Cape.

Adrian Tiplady, the SKA site bid manager for South Africa, outlined to Parliament the advantages South Africa enjoyed over Australia, which "no amount of financial investment could ever buy". These included the extreme quiet of the Karoo and the lack of radio signals in the area—the sensitivity of the equipment means there can be no local signals, such as from cellphones and terrestrial television. The Karoo also provided "the best window on the planet out of which to gaze upon the universe", he said.

Tiplady also said a "flagship project" like this could spark the interest in young people that science needed to survive in the country and could help to stop the brain drain.

The SKA site advisory committee submitted its report in February and a decision was expected when all its members met on April 3.

But the Sydney Morning Herald released what it said were the findings of the report, which made it clear that the South African bid was the better of the two. Since then many people on both sides have rubbished the validity of this leak, but it has set the agenda.

The Australian then quoted Australia's science minister, Chris Evans, as saying: "The thing that works against us the most is the -sympathy for doing more in Africa—the European view that says we ought to be doing more development in Africa." Other media have reflected the national sentiment in their headlines, such as the Australian's "Aussie SKA bid far 'superior' too cocky South Africa".

Naledi Pandor, the minister of science and technology, responded to the Herald's article, saying: "If the leaked reports are, indeed, accurate and there is no scientific or economic basis for a split decision, then it's entirely logical to expect that the South African site will be preferred."

She also said Evans's comments "reflect an inadequate understanding of where Africa is today — Our bid is sound and we won't insult any party in an effort to sway decision-makers."

Pandor said the attacks by the Australian press were part of a concerted bid to "diminish South Africa's scientific superiority" and "undermine the scientific and technical rigour of the site adjudication process".

The debate is likely to continue until the SKA Organisation decides which country will get the nod or how a compromise will be handled. Its head, John Womersley, said this could have been decided by the time the members meet next month.

If South Africa does get sole custody of the telescope, half of its dishes will be within a five-kilometre radius of Carnavon. The rest will be spread as far afield as Ghana and Mauritius. The dishes will act like a single one-kilometre square radio telescope that will absorb radio waves from millions of light years away. These will then be turned into images.

The frequency and size of the data mean the telescope will be able to see further into space and in more detail than conventional telescopes that use light waves. This will allow it to investigate how gravity acts near black holes. It will also be able look back in time to provide graphics of the formation of the universe because radio signals from that time are still travelling through space.

It could also catch a television signal from 50 light years away, giving people who are not rugby fans the possibility of watching alien soapies.

Appendix E: The SKA sets universities abuzz

22 JUN 2012 12:32 ANDILE NAYIKA

South African institutions are keen to capitalize on the widespread interest the telescope has created, writes Andile Nayika.

South African universities have welcomed the establishment of the world's most powerful radio telescope, the Square Kilometre Array (SKA).
Following the SKA Organization's announcement late last month that South Africa, Australia and New Zealand would share the R26-billion project, local academics have spoken enthusiastically about the research, job and study opportunities that will be created.
"The SKA is an international collaboration … It's a fantastic opportunity for South African graduates to get exposure in the international arena," said Petrus Meintjes, professor of physics at the University of the Free State.
Professor Ramesh Baruthram, deputy vice-chancellor (academic) and head of the astronomy desk in the University of the Western Cape's Science and technology department, said: "The SKA heralds a new era for African science and technology." Astronomers at the university are deeply involved in the SKA project, backed by its astronomy group that was started in 2008.
Combined with the existing MeerKAT project, the SKA main site will be at 1000m on a plateau in the Karoo. Construction is due for completion in 2025.
Flooded by applicants
Tim Gibbon of the Nelson Mandela Metropolitan University said the university's physics department had 10 years' experience in optical- fiber telecommunications research.
"Broadband optical fiber forms the backbone of the SKA in terms of transporting and aggregating huge volumes of information collected by the telescope array," he said.

"Nelson Mandela Metropolitan University aims to assist and advise in the construction of the SKA optical-fiber network and produce highly skilled graduates to maintain and operate the SKA network into the future."

Since 2005 the National Research Foundation, through its SKA Africa project, has provided nearly 400 scholarships in astrophysics and engineering for SKA-related projects and the National Astrophysics and Space Science Programmed has paid for nearly 150 scholarships for South African

and other African students.

The foundation and the SKA also provide bursaries for students at the Nelson Mandela Metropolitan University to undertake SKA-related research at the institution. “We were absolutely flooded by applicants. This reflects the tremendous interest from students to be involved in the SKA project,” said Gibbon.

The University of the Witwatersrand, which has participated in the SKA project for the past two years, has appointed Sergio Colafrancesco to promote research and develop high-level skills for the project.

Research infrastructure
Colafrancesco holds one of the South African SKA research chairs jointly awarded by the National Research Foundation and the department of science and technology.
“Wits is supporting the SKA chair group at various levels, from local logistics and research infrastructure to the support of the overall strategic vision of the SKA research chair,” Colafrancesco said.

The SKA chair group at Wits University is trying to link its astrophysics and cosmology studies with the research activity, he said.

“With this we hope to present career paths from the undergrad level to the post grad and research assistantship levels, taking the more modern and cutting-edge activities in this research field and the impact of the SKA for the next decades into consideration.

“We at Wits believe that we should create an education path going from the necessary teaching-based approach to the required research-based approach that is needed to manage and exploit the huge information content stored in the future database achievable with the SKA.”

Researchers in the astrophysics and cosmology research unit at the University of KwaZulu-Natal have worked closely with the South African SKA project since its inception nearly a decade ago and now “host a node of the [SKA project’s] astronomy undergraduate bursary programmed that will train the next generation of astronomers in South Africa”, said spokesperson Indumathie Moodley.

Invaluable guide
she said Kenda Knowles, a master’s student at the university, had been recruited by the project to work on data from the Karoo Array Telescope, KAT-7, a radio array comprising seven dishes. Knowles is interested in studying the growth of galaxy clusters, the most massive objects in the universe, held together by gravity.

Rhodes University, whose radio astronomy unit was established more than a half-century ago, has been instrumental in developing the KAT-7 and the MeerKAT array. The lead scientist in South Africa’s SKA project, Justin Jonas, is involved in the construction of these telescopes.

“Jonas was an invaluable guide in designing and building the MeerKAT telescope and infrastructure,” said Bernie Fanaroff, director of the SKA South Africa Project. “Rhodes will be at the forefront of designing the massive SKA radio telescope.”

A number of Rhodes students, including Adrian Tiplady, who was later appointed as site manager for the SKA project, worked on building the MeerKAT telescopes. Rhodes will award a number of bursaries to students to work on the design and development of the SKA.

“These students will be part of the newly established centre for radio astronomy techniques and technologies at Rhodes. The centre has already started working with leading international radio astronomy groups and will play a large role in the design and development of the SKA, bringing

together a number of scientific fields, including mathematics, physics and computing," said Rhodes spokesperson Zamuxolo Matiwana.

Fantastic job of communication
In recognition of the university's contribution to the design and construction of the telescope and its role in the SKA bid, Rhodes was awarded a chair in radio astronomy techniques and technologies.

Claude Carignan, the South Africa SKA research chair in multi-wavelength astronomy in the department of astronomy at the University of Cape Town, said: "Think of the message [the project] sends to the young generation. It will surely motivate them to think about careers in sciences, which is so essential for the development of the country."
Carignan, who is Canadian, took up the chair last year. He highlighted the role played by the government in ensuring astronomy's survival.
"I expected that a majority of engineers would be foreigners like myself but, to my surprise, 80% of them were young South Africans," he said.
"The government and institutions have done a fantastic job of communication, starting with Science and Technology Minister Naledi Pandor," Carignan said.
Gibbon said he sensed "an intense buzz of interest around the SKA project. Most people that I talk to are aware of the project and are eager to know more. This is particularly true of the general public, for which SKA has ignited the spark of scientific curiosity.
"There are insufficient astronomers in South Africa, but the development we've seen in the last few years will accelerate with the decision. Now we have to 2025 – 12 years – to increase our capacity.

http://mg.co.za/article/2012-06-22-ts-universities-abuzz

Appendix F: SKA telescope on the lookout for aliens

19 MAR 2013 10:26 SAPA

> The Square Kilometre Array radio telescope will be looking for signs of life on other planets, says project director Bernie Fanaroff.

"We want to look for organic molecules, the molecules of life out in space and, of course, we want to look for extraterrestrial intelligence," he told delegates at a *New Age* breakfast in Johannesburg on Tuesday.

Fanaroff said the telescope would be so sensitive that if a person was sitting with the SKA on a star 50 light years away from Earth, and they looked back at the planet, they would see "all the airport radars, TV transmitters and SABC programmers".

"So, if we have it on Earth and we are looking out at all these stars and new planets which are being discovered, we hope to be able to see if there is a civilisation out there that is broadcasting."

The SKA project would be the most powerful radio astronomy telescope in the world upon completion. Construction was set to start in 2017.

The majority of the project, the full dish array and the dense aperture array, will be built in Africa. The sparse aperture (or low frequency) array will be built in Western Australia. Fanaroff said the global project has 10 member countries and four guest countries.

The "very substantial" costs would be shared by all countries. He said that for the pre-construction stage, a total of R9.2-million was committed for the four years leading up to 2016.

"We are still waiting to hear for contributions from Germany and India."

Leading role
He said the design for the first phase of the telescope would be sent to the SKA board in July for costing, and a decision would be made whether to cap costs or build to design. Still under negotiation was the amount each country would contribute.

"Every country wants to be able to say we are investing in it and what are we getting back from it?" Fanaroff said. He hoped to get the United States of America on board from 2020 onwards.

In the meantime, South Africa signed an agreement with IBM and the Netherlands Institute for Radio Astronomy to research the vast high-performance technology needed to read, store, and analyse raw data.

"We are [also] playing a leading role in the international SKA organisation in many of these [wireless technology] projects and are doing some really nice work on digital signal processing," Fanaroff said.

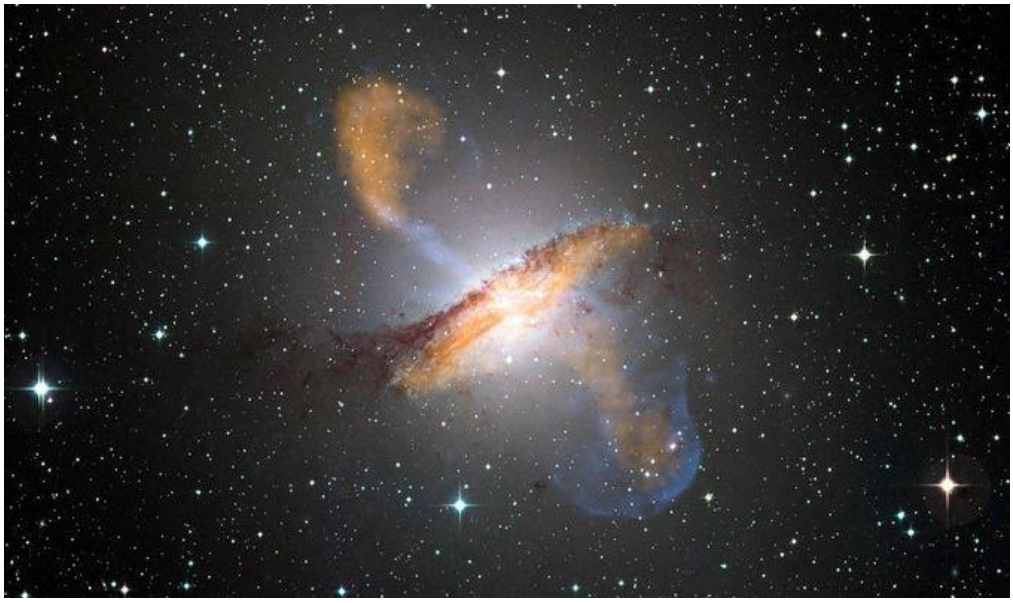
A team in Cape Town, together with institutions in the US and other countries, developed very fast computing boards that digitised signals and converted them into something that could be understood.

The US apparently completed the first-generation design. Fanaroff said it was encouraging that South Africa completed the second and third generation designs and was selling them back to the US and other countries.

"That's a really nice example of the fact that we can do it in South Africa," he said. – Sapa

http://mg.co.za/article/2013-03-19-ska-looking-for-extra-terrestrials

Appendix G: Trio of black holes marks the spot for gravitational waves



25 JUN 2014 20:11 SARAH WILD

Scientists say the new discovery "is just scratching the surface of a long list of discoveries that will be made possible with the SKA".

An international team of astronomers, headed up by University of Cape Town postdoctoral fellow Roger Deane, has discovered three super massive black holes, caught in a tight orbit four-billion light years away.

The research, published in scientific journal *Nature* on Wednesday, suggests that these black-hole systems might be more common than we thought, and might open up a new era of the search for gravitational waves. Black holes form when very massive stars collapse in on themselves, but the formation of super massive black holes is not certain even though most – possibly all – galaxies are thought to have one at their centers.

They used a technique called VLBI – Very Long Based Interferometry – which involves multiple telescopes sometimes tens of thousands of kilometres apart, to look at the same object. “Using the combined signals from radio telescopes on four continents, we are able to observe this exotic system one-third of the way across the universe,” said Deane, who is a postdoctoral fellow. “It gives me great excitement as this is just scratching the surface of a long list of discoveries that will be made possible with the Square Kilometre Array (SKA).”

One of these science questions is gravitational waves, something that Albert Einstein predicted in his theory of general relativity, which have not been observationally proved.

“These binary supermassive black holes [are also] the strongest source of gravitational waves,” says Deane.

The gravity of black holes is so strong that not even light can escape, hence the name.

“The SKA and the MeerKAT are sensitive enough to be able to study the source of those gravitational waves. In high resolution.”

Deane said this is why the African VLBI Network will be an important addition to radio astronomy. Old telecommunications dishes are being converted into radio telescopes in Ghana, Kenya and Mozambique. A VLBI network requires at least four radio telescopes looking at the same object. South Africa's Hartebeeshoek Radio Astronomy Observatory, for decades, was the only radio telescope on the African continent, and was part of the European VLBI.

"The further apart the dishes are, the finer the details," said Deane, adding that dishes used for VLBI in Africa would dramatically improve our ability to "see" finer details.

Research co-author Zsolt Paragi from the Joint Institute for VLBI in Europe said: "VLBI is widely recognized as one of the best ways to confirm close-pair black hole systems, but the main difficulty has always been pre-selecting the most promising candidates.

"Our research shows that close-pair black holes may be much more common than previously thought, although their detection requires extremely sensitive and high-resolution observations."

Paragi said that the next generation of telescopes "will allow us to broaden our understanding of how black holes grew and evolved together with their host galaxies".

Appendix H: South Africa eyes SKA telescope with bated breath

15 FEB 2012 16:02 RICHARD DAVIES

The international board members of the SKA radio telescope will meet on April 4 to decide whether the site will be built in SA or in Australia.

April 4 is a red letter day on South Africa's investment calendar.

It is the date on which international board members of the Square Kilometre Array (SKA) radio telescope will meet to decide whether the core site for the giant instrument will be built in South Africa or in Australia.

Science and technology director general Phil Mjwara said on Wednesday that if South Africa won the bid, billions of rand would flow into the local economy.

After updating Parliament's science and technology portfolio committee on the bid process, he noted that the cost of building dishes for the MeerKat radio telescope, in the Karoo, was about R1-billion.

"If we're spending about R1-billion on 64 dishes, you can imagine that if all of the dishes for the SKA are going to be manufactured here—about 3 000 dishes—you can just do the maths. So huge resources are going to flow into South Africa," said Mjwara.

"But it's not just going to be the huge resources; it's the intellectual capital that's going to flow in, with all the spin-offs in terms of some of the ICT and processing technology that we need for the country."

Asked if it would be correct to say the SKA would provide a multi-billion rand boost to the South African economy, he replied: "That would not be an exaggeration."

Vote in favor
earlier, the committee heard that the April 4 decision would be made by four countries: China, Italy, the Netherlands and the United Kingdom.

For South Africa to win, three of these four SKA founding-member countries need to vote in its favor.

Science and technology's deputy director general for research, development and innovation Val Munsami told MPs that if there was no clear-cut decision on April 4, deciding which country hosted the SKA could become a "prolonged process".

He said this could involve a second round of voting, six weeks after the first.

If there was still no decision, there would then be “some sort of negotiation” process, involving further inputs from the two bidders.

MPs were advised on Wednesday not to focus on the “noise” coming out of Australia on the SKA bid.

Mjwara told them South Africa was focusing on “things we are doing well”.

Political and economic stability
these included the country having better infrastructure in place around the proposed core site, near Carnarvon in the Northern Cape.

Media reports in Australia have stressed its political and economic stability, and have been interpreted as a swipe at South Africa and its partners.

While the SKA core site will be built in South Africa—if the country’s bid succeeds—many of the receiving dishes for the radio telescope will be spread across eight other African countries.

These are Botswana, Ghana, Madagascar, Mauritius, Mozambique, Namibia, Kenya and Zambia.

The SKA gets its name from the fact that the total radio wave receiving area of its 3 000 satellite dishes adds up to one square kilometre.

Although about half of the dishes will be concentrated in a five kilometre wide core region, the rest are to be located further out, some up to 3 000km away.

Biggest mysteries
Astronomers believe the power of the instrument—the SKA will be 50 times more powerful than any previous radio telescope—will help them unlock some of the universe’s biggest mysteries, including the origin of dark energy and whether Einstein’s gravitational waves really exist.

Mjwaru said South Africa had been “engaging with China” on partnerships around the SKA.

He also suggested that the estimated cost of the international project, €1.5-billion, might be too low.

“We are making contributions into the costing of the SKA ... from the work done by the SKA project office in South Africa, we are of the opinion that the 3 000 dishes we are going to be building, the €1.5-billion may not be adequate,” he said.

Meanwhile, according to media reports, Australia’s Science Minister Chris Evans is to travel to China and Italy this week to make his country’s case to international authorities. Australia is in partnership with New Zealand in its bid to build the SKA.—Sapa

News24 articles

Appendix I: Dust cloud, aurora detected around Mars

2015-03-19 13:48

Miami - A Nasa spacecraft circling Mars has detected a mysterious dust cloud and a vibrant aurora, both unexpected phenomena on Earth's neighbouring planet, researchers said on Wednesday.

Nasa's Mars Atmosphere and Volatile Evolution (MAVEN) detected the aurora, known on Earth as the Northern lights in December, so they were nicknamed "Christmas Lights", according to a statement issued by Nasa on the same day as the findings were presented at a Texas astronomy conference.

"For five days just before 25 December, MAVEN saw a bright ultraviolet auroral glow spanning Mars' northern hemisphere," it said.

Aurora are seen when geomagnetic storms unleashed by eruptions on the Sun cause energetic particles like electrons to crash into the atmosphere, causing the gas to glow.

"What's especially surprising about the aurora we saw is how deep in the atmosphere it occurs, much deeper than at Earth or elsewhere on Mars," said Arnaud Stiepen, Imaging Ultraviolet Spectograph team member at the University of Colorado.

"The electrons producing it must be really energetic."

Experts believe the source of the energetic particles for the Mars aurora is the Sun, because MAVEN's Solar Energetic Particle instrument "detected a huge surge in energetic electrons at the onset of the aurora," Nasa said.

Since Mars lost its protective magnetic field billions of years ago, the solar particles can directly strike the atmosphere and penetrate deeply.

Scientists also observed an unusual dust cloud, with the help of MAVEN, about 150km above the Red Planet's surface.

The source of the dust, its contents, and whether it is temporary or permanent, is all unknown. "Possible sources for the observed dust include dust wafted up from the atmosphere; dust coming from Phobos and Deimos, the two moons of Mars; dust moving in the solar wind away from the Sun; or debris orbiting the Sun from comets," Nasa said. "However, no known process on Mars can explain the appearance of dust in the observed locations

from any of these sources." The findings were presented at the 46th Lunar and Planetary Science Conference in The Woodlands, Texas.

MAVEN launched toward Mars in November 2013, on a mission to study how the planet lost most of its water and atmosphere. The unmanned orbiter is four months into its one-year mission.

http://www.news24.com/Green/News/Dust-cloud-aurora-detected-around-Mars-20150318

Appendix J: Astronomers find oldest known star

2015-01-28 08:33

Miami - International astronomers said on Tuesday they have discovered the oldest known star in a distant galaxy encircled by five Earth-sized planets, signalling that planets formed throughout the history of the universe.

The system is 11.2 billion years old and was born near the dawn of the galaxy, said the report.

The star has been named Kepler-444, since it was found with the help of Nasa's planet-hunting Kepler spacecraft.

Its five planets are a bit smaller than the Earth. They circle their Sun-like star in less than 10 days, at a distance smaller than one-tenth the distance between the Earth and Sun -- making them too hot to be habitable.

But the sheer age of the star has stunned astronomers.

At a distance of 117 light-years from Earth, Kepler-444 is two and a half times older than our solar system, which is 4.5 billion years old.

"We've never seen anything like this -- it is such an old star and the large number of small planets make it very special," said co-author Daniel Huber from the University of Sydney's School of Physics.

"It is extraordinary that such an ancient system of terrestrial-sized planets formed when the universe was just starting out, at a fifth its current age," he added.

Astronomers can measure a distant planet's age using a technique called asteroseismology, which measures the oscillations of the host star caused by sound waves trapped within it.

These waves lead to small pulses in the star's brightness, which can be analyzed to measure its diameter, mass and age.

Co-author Steve Kawaler, an Iowa State University professor of physics and astronomy, said Kepler-444 is very bright and can be easily seen with binoculars.

"We now know that Earth-size planets have formed throughout most of the universe's 13.8-billion-year history," said lead author Tiago Campante from the University of Birmingham.

"Which could provide scope for the existence of ancient life in the galaxy."
http://www.news24.com/Green/News/Astronomers-find-oldest-known-star-20150128

Appendix K: Astronomers see 'glue' of the universe

2014-01-19 22:02

Paris - Astronomers said Sunday they had for the first time seen the gas strands theorised to hold the universe together in a "cosmic web".

They had used the intense radiation generated by a quasar - a byproduct of a supermassive black hole - acting as a type of cosmic flashlight to illuminate part of the vast filament network.

Cosmologists believe that matter between galaxies is distributed in a network of strands known as the cosmic web.

The vast majority of atoms in the universe are thought to reside in this web as hydrogen left over from the Big Bang, and galaxies are believed to form at network nodes.

"This is the first time anyone has been able to capture an image of the cosmic web, demonstrating its filamentary structure," said astronomy doctoral student Fabrizio Arrigoni Battaia, who took part in the observations at the Keck Observatory in Hawaii.

The team had focused on massive nebula, or deep-space cloud, where the strands intersect.

They could study the nebula thanks to illumination provided by a quasar - radiation generated by cosmic matter falling into a galaxy's central supermassive black hole - with the aid of computer light filters.

Quasars are the most luminous objects in the universe.

"In this case, we were lucky that the flashlight is pointing right at the cosmic web, making some of its gas glow," said researcher Sebastiano Cantalupo of the University of California in Santa Cruz.

The findings were published in the journal Nature.

Appendix L: SKA to spur science, maths interest

2013-05-27 12:05

Cape Town - The S

quare Kilometre Array Radio Telescope is South Africa's biggest ever science and engineering project and will contribute greatly to science in general, to astronomy and to development in the country.

A critical aspect of the SKA is its potential impact on education and skills development. The SKA needs a wide range of skills and so it provides exciting career development opportunities, said David Kramer, chief executive of Sic-Bono.

According to him the SKA has seen an increase in research opportunities in engineering, mathematics, physics and astronomy at under- and postgraduate level. It also offers important benefits for school level maths, science and technology education.

"The SKA provides wonderful opportunities to excite children about science, mathematics and technology. It is a focal point to boost interest in gateway subjects. The current generations of learners will reach higher education or employment in the technical economy just as the SKA approaches operational maturity around 2020."

Kramer said today's children will drive the SKA in future and will develop science and technology that doesn't yet exist.

"So it is important to invest in maths and science education, in building children's capacity for innovation and in stimulating their interest in science, engineering and technology. We are advocating science and mathematics more aggressively to grade nine learners so that more talented learners, particularly those in disadvantaged communities, choose these subjects for metric and post-school study."

Achievement levels

He said they have accelerated efforts to improve achievement levels in maths and science. In 2012, the national maths pass rate for Grade 9 was 13%. We also had too few matriculates achieving 65% and higher for maths and science.

"Policymakers know that poor maths and science education and successful implementation of the SKA can't co-exist so much effort is going into fixing the problem. But the problem can't be left to education departments to fix. Industry needs to help."

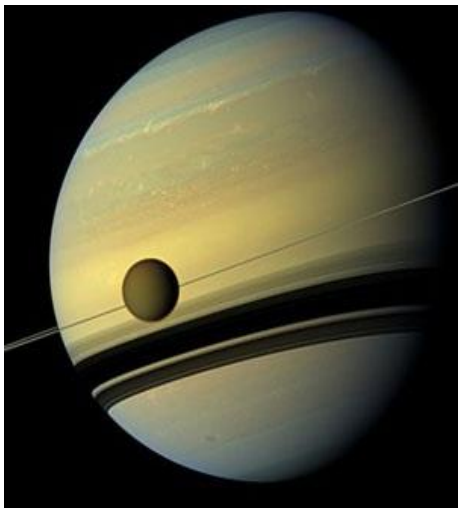
According to Kramer they have implemented a new modernized national curriculum which includes the SKA as part of the science curriculum.

He said people will also increasingly see more competitions, Olympiads, special events, science projects and field trips that focus awareness on the SKA and which build interest in the areas of study and work related to it.

"We are improving teachers' awareness of the SKA and to help them to link the SKA project to work in the classroom. Science centers have started to focus public awareness on the SKA so that communities and parents understand why it is important and what study and career opportunities it creates for their children."

Appendix M: Saturn moon may have 'life-friendly' ocean

2014-10-17 12:02



This Nasa image shows Saturn's largest moon Titan passing in front of the giant planet. (Nasa, AP)

Cape Canaveral - Saturn's battered moon Mimas may have a thin global ocean buried miles beneath its icy surface, raising the prospect of another "life-friendly" habitat in the solar system, scientists said on Thursday.

An underground ocean is one of two explanations for why the 250km diameter moon wobbles as it orbits around Saturn, scientists using data from Nasa's Cassini spacecraft said.

The other possibility is that Mimas has an oblong or rugby ball-shaped core. Follow-up measurements should provide more answers, the scientists said.

Either way, the findings point to a more complex and intriguing history for a moon best known for a large crater that dominates its surface, making it look like the "Death Star" from the movie Star Wars.

"If Mimas does have an ocean, this would definitely be another interesting body in the solar system to be added to list of potential 'life-friendly' environments," wrote Radwan Tajeddine, a research associate in Cornell University's astronomy department.

"The ocean hypothesis sounds unlikely because... Mimas' heavily cratered surface has shown no evidence of liquid water, thermal heating or geological activities," researchers wrote in an article published in this week's issue of the journal Science.

Moon formation

But a closer look at Mimas' eccentric orbit provides a clue. Gravitational tugging by Saturn as the moon circles closer and then farther away from the planet could cause enough frictional heating to melt ice and form an ocean.

"This ocean will sustain as long as the orbit is eccentric," Tajeddine, lead author of the article, wrote in the email to Reuters.

The other idea that Mimas has an elongated core raises a different set of questions about how the moon formed.

One theory is that Mimas, and possibly sister moons Enceladus, Tethys, Dione and Rhea, evolved from a collection of rocky chunks circling close to Saturn. Gravitational forces from Saturn would have sculpted the moon's core into an oblong shape, which was then covered in ice.

In this scenario, Tajeddine said, the icy shell relaxes and forms a nearly spherical shape while the moon migrates outward. Meanwhile, low temperatures preserve the shape of the oblong core.