How does science become news?

A quantitative and qualitative analysis of the news values and factors that influence the publication of science in South African newspapers

Patel, Shirona

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1. Introduction

South Africa, a developing country (Bakari 2017), is increasingly adopting the ideals of open, democratic societies to make scientific knowledge accessible[1], to decommodify knowledge[2], to produce research with socio-economic impact[3] that enables sustainable and inclusive development,[4] and to hold public research institutions accountable[5].

As paradigms shift towards open access and decommodified knowledge systems[6], so too does the demand for science content and information rise (Badenschier and Wormer 2012). In this context, scientists are under substantial pressure from funders, the state and other societal actors to make scientific knowledge accessible and visible in the public sphere. The draft South African White Paper on Science, Technology and Innovation (2018) stipulates that new funding conditions will make it "mandatory for recipient individuals and institutions to communicate their research to the public". This is also a strategic priority of the National Research Foundation's[7] science engagement unit, the South African Agency for Science and Technology Advancement[8], which encourages scholars to share science and new knowledge in an open society.

Scientists often use the mainstream media as a conduit to reach multiple publics (Joubert and Guenther 2017). However, the South African print media is under severe economic strain due to the advent of new digital technologies and platforms, changing patterns of media consumption, declining circulation[9], the closure of national newspapers, and the introduction of new business models[10]. The 'decimation' of newsrooms (Daniels 2018), the integration of editorial and commercial activities (Cornia *et al* 2018) and the decline in the number of specialist journalists assigned to specific beats, like science, health and

1 Berlin Declaration (2003), EU Declaration (2020)

2 Science International Accord on Open Data in a Big Data World (2015)

3 National Development Plan 2030

4 Draft White Paper on Science, Technology and Innovation (2018)

5 Science International Accord on Open Data in a Big Data World (2015)

6 Draft White Paper on Science, Technology and Innovation (2018)

7 South Africa's National Research Foundation is the intermediary agency between the policies and strategies of the Government of South Africa and South Africa's research institutions.

8 National Research Foundation's 2020 Strategy

9 Audit Bureau of Circulation Q4 Report (2018)

10 *South African State of the Newsroom Report (*2017)

education, has long been lamented (Thloloe 2005), with the general quantity and quality of science reporting found to be inconsistent, unstructured and relegated at the expense of more newsworthy genres like politics and economics (van Rooyen 2002, Claassen 2011). The number of specialist science journalists in the traditional media is diminishing with less than ten permanent science journalists in South Africa.[11]

Whilst the pursuit of the truth is a value that forms the basis of both the journalistic and scientific fields, and whilst both journalists and scientists seem to embrace the shift to an open, transparent society, given the waning trust in the South African media[12] and the difficult relationships between scientists and journalists (Claassen 2011), scientists are gradually employing direct, digital communication strategies to make science accessible to multiple publics, thereby discounting the reliance on the traditional media to "serve up audiences" (Fuchs 2014, De Lanerolle 2017). Scientists are also increasingly relying on professional science communication practitioners (science communicators) to share and amplify science in order to make their research relevant and visible in the public sphere (Kiernan 2006, Stromback *et al* 2012).

This raises questions about how much science features in the news, which science themes feature prominently, how science items are sourced, assessed and selected, and what the noteworthy news values and factors are that impact on publication. The responsibility of the media in making science visible and accessible in a developing democracy like South Africa is also worthy of investigation.

This study attempts to respond to these questions through an analysis of interviews with twelve science communicators, journalists and editors, and a systematic review of twelve South African newspapers over a three month period.

It would be ideal to determine if there is more or less science in South African newspapers over time, and to examine if the quality of science reporting has improved or declined over time. However, given that only one other similar substantial study pertaining to the publication of science in South African newspapers has been published in recent decades (van Rooyen 2002), which focuses on the representation of science in South African newspapers rather than the news values or factors that influence publication, it would be speculative to draw comparisons. Moreover, the media environment has changed dramatically over the last two decades, with digitisation providing new broadcast, online and

[11] South African Science Journalists' Association (2018)

[12] Edelman Global Trust Barometer (2018)

social media platform options (Daniels 2018) for communicating science, bringing with it new technological factors to consider (Patelis 2000, Castells 2010b).

For example, the van Rooyen (2002) study speaks to newswires like the South African Press Association (SAPA) that no longer exist, analyses the profiles of over 30 science reporters across titles, the majority of whom have been retrenched today and provides a qualitative analysis of each science story and how it is represented in the media. This does not dovetail with the scope of this study which is limited to a focus on the news factors and values that influence publication, rather than that how science news is represented in the newspapers.

The only area worthy of direct comparative analysis is the comparison with themes which feature regularly in the press. For example, in this study, the top five science themes in the media are in descending order the environment and ecology; the health sciences; science and technology; zoology and astronomy. In the van Rooyen (2002) study, the top themes were biomedicine; astronomy; HIV/Aids; technology; and environment and ecology. From this, we can deduce that the climate sciences are definitely more newsworthy than they were almost two decades ago. We also notice that biomedicine and HIV/AIDS have been displaced from the top five and replaced more broadly by the health sciences, likely given the attention dedicated to non-communicable diseases and diseases of lifestyle in South Africa.

A 2003-2004 study in Germany saw medicine, biology and technology dominate science coverage in newspapers, with coverage of the environment ejecting technology news from the top list three years later (Badenschier and Wormer 2012). A long-term study of *The New York Times* by Clark and Illman (2006) put health, medicine and behavioural science at the top of the list of science news most covered.

2. Aim

This research seeks to identify the important news values and factors that impact on the publication of science in the South African English and Afrikaans daily, weekly and weekend newspapers. It explores what science themes become news, and seeks to answer, in the context of science news, "what is included and what is excluded, and why," (O'Neill and Harcup 2009).

Drawing on Schudson's (2003) theories related to the sociology of news production and the "social realities" at the point of news production (Schudson 2009), this study seeks to explore the news values and factors that impact on the production of news, the intersection with the demands of various internal and external actors, and the influence of central role-players like sources and gatekeepers, in determining how science becomes news.

However, a study of news values only does not provide a complete depiction of how decisions pertaining to science news selection are made in newsrooms (Harcup and O'Neill 2016), and who makes them. It is therefore prudent to reflect on the perceptions of science reporters, science communicators and news editors to garner their first-hand experiences about how science becomes news worthy of publication and what role the media plays in generating and publishing content that makes science accessible.

2.1 Research questions

Specifically, this research seeks to answer the following questions:

1. What are the most prominent factors that influence the publication of science in the South African print daily, weekly and weekend newspapers? What does this say about the newsworthiness of science coverage in the South African press?
2. What science themes become news in the South African press? What is included, what is excluded, and why?
3. What is the role of the media in making science accessible in a developing democracy?

3. Rationale

3.1 The role of the media in developing an informed, science-literate public

The media has an essential role to play in open progressive democracies to develop an informed public (Gumede 2014, Dahlgren 2009), amongst other priorities.

In a "fake news" and "post-truth" environment[13], where "science is vulnerable to abuse and distortion, particularly for political purposes" (Kizer 2017), where newsrooms are being decimated (Daniels 2018), where specialist and beat journalists are almost non-existent (Thloloe 2005), and where false information, science quackery and "information disorder" is on the increase[14], it is becoming critical for scientists to take an active lead in setting the record straight. It is also imperative to understand how science items are sourced, assessed, selected and published, and for whose benefit.

Given the constraints facing newsrooms, including the increasing power of commercial actors, advertisers, audiences, media owners, politicians and sources (Stromback and Karlsson 2011), journalists and editors are under significant pressure to publish new content regularly and are thus in need of a steady flow of reliable information (Schudson 2003).

Due to resource constraints, there is a real risk that new, important scientific research may be ignored and that society may remain in the dark regarding innovative scientific developments (Badenschier and Wormer 2012). Limited resources often result in the lack of capacity to proactively pursue stories; to report fairly, accurately and credibly; to fact-check; to explore multiple angles of an issue; and to properly investigate important, relevant viewpoints pertaining to a specific matter. There are several examples that demonstrate how the constraints of the media influence reporting in South Africa, including the edited volume by Struthers and Harber *et al* (2011) titled *What Is Left Unsaid: Reporting the South African HIV Epidemic*, that delves into how the HIV/AIDS pandemic was covered in South Africa over time.

3.2 Understanding the tension between scientists and science journalists

Science journalism developed as a genre just after World War I with specialist science writers appearing in the 1930s largely in support of scientific progress and developments (Allan 2009). After World War II, there was an explosion of science coverage in both the

[13] South African State of the Newsroom Report: Fakers and Makers (2017)

[14] World Economic Forum (2018)

academic and popular press (Bauer *et al* 1995), tapering off in the 1960s as the systematic promotion of science was replaced with a critical evaluation of science. Whilst publication in the academic press continued to grow, coverage of science and technology in the popular press declined by about 30% between the 1970s and the 1990s (Bauer *et al* 1995, van Rooyen 2002). Several longitudinal studies have since been conducted to discern how 'science news' has transformed over time (Allan 2009, Badenschier and Wormer 2012).

There are also a range of critiques put forward by different scholars on how science journalism is perceived. According to Nelkin (1995) science appears in the press as "an arcane and incomprehensible subject". She blames the media for creating distance between scientists and publics, for not contributing enough to the public understanding of science and for not demonstrating the impact of science on the daily lives of people.

Science journalism is described as a "mental escape from the daily diet of human disaster" by Petit (1997), who states that people enjoy stories related to astronomy or prehistoric people to "escape the real world".

Wilcox (2003) claims that science journalism norms do not sit comfortably with those of the science being covered. She states that nowadays journalists need conflict, drama or exclusives to make news appealing to news editors, whilst scientists de-emphasise single studies and rather promote the full body of science in context. She uses illustrations from the content of media coverage of scientific research on homosexuality which she says should be evaluated using the conventions of scientific journalism, i.e. it should include a discussion on the context, the findings and the conclusions of the research, amongst other norms. However, her findings demonstrate that the coverage of biology in relation to homosexuality is "deeply contradictory" and not in line with conventional science journalism standards.

This tension is also identified by Lynch and Condit (2006) who expand on the tension between journalists who need to make stories interesting and "sellable" on the one hand, and scientists who want stories to be neutrally reported, balanced, and factually and scientifically accurate. Journalists often write to please audiences and "to satiate curiosity" according to Toner (1997) in Badenschier and Wormer (2012).

In a paper on how science news is selected for publication, Badenschier and Wormer (2012) decry that science journalism is often subject to the same general journalism theories that apply to the rest of the newspaper, including politics and crime. The duo argue for a special science news index for science journalism that takes into consideration the dynamism of journalism, time dependent selection factors (including the passive background effect and the active background effect), and time independent selection factors.

An example of the former is where a topic may be interesting at a particular date or time, for example in relation to a national science day, a politician's speech, an outbreak or a breakthrough, yet it may lose its news value the next day. The science news could be crowded out by political or crime hard news stories on one day whilst a science story that has been held back can be given prominence on a slow news day. The context in which science is selected to become news, as well as the other news of the day, is important to understand what science is left out, what science makes the news and how it is represented.

The dynamic link between science news and current news is often overlooked. Badenschier and Wormer (2012) use the example of the 2004 tsunami that struck the island of Phuket in Thailand to demonstrate this point. The discussion of tsunamis at a conference in November 2014 had strong scientific value but little news value at the time. However, a month later when the tsunami struck, the term "tsunami" and its scientific explanation made the front pages of newspapers and carried immense news value.

The publication of science news based on scientific conference proceedings, the publication of a paper in a high impact scientific journal and science news with a political angle have a better chance of being published than other science news (Badenschier and Wormer 2012). These are the time independent factors that influence the publication of science news, which are sometimes different to the news values that apply to the selection of hard news.

There are three major factors confronting science journalism according to Cornelia Dean, the former news editor of the *New York Times*. She claims that science journalism's reach has to be very broad, yet science is becoming increasingly specialised, so journalists cannot keep up, and scientific research is becoming more commercialised.

Hotz (2002) in Badenschier and Wormer (2012) believes that the relationships between science journalists and scientists "is becoming increasingly fraught", a tenet supported by Claassen (2011) who also laments the declining number of science journalists in South Africa and the non-existence of structured science news desks at major media houses in the country. Public health workers describe the media as "untrustworthy" and accuse journalists of spreading misinformation in a study conducted by Holmes (1985) mentioned in Muchendo (2005). The changes in newsrooms in recent years have also resulted in the obliteration of specialist science journalists in the country[15].

Concomitantly, scientists are under increasing pressure from various social actors (including funders and the state) to share science and to make their work accessible and visible in the

[15] South African Science Journalists' Association (2018)

public sphere, and are “becoming increasingly skilled in media management” (Franklin 2004, Miller *et al* 1998). They are also progressively relying on science communicators to share and amplify their science, and to make research relevant and visible in the public sphere (Kiernan 2006, Stromback 2011).

A study focusing on South Africa’s most vocal scientists (Joubert and Guenther 2017) reveals how scientists who are also good science communicators emerge in the news. Joubert and Guenther (2017) worked with a panel of 45 science media experts in South Africa and identified 211 scientists who were “visible in the public sphere”, of whom 78% were white and 63% identified as male. One of the key findings was that too few Black and female scientists are visible in the public sphere and that older professors tended to be more visible. The study also found that the majority of the visible scientists hailed from four public research-intensive universities in South Africa and that “organisational culture, policies, norms, reward structures, institutional expectations and the quality and availability of communication support services” influenced the public visibility of researchers.

3.3 The importance of studying news values and newspapers

According to Harcup and O’Neill (2009), studying news values is “one of the most important areas of journalism studies” and “who selects the news for whom, in what medium, and by what means (and available resources) is as important as the news values of a particular story,” (Harcup and O’Neill 2017). The pair add that newspapers are worth studying because they operate in a highly competitive media environment within format constraints, they publish high impact stories and breaking news, and they influence other media. According to Shoemaker and Vos (2009), selection is increasingly more important in constricted environments.

The *Sunday Times* in South Africa is a good case in point. It reaches on average three million readers a week[16], publishes exclusive stories in the main, some of an investigative nature, sets the news agenda and influences broadcast, online and social media in unprecedented ways.

Despite the current state of newsrooms and a dwindling traditional press in South Africa, politics and crime continue to dominate the news agenda with science news often relegated at the expense of other genres (Claassen 2011).

[16] Audit Bureau of Circulation Q4 Report (2018)

The difference between what makes news, how it is selected and eventually published on the one hand (the production of news process) and what journalists and audiences believe is newsworthy and valuable on the other, is worthy of further scrutiny Stromback *et al* (2012).

3.4 Evaluating sources, science items and news subsidies

Stromback *et al* (2012) warn against professional source organisations, powerful and elite scientists and scientific publications (Kiernan 2006) that provide "news subsidies" (measures that make it convenient for news organisations to cover the news). So, too, does FitzPatrick (1999) who encourages both scientists and science journalists to "re-evaluate the criteria they use to judge the newsworthiness of science stories".

Specifically, Stromback *et al* (2012) identify five factors that influence news selection: the competition for advertising revenue and audiences; news subsidies which is defined as "any measures taken by source organisations to make it convenient for news organisations to cover the news" including media releases, media conferences, good audio-visual material and access to sources; stories that involve officials and the elite; format considerations and the news production processes. Exclusive news is also sought by the media regularly.

A study by Stromback and Karlsson (2011) found that journalists are best placed and empowered to influence media content as they interact with audiences, politicians, interest groups, and indirectly with media owners and advertisers, on a daily basis. The study also reveals that journalists feel that media owners and advertisers are increasingly trying to influence content.

3.5 Digital disruption

The advent of the Fourth Industrial Revolution is set to dramatically change how humans interact with technology, how we express ourselves, how we communicate and how we work in a new world order (Schwab 2016). Whilst Patelis (2000), Fuchs (2014) and Castells (2010) express different opinions on the role of technology in society, they all agree that digital disruption impacts on the public sphere in unprecedented ways.

The tensions described in 3.3, coupled with the "tectonic shifts reshaping the landscape of science journalism" (Allan 2009) and the impact of new media technologies in a changing media environment that will "dramatically recast science journalism's familiar norms and values in unanticipated ways" (Allan 2009), make the study of news values and the aspects that impact on the publication of science in the South African print media ever more important.

4. Theoretical Framework and Literature Review

Drawing on mass communication theories related to the sociology of news production (Schudson 2009), this study examines the professional news values and factors that influence the publication of science in South African newspapers. It further explores the role of the media in covering science in a developing democracy like South Africa.

Schudson (2009) outlines three key perspectives from which the news is studied, namely critical political economy, the cultural approach to news-making and the social organisation of news - this study is entrenched in the latter perspective. Four critical areas are examined including the intersection of professional news values and factors; the internal and external actors (including sources, gatekeepers and organisations) that influence science coverage; the science themes that are most published; and the role of the media in making science accessible in a developing democracy.

Whilst theories relating to the intersectionality between the economic organisation of the media industry (including the power it yields through its infrastructure, funding and enterprise) and its impact on the production of content through which people make sense of the world be it through words, audio-visual or other cultural productions could be considered, given the scope of this project, it was not possible to delve into such an in-depth analysis.

Theories related to the political economy of the media were considered, especially in relation to the systemic influence of media owners, advertisers and politicians on the selection of science news, and the role of the media in a developing democracy. However, other components of this approach like the history of science journalism in South Africa, media policy and regulation and audience research are beyond the scope of this study.

Similarly, the framing of science in the media and the representation of science in newspapers could have been examined through a cultural lens to explore what Hall *et al* (1997) describe as “shared meaning” through an analysis of the intersection of news discourses, content and audience reception studies.

However, given the need for a baseline study to understand how science becomes news, the process whereby news is selected for publication and the important role of the key actors in the news production process, a sociological approach was adopted for this study. Aspects of the agenda setting function theory were also explored and are mentioned as appropriate.

4.1 The social organisation of the newsroom

Schudson's (2009) social-organisational perspective on news-making serves as the basic framework for this study. He describes this phenomenon as the "social realities that can be observed at the point of news production" or the juncture at which journalistic values and professional values intersect with the demands of audiences, advertisers, journalists, editors, news generators and cultural traditions.

These "social realities" are probed through interviews with science journalists, science communicators and editors who provide different perspectives on the realities pertaining to news production, science communicator-reporter-editor relations, the constraints facing newsrooms, gatekeepers, access to credible sources, and the supply and selection of science content from international newspapers and newswires.

The social construction of news is described as a "product of transactions between journalists and sources" by Ericson *et al* (1989) influenced by the powerful (Corner and Schlesinger 1991). This necessitates a deeper investigation into how science news is sourced, which individuals or institutions serve as accredited primary or unofficial secondary sources (Hall 1978, Corner and Schlesinger 1991), and why some sources are favoured over others.

4.2 Examining news values and their indices

It is essential to study news values because it "goes to the heart of what is included, what is excluded, and why," some news is given precedence over others and it also "makes news selection more transparent" (O'Neill and Harcup 2009).

Weaver *et al* (2007) describe news values as a "reflection of organisational, sociological and cultural norms combined with economic factors".

According to Badenschier and Wormer (2012), news values are factors that make news valuable but add that the value of news increases based on the number of news factors present in the article as well as "the intensity of these factors". For example, the more people whose lives are impacted by an event in the vicinity and in close proximity to the readers of a newspaper, the higher the news value of the event is considered to be.

Whilst the term "news value" was first mentioned in Lippmann's 1922 book *Public Opinion*, Ostgaard (1965) created the first classification of news factors. This was followed by the influential work of Galtung and Ruge (1965) that reflected on how foreign events were reported in newspapers in Norway. They classified news factors or values and proposed that events are covered in the news based on their negativity, frequency, intensity,

meaningfulness, proximity, unexpectedness, composition and reference to powerful people or nations.

Harcup and O'Neill revisited Galtung and Ruge's original list of ten news values and in 2001 developed a list of ten factors that make stories newsworthy. The pair claim that particularly good and bad news make the news; those that are significant in magnitude and relevant to audiences; stories with an element of surprise or those that are entertaining, write ups that focus on the powerful, the elite or celebrities; follow up articles; and those that fit the newspaper's agenda. Their most recent list of contemporary news values published in 2017 is adapted to accommodate digital and social media with the following five news values added: exclusivity; conflict; audio-visuals; shareability and drama.

According to Badenschier and Wormer (2012) further variants of news factors were published by Shulz (1976), Staab (1990) and several other scholars. Schultz (2007) created a list of six news values which are viewed as important by television journalists in Denmark, summarised as timeliness; relevance; identification; conflict; sensation and exclusivity. Allern (2002) developed a set of commercial news values whilst Brighton and Foy (2007) developed seven news values which "vary from medium to medium" and include relevance; topicality; composition; expectation; unusualness; worth; and external influences. Phillips (2015) feels that "conflict" is an important indicator of what makes news.

Badenschier and Wormer (2012), Dick (2014) and Caple and Bednarek (2013) add "visuals" to the list of important news values while Shoemaker (2006) stresses that proximity, power and prominence are significant factors in what makes news. Exclusivity, breaking news and good images increase the potential of stories being published (Allern 2002, Schultz 2007, Lewis and Cushion 2009). Despite the extensive lists of news values developed over five decades, there are calls for the development of a special news value index for science news.

4.2.1 A special news value index for science news?

The hierarchy of news in the newsroom and the dominance of politics and political news as one of the most powerful factors that influence whether science news is published, where in the newspaper it is published and how prominently it is displayed (Badenschier and Wormer 2012). Science can only ever make the front page if a politician talks about it (Schultze 1996). Homberg (1989) in Badenschier and Wormer (2012) feels that the perception that science news is not timely and can be delayed is another factor that results in science being denigrated to the middle pages of newspapers. This is exacerbated by the fact that "medicine, health and biology dominate science coverage worldwide" (Bauer 2000, van

Rooyen 2002). “News coverage of science tends to favour certain areas of scientific inquiry over others” and that this is as a result of complex “institutional imperatives” (Allan 2009).

Badenschier and Wormer (2012) state that science researchers like Homberg (1987); Staab (1990); Ruhrmann (1990) and Peters (1994) are in favour of specific criteria being developed to determine what makes science newsworthy. Building on Ruhrmann’s (1997) attempt to determine what news values resulted in the coverage of science in the press, Badenschier and Wormer (2012) developed a revised catalogue of 14 news values and applied it to science in relation to common theories of news values and journalistic practices. Their study found empirical evidence “that some definitions of classical news factors are incomplete to describe the selection of science news” and that “classical catalogues are incomplete and insufficient to describe the selection processes in science journalism precisely”. For example, one of the classical news factors is “influence” or “powerful elite” but does not speak to “scientific influence” or “powerful scientists”. However, the research is ongoing and continues and more data is needed to finalise such a catalogue.

Badenschier and Wormer (2012) found that with regards to the selection of science in particular, that “graphical material” was an important factor for making news and that editors had to not only select the news but also the platform on which the news would be published, an additional component of the selection process that influences what becomes news.

Five criteria that make a good science news story were identified by Rensberger (1997) as: fascination value; size of the natural audience; the importance for society and readers; the reliability of the scientific results and timeliness. However, scepticism about whether “new” science news absolutely matters any longer is shared by Badenschier and Wormer (2012). The “human interest factor” is identified by Hansen (1994) as the most important value for making science news worthy of publication.

4.2.2 News and News Selection versus News Values and Newsworthiness

There is a fundamental distinction between how news is sourced, evaluated, selected and published on the one hand (the news production process) and what journalists and audiences value and believe is newsworthy on the other. Shoemaker (2006) argues that news that is published may never truly represent what is most newsworthy to journalists and audiences and that newsworthiness is only one factor that determines how prominently a story will be covered. With Cohen (2006), she makes a distinction between “news and news selection” – news that is socially constructed and actually published (a commodity) versus the “criteria of news values and newsworthiness” – the subjective, cognitive mental judgments made by journalists when selecting news (Donsbach 2004, Caple and Badnarek

2013, Shoemaker 2006). This is an important distinction as Shoemaker and Cohen (2006) found in a global study where there is a disconnect between what news is actually published and what journalists think is newsworthy.

4.3 Significant factors that influence the selection of science

In a study conducted amongst journalists in Sweden, Stromback *et al* (2012) found that news events and issues are more likely to be published because they are relevant to audiences, economical to produce and fit into the production schedules of media houses rather than because they enhance democracy, or inform or educate the public. There is thus discord between the journalistic norms pertaining to news values as understood by journalists, and what was actually published in what Stromback *et al* (2012) conclude as a "difference in the practice of journalism versus the theory of journalism".

Specifically, Stromback *et al* (2012) identify four factors that influence what becomes news: advertising revenues and audiences; news subsidies and sources; powerful/elite actors and organisations (including the proximity to these social actors or events); and format considerations (including visual material, exclusive news and access to events).

"Advertising revenue and audiences" are important considerations that sway what makes the news, especially for the commercial media, as journalists have to increasingly consider how to cultivate audiences that advertisers want to reach (Stromback *et al* 2012; Caple and Bednarek 2013). Hamilton (2004) concurs that profit triumphs over "whether the news is important". In a 2018 study, Cornia *et al* found that a "new norm" has been established which favours the integration of, rather than the separation of, editorial and business activities in newsrooms.

"News subsidies" are described as "any measures taken by source organisations to make it convenient for news organisations to cover the news" (Brighton and Foy 2007). These include professional sources like news events, media releases and media conferences, public relations material and "information subsidies" that are usually hosted by powerful institutions (Miller et al 1998, Gandy 1982), although these practices often marginalise those who do not have access to resources and who cannot advocate for space in newspapers (Goldenberg 1975).

The reliance on media releases and official events and sources to cover HIV/AIDS in South Africa in the 1990s is an example of how the press was reliant on news subsidies in the early days when covering the pandemic (Shepperson 2000).

The **powerful and elite** also make the news, whether they are individuals, organisations, the elite or celebrities, but more so when they are in close **physical or cultural proximity** to journalists and audiences (Stromback *et al* 2012).

Shoemaker and Reese (1996) concur with Stromback *et al (*2012) that **format considerations** are important factors as are **news production processes** like deadlines and the sociology of the workplace (Schultz 2007; Bourdieu and Wacquaint 1992). The need for a regular flow of information to meet newspaper deadlines is one of the main factors that influence the publication of news (Schudson 2003).

4.4 Gatekeeping and the role of journalists in determining the news

Stromback and Karlsson (2011) agree with the theory of Shoemaker and Reese (1996) that "news is never formed in a void or vacuum" and that commercialisation, resources, audiences, news subsidies, sources and production processes influence the news. However, Stromback and Karlsson (2011) found that journalists still considered themselves to be "driving news production".

The "degree of autonomy" given to a journalist, the organisation's values, the organisation within which the journalist works and the type of journalism practiced determines how much "editorial capital" a journalist holds (Schultz 2007).

Whilst the first theory relating to gatekeeping was developed by Kurt Lewin (1947), it was applied by White (1950) and Gieber (1964) to journalism. White's study found that journalists were "highly subjective" and that news selection occurred based on their "experiences, attitudes and expectations". On the other hand Gieber (1964) observed that "the goals of production, bureaucratic routine and interpersonal relations within the newsroom" influences how news is selected.

The availability of resources and time, the environment in which they work, the "social, educational, ideological and cultural influences of journalists", their level within the organisation and the audiences that they serve, are all factors that influence how journalists select news (Harcup and O'Neill 2017). Other critical factors that influence the publication of news include commercialisation, resources, audiences, news subsidies, sources and production processes according to Stromback *et al* (2012).

4.5 Sources that shape science news

The sources that supply information to the press are the real originators of power (Schudson 2003, Gans 1979) that shape the news in multiple ways. The use of authoritative knowledge

experts from powerful institutions are described as “accredited sources” who are frequently called upon to provide comment (Hall *et al* 1978) and who provide a steady flow of information to feed fast looming content deadlines (Schudson 2003). They are newsworthy because of their status in society (for example corporates, government officials), because they represent “the people” or interest groups and in the case of scientists, because they are knowledge experts and claim to advance the public good. On the other hand, secondary and non-official sources can also be powerful (Corner and Schlesinger 1991).

In *News and News Sources: A Critical Introduction* (2001), Manning proffers a framework for understanding the relationship between journalists and sources in the newsroom in liberal democratic societies. He advocates that the power of governments, corporates, advertisers, audiences and the elite in society must be scrutinised as these powerful social actors have the ability to “set agendas”. The “struggle to control information” where the powerful use their resources to control the flow of information is further highlighted by Ericson *et al* (1989).

Institutional sources and the privileged and elite tend to feature more in the news than others (Hall 1978) due to their socioeconomic standing, their position in society, their power and influence, and their expertise (Fishman 1980, Gans 1979). These sources tend to be from influential and politically conservative classes (Herman and Chomsky 1988, Miller and Williams 1998, Witttebol 1995). A study of how the media reported on HIV/AIDS in South Africa in the early years also demonstrates that official government sources and corporate experts were relied upon as sources (Shepperson 2000).

Various sets of “internal and external actors” shape media content and the news including journalists and editors; media owners; advertisers; audiences and sources (Stromback and Karlsson 2011). But not all sources are equal, especially in relation to experts and commentators who express their views on scientific issues.

Takahashi and Tandoc (2016) found that people are more interested in science if they believe in the press and trust sources and the experts being cited. Yeo *et al* (2018) demonstrate this phenomenon in a study focusing on the documentary *An Inconvenient Truth* featuring US politician Al Gore. The study reveals that people in authority influence and encourage ordinary individuals to better engage with the information presented in the documentary.

On the other hand “unaccredited” or secondary sources like activists also have the ability to become dominant sources (Muchendo 2005) over time. Her research examined the sources of HIV/AIDS content presented in the news in South Africa, and found that whilst official sources were used regularly, it was possible for secondary sources like the Treatment Action

Campaign to also feature as credible sources in the South African press. Muchendo's study supports the views of Corner and Schlesinger (1991) that secondary sources can sometimes become primary sources especially on policy issues. These views are not shared by Hall (1978) and Manning (2001) who describe activists and unofficial sources as "secondary sources".

Summary

The theoretical framework outlined above is used as the basis by which to analyse the social realities in the newsroom, including news values and the factors that influence the publication of science in South African daily, weekly and weekend newspapers. It further provides a grounding that enables a better understanding of the influential role of internal and external actors, including science journalists, communicators, editors, gatekeepers and sources. It allows for a better interpretation of what science is included and excluded, and reasons for why some science news items are published instead of others. Finally, it provides a basis for the appreciation of the role of the media in making science accessible in a developing democracy.

Limitations: This study will not focus on the effects of the agenda setting function of the media and will not explore theories relating to representation, framing, bias or the effects on audiences in detail.

5. Methodology

A two pronged methodological approach was adopted – a systematic quantitative content analysis of twelve daily, weekly and weekend English and Afrikaans newspapers and a qualitative analysis of interviews with twelve science reporters, editors and science communicators.

This mixed-method approach is described by Allan and Skinner (1991) as a "durable" form of research which is suitable for studies in the social sciences. The quantitative method provides the requisite elements of verification, repeatability and durability, whilst the qualitative research hones in on the perspectives, world-views and professional values espoused by journalists, editors and science communicators, their interactions with one another and their personal experiences in newsrooms.

A straight quantitative investigation provides some insight into news values, its hierarchical value and a tabulated inventory of the science themes present in science items published in newspapers. However, it does not adequately explain how decisions are taken by journalists

and other editorial staff in newsrooms (O'Neill and Harcup 2016). This makes a dual methodological approach optimal as it deepens the credibility of the research.

5.1 Quantitative Content Analysis

Quantitative research can be described as "a formal systematic process in which numerical data are utilised to obtain information about the world" (Burns and Grove 2001). An examination of published outputs allows one to determine exactly what science events or items have been selected, and to compare the selection of science news events and items across publications and genres, over time (Harcup and O'Neill 2017). It is also "robust, repeatable and reliable" to analyse what has already been published in the news, a view supported by Allan (1991).

Newspapers are worth studying because they operate in an extremely competitive media environment within format constraints, they publish high impact stories and breaking news, and they influence other media (Harcup and O'Neill 2017). In addition, limited space and format constraints mean that news selection is increasingly more important in constricted environments, particularly in print newsrooms (Shoemaker and Vos 2009).

Against this background, a quantitative content analysis of twelve daily, weekly and weekend newspaper titles was conducted over a period of three months (1 August 2018 – 31 October 2018). The three month period was selected arbitrarily with no science news, events or issues known before the commencement date.

In order to better understand which news values make some science items more worthy of publication than others, each science item was tabulated and analysed as per the following categories: proximity, exclusivity, visuals, public interest, relevance, magnitude, tone, the powerful and elite and/or celebrities and drama and/or contention. The newspapers were studied daily in hard copy in real time. The comprehensive tabulation and analysis is included as **Appendix A[17].**

5.1.1 Newspaper selection

Newspapers are impactful, often carrying exclusive news and breaking news stories (Nelkin 1995). According to the Audit Bureau of Circulation's 4th Quarter Report for 2018 (**See Appendix D),** there are 54 daily, weekly and weekend newspapers in South Africa with a combined circulation of over two million, as deconstructed in Table 1 below:

[17] A tabulation and analysis of all the science items published in twelve South African newspapers over three months (1 August 2018 – 31 October 2018)

Frequency	Total number of newspapers in South Africa[18]	Circulation[19]
Dailies	23	676 731
Weeklies	5	345 158
Weekend	26	1 128 799
Total	**54**	**2 150 688**

Table 1: Number of daily, weekly and weekend newspapers and their circulation in South Africa

Of the 54 daily, weekly and weekend newspapers (excluding free, local and hybrid newspapers) that exist in the country, twelve newspapers as listed in the table below are included in the study, based on the following criteria:

1. At least one leading newspaper from each of the five major media houses is included: Media 24, Tiso Blackstar, Caxton, Independent Newspapers and the Mail and Guardian Media Limited.

2. Of the twelve newspapers selected, six are daily newspapers, five are weekend newspapers and one is a weekly newspaper. Where major daily newspapers are included like *The Star* or *Beeld*, the corresponding Sunday newspapers (in this case *The Sunday Independent* and *Rapport*) have also been incorporated in order to test if science is reserved for weekend newspapers where more space is available or to determine if stories are repeated.

3. In terms of geographical reach, four of the twelve selected newspapers are regional newspapers, whilst the remaining (eight) are national newspapers.

4. Cultural diversity in terms of readers was considered and two newspapers that serve Afrikaans-speaking communities are included – *Beeld* and *Rapport*. The latter newspaper (together with the *Sunday Times* and the *Sunday Independent*) serve audiences with the highest Living Standards Measure (LSM) in South Africa (8-10). Newspapers that historically served predominantly Black (African, Coloured, Indian and Asian) audiences like the *City Press*, the *Daily Sun* and *The Sowetan* are deliberately included in the study. However, a major limitation of the study is that

[18] Audit Bureau of Circulation's 4th Quarter Report (2018). See Appendix D.

[19] A newspaper's circulation is the number of copies it distributes on an average day.

aside from English and Afrikaans, no newspaper published in any other language is included.

5. The *Mail & Guardian* is included because of its reputation for in-depth coverage of higher education, research, science and innovation. The *Business Day* is incorporated as it is an influential national daily newspaper that serves business and financial audiences in particular.

The twelve newspapers that are included in this study are summarised below:

Media House	**Title**	**Description**	**Circulation[20]**	**Geographic area covered**	**LSM[21]**
Media 24	*Beeld* *Rapport*	Afrikaans daily Afrikaans weekly	32 500 105 900	Gauteng National	6-10 8-10
Media 24	*Daily Sun*	English daily	119 772	National	5-6
Media 24	*City Press*	English weekly	46 498	National	5-10
Tiso Blackstar Group	*Business Day* *The Sowetan* *The Sunday Times*	English daily English daily English weekly	20 014 70 392 250 176	National National National	6-10 7-10 8-10
Caxton	*The Citizen*	English daily	42 045	National	6-10
Independent Newspapers Limited	*The Star* *Saturday Star* *The Sunday Independent*	English daily English weekly English weekly	75 772 44 200 20 326	Gauteng Gauteng National	6-10 6-10 8-10
Mail and Guardian Media Limited	*The Mail & Guardian*	English weekly	25 834	National	6-10

Table 2: The selected newspapers, their media houses, circulation, geographical reach and LSM indicators

[20] The Audit Bureau of Circulation Q4 Report (2018)

[21] Living Standards Measure is a marketing research tool used to classify a person's standard of living and disposable income.

5.1.2 Live Media Monitoring

All twelve publications were monitored in real time through the daily monitoring of the print editions of the newspapers. Ten of these newspapers were sourced via the University's various subscription facilities, whilst the remaining two titles were secured through short-term subscriptions to the newspapers. All relevant science news items are kept in hard copy for a period of six months.

5.1.3 Criteria for the inclusion of science items in the study

5.1.3.1 Definition of Science

The definition of "science" is a contested term which is defined differently the world over. The British Science Council developed a new definition of science in 2009, describing science as "the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence"[22], with the emphasis on discovery and the creation of new knowledge as well as science being undertaken in a logical, ordered manner.

Some researchers at the University of California at Berkeley adopt a broader view of science, describing it as both "a body of knowledge" and a "process of discovery that allows us to link isolated facts into coherent and comprehensive understandings of the natural world". It emphasises the scientific process and the testing of ideas based on evidence.[23]

The South African National Department of Science and Technology's (2012) definition of science encompasses the natural sciences, engineering sciences, health sciences, agricultural sciences, social sciences and the humanities. The draft White Paper on Science, Technology and Innovation (2018) broadens the definition even further to include matters related to science for development, technology and innovation, with an emphasis on the fourth industrial revolution and its future impact on South Africa.

For the purposes of this study, science is defined as both the body of knowledge that exists, as well as the process of discovery that changes disciplinary thinking in the natural sciences, engineering sciences, medical sciences and agricultural sciences. It includes discovery research, translational research and innovative research but excludes reports relating to society and the humanities unless such items have a strong social sciences research angle.

[22] British Science Council via https://sciencecouncil.org (2009)

[23] Understanding Science, University of California at Berkeley (2019) https://undsci.berkeley.edu/article/0_0_0/intro_01

The following **criteria** were used to determine which science items should be selected for inclusion in this study:

1. All items that have defined science as described above as a main theme, topic or angle, including news reports, news briefs, feature stories, opinion pieces, commentary, editorial pieces and/or columns are included in the study.

2. Letters to the editor, health fact sheets for different ailments, health education articles that do not include elements of research, and science-related items in the travel, tourism, food, technology or sports sections are excluded from the study. For example, health fact sheets that expand on menopause or nutrition are excluded from the study if no new science or research is mentioned.

3. No advertorials, supplements or paid for content is included in the research. For example, a monthly series of pull-out supplements paid for by the state which highlight the achievements of government departments is not included in the study, even when they focus on areas like the bioeconomy or the women in science awards.

4. The study includes references to policies and practices that involve science and research, but excludes all references to new technological products unless it contains an element of scientific research. For example, articles relating to farming and entrepreneurship in rural areas are excluded, as these items refer to articles about agriculture, rather than agricultural science. Product reviews for new cellphones or drones are excluded unless they include an element of science or research in the news item.

5. Items that exclusively mention social, economic, health, engineering or political topics are excluded, and are only included where these items include aspects of scientific discovery, development or new knowledge. For example, a news item focusing on babies dying from klebsiella in a hospital is excluded, as are articles related to access to land, crime statistics, violence in society, a learner who excelled at maths at school, and obituaries that pronounced on the passing of the Minister of Environment Affairs and Forestry, as these items do not meet the definition of science described above.

6. This study only includes items pertaining to science, even if they form part of a series of articles that cover major scientific issues via different angles. For example, items on conservation and the protection of wildlife are included, but articles related purely

to the criminal or legal aspects around poaching are excluded. Similarly, items which explore the pollution of the Vaal River are included when science or a scientist is mentioned in the item but excluded if the item concentrates solely on the political conflict or legal proceedings pertaining to the contamination of the Vaal River.

7. The inclusion of selected health sciences and engineering sciences items requires explanation. Only items that include a science or research aspect, or items wherein which a scientist, researcher or expert is quoted is included in the study. Articles related to general health, socio-political issues or healthcare policies solely are excluded.

   One such example is the issue of mental health, which featured prominently during the three months under review, given the suicides of two famous South Africans during this period. Only articles that included a scientific aspect or that explained the science related to mental health conditions are included. All articles related to the socioeconomic circumstances of the persons or the politics around the passing of the individuals, funerals and memorial services are excluded from the study.

   Similarly, whilst there were tens of articles focusing on the Constitutional Court's ruling in favour of the private use of cannabis, only items that included scientific elements related to cannabis are captured in this study.

5.1.3.2 Cataloguing the science items

Based on the selection criteria above, 409 science items were catalogued and tabulated according to the science themes, general data and news values described below.

Science themes

Over 800 science items collated over three months were classified into 19 sub-categories or themes over a three month period in a similar study by van Rooyen (2002). One of the recommendations of the van Rooyen (2002) study was that it should be replicated at regular intervals. This recommendation partially informed the decision to replicate (with some adaptation), similar categories or themes as part of the quantitative component of this study, which are classified into the following 16 themes:

Anthropology and Archaeology	Computer Science	General science (including science and technology policy and science awards)

Astronomy	Earth Sciences (including geography and the geosciences)	Health sciences (clinical sciences, biomedical sciences, therapeutic sciences, anatomical sciences, oral health sciences, mental health sciences, reproductive health sciences)
Behavioural studies (including physiology)	Engineering sciences (mining, chemical, civil, mechanical, industrial, aeronautical)	Mathematical sciences
Botany	Environment and Ecology (including climate change and conservation)	Palaeosciences
Cellular and Molecular Biology	Food Sciences and Nutrition (including agricultural science)	Zoology
Chemistry		

5.1.3.3 Data collation

Each science item that met the criteria were tabulated and catalogued as per the themes described above and as per the categories stipulated below:

General data

- Title (The name of the newspaper)
- Media House (The owner of the newspaper)
- Date (The date on which the science item was published)
- Day (The day on which the science item was published)
- Frequency (How often the newspaper is published)
- Headline (The actual headline that appears in the newspaper)

- Section (The section as labelled in the newspaper under which the item falls)
- News type (Items categorised according to News, Opinion, Features and Briefs[24])
- Byline (The name of the individual science journalist or reporter writing about science). This is the actual byline that appears, including those items marked as "Staff Reporter". Items which have no stipulated byline are recorded as such.

News values

- Sources (The likely originator of the science item be it an individual, group or institution)
- Proximity (Distinction between local and international news only)
- Exclusivity (The only newspaper to carry the science item or to carry it first)
- Public interest (Importance to the general public)
- Relevance (Relevance to the general public and the newspaper audience)
- Tone (Neutral, positive, negative)
- Powerful and elite (Individuals and institutions of an elevated socioeconomic, political, religious or other status standing in society)
- Contentious issues and drama (Contentious or Neutral)

Prominence

- Page placement (Page on which the science item is published)
- Position on page (Actual position of the science item on the page)
- Headline size (Tier 1 is the lead headline and Tier 7 the most inconspicuous)
- Blurb (Summary or most important points of the science item)
- Sub-headings (Headings within an item)
- Visuals (Images, infographics and cartoons)
- Prominence of visuals (Tier 1 is the most prominent and Tier 7 is the least prominent)

[24] Briefs are described as short articles or news items consisting of no more than four paragraphs

- Captions (Included or Excluded, actual text of captions if included)

The data was collated, tabulated and catalogued systematically as detailed in **Appendix A.**

5.2 Qualitative Research

A qualitative research component was introduced as part of the methodological approach in order to better understand how and why decisions are made by internal and external actors and gatekeepers in newsrooms; to explore the relationships and interactions between these journalists, communicators and editors; and to determine which news values and factors most influence the publication of science in South African newspapers.

Qualitative research is ideally suited to studies where researchers seek to "understand meanings, or look at, describe and understand experiences, ideas, beliefs and values" (Wisker 2001). On the other hand, a critical view of qualitative research describes the data derived as largely subjective, generalised and not readily verifiable according to Allan (1991), who also argues that it could be a precursor to quantitative research. For the reasons stated above, a combination of quantitative and qualitative methods was adopted for this study.

5.2.1 Interviews with science journalists, science communicators and editors

Interviews, whether simple or complex are an appropriate method for collecting qualitative research data from respondents according to Merriam (1998) and Jensen (2002).

In this study, following an initial discussion with about twenty selected potential interviewees, comprising of science journalists, science communicators, scientists and editors, thirteen individuals agreed to participate in the study.

A two-step approach was then enacted, which included an initial discussion or semi-structured interview with the individuals, followed by a comprehensive questionnaire[25]. Given the time constraints of the individuals, particularly those located in newsrooms, the dual approach worked well. The initial discussions provided the context of the research and garnered preliminary top of mind responses from the respondents, whilst the data retrieved from the questionnaires provided deeper, considered insight from the journalists and editors in particular. This data is included as **Appendix C**.

All thirteen respondents were called and following a short telephonic discussion or semi-structured interview, a questionnaire was emailed to them. Nine individuals completed the

[25] See Appendix B

questionnaire, whilst three were conducted telephonically and then transcribed. One news editor was disqualified as he did not return a completed questionnaire on time and could not later be reached to participate in a substantial telephonic or personal interview. His incomplete questionnaire was subsequently not considered and he was eliminated from the study, thereby reducing the number of respondents in this study to twelve.

5.2.2 Questionnaire

The purpose of the questionnaire[26] is to explore the news values and influential factors that make science worthy of publication and to uncover the perceptions around the importance of the media in covering science news in South Africa. The questionnaire includes 19 questions related to the sociology of news production, professional news values and the role of media professionals as gatekeepers in relation to the publication of science news. The use of sources is also explored, an area also covered in the quantitative analysis.

5.2.3 Issues related to the interview process

The time constraints of the respondents was a major hurdle and it often took multiple calls and emails to secure time for a discussion, and then time to retrieve the questionnaires. Three of the twelve completed interviews were conducted verbally only, whilst nine responses were received in writing. One respondent was disqualified as the responses received via email were incomplete. Only one candidate asked for a specific question to be treated anonymously.

In three instances, where respondents were too busy to be interviewed or to complete the questionnaire, replacement candidates in similar positions were approached to be interviewed.

As the quantitative research was undertaken, it became apparent, largely due to newsroom changes, that there were sometimes other journalists or editors who were more appropriate to interview, aside from those originally selected. During the six month period during which the qualitative data was gathered, three of the respondents (one science journalist and two editors) were retrenched or left their jobs.

A compendium of the verbatim responses of the twelve interviewees is included in **Appendix C**.

The following respondents participated in the study:

[26] See Appendix B

Category	Respondent	Institution / Publication
Practicing science journalists in South Africa	Sarah Wild	Former *Mail & Guardian* Science Editor, now a freelance science journalist who writes for local and international publications
	Elsabe Brits	*Die Burger* / *Beeld*, now freelancing for Media 24
	Tamar Kahn	*Business Day*'s, Health, Education and Science Editor
	Tanya Farber	*Sunday Times* science writer
	Pericles Anetos	*Sunday Times* science writer
Former editors and news editors (mix of daily, weekly, regional and national editors from different media houses)	Kevin Ritchie	*The Star*, now freelancing after 27 years of editing newspapers
	Schalk Mouton	Former news editor of *Beeld* and *The Times* newspapers. He is now employed at the University of the Witwatersrand.
	Natasha Joseph	Former news editor of *The Times* and *City Press*, now with *The Conversation Africa*
	Shaun Smillie	Former Science Desk Editor at the *Saturday Star*
	News editor who did not complete questionnaire	News editor at *Independent Newspapers* Limited
Science communicators	Robert Inglis	CEO of *Jive Media*, a science communications agency that generates science news content

	Prim Gower	Former education editor of the *Mail & Guardian*, now a science writer at the University of Pretoria
Scientist	Professor Lee Berger	Palaeoanthropologist, Professor of Evolutionary Studies and Reader in the Public Understanding of Science at the University of the Witwatersrand

6. Findings

This research analyses the important news values and factors that make some science items worthier of publication than others in the South African press. The role of internal and external actors, including science journalists, communicators, editors, gatekeepers and sources that influence the publication of science is probed. The study further examines the science themes that feature regularly in the press and explores perceptions around the role of the media in making science accessible in a developing democracy.

A systematic quantitative analysis of twelve daily, weekly and weekend South African English and Afrikaans newspapers was undertaken over a three month period (1 August 2018 – 31 October 2018) and each item which was defined as science (as described in 5.1.3.1 above), was tabulated, analysed and summarised in accordance with the 16 themes and criteria described in 5.1.3.2 above. The complete data set can be found in **Appendix A.**

6.1 Summary of the Quantitative Data

The following table provides a summary of the data contained in **Appendix A**. It summarises only the fundamental data related to the number of science items that are published in newspapers, the science themes that feature in the news, the top bylines[27], and the news organisations that are regular suppliers of science news items.

Title	Quantity of science items	Content Type	Top Bylines	Top News Source Organisations	Themes
The Star	59	News (33) Briefs (20) Opinion (6)	Lisa Isaacs (6) Tebogo Monama (3) No Byline (24) Staff Reporter (4)	Original story or original based on lead[28] (34) International newspapers (14) Newswires (11)	Anthropology and Archaeology (1) Astronomy (1) Earth Sciences (1) Energy (2) Environment and Ecology (25) Health Sciences (22)

[27] A byline is usually the name of a person, usually a journalist, who writes the article.

[28] "Original based on lead" in the context of this study refers to a science news item that is written by a journalist or a reporter, based on a tip-off or hint from an individual, report or institution. For example, it could be a story based on a media release from a scientist or research university or climate change data from a United Nations report.

					Science and Technology (3) Zoology (4)
The Sowetan	15	News (12) Opinion (3)	Karabo Ledwaba (4) Penwell Dlamini (2) No Byline (4)	Original story or original based on lead (11) Newswires (3) Other[29] (1)	Astronomy (1) Engineering Sciences (3) Environment and Ecology (7) Health Sciences (2) Science and Technology (2)
Business Day	50	News (41) Opinion (9)	Tamar Kahn (7) Neels Blom (4) Heather Dugmore (3) Agency Staff (8)	Original story or original based on lead (36) International newspapers (4) Newswires (9) Syndicated Media[30] (1)	Anthropology and Archaeology (1) Astronomy (1) Energy (8) Engineering Sciences (1) Environment and Ecology (17) Health Sciences (14) Palaeosciences (1) Physics (1) Science and Technology (5) Zoology (1)
Sunday Times	21	News (13) Features (8)	Claire Keeton (5) Shanthini Naidoo (3) Tanya Farber (3)	Original story or original based on lead (21)	Anthropology and Archaeology (3) Engineering Sciences (2) Environment and Ecology (8) Health Sciences (3) Science and Technology (3) Zoology (2)
Saturday Star	63	News (44) Briefs (15)	No Byline (24) Sheree Bega (19)	Original story or original based on lead (30) International	Agricultural Science (1) Anthropology and Archaeology (2)

[29] In this category, "other" refers to a story lifted verbatim from a sister newspaper's website - Lack of maintenance threat to Vaal, *Times Live*, 20 August 2018

[30] Syndicated media in this instance refers to an article lifted from *The Conversation Africa* - Blood a better predictor of future health, 17 October 2018

		Opinion (1) Features (3)	Shaun Smillie (3)	newspapers (16) Newswires (15) Syndicated media[31] (2)	Astronomy (2) Botany (1) Engineering Sciences (1) Environment and Ecology (22) Food and Nutrition Science (2) Health Sciences (22) Palaeosciences (1) Science and Technology (2) Zoology (7)
Sunday Independent	19	News (6) Briefs (5) Opinion (8)	No Byline (6) Tshilidzi Marwala (2)	Original story or original based on lead (13) Newswires (5) Syndicated Media[32] (1)	Anthropology and Archaeology (1) Astronomy (2) Energy (2) Engineering Sciences (1) Environment and Ecology (6) Health Sciences (4) Science and Technology (2) Zoology (1)
Mail & Guardian	29	News (22) Briefs (1) Opinion (5) Features (1)	Sipho Kings (9) Matthew du Plessis (6)	Original story or original based on lead (27) Newswires (1) Other (1)[33]	Anthropology and Archaeology (1) Astronomy (2) Energy (4) Engineering Sciences (1) Environment and Ecology (13) Health Sciences (3) Palaeosciences (2)

[31] Syndicated media in this instance refers to articles lifted from *The Conversation Africa* - 3 200 year old cheese unearthed by archaeologists, 4 August 2018 and No black scientist has ever won a Nobel prize, 13 October 2018

[32] Syndicated media in this instance refers to an article lifted from *The Conversation Africa* - Big lifestyle changes to curb global warming, 14 October 2018

[33] In this instance, the story was lifted from the *Times Live* website - Lack of maintenance threat to Vaal, 4 October 2018

					Science and Technology (1) Zoology (2)
City Press	15	News (12) Opinion (3)	Vuyo Mkize (4) Mandi Smallhorne (2)	Original story or original based on lead (15)	Astronomy (1) Energy (2) Environment and Ecology (3) Health Sciences (4) Science and Technology (4) Zoology (1)
Rapport	7	News (6) Opinion (1)	Mandi Smallhorne (2)	Original story or original based on lead (7)	Anthropology and Archaeology (2) Environment and Ecology (4) Science and Technology (1)
Daily Sun	23	News (18) Briefs (5)	No Byline (12)	Original story or original based on lead (11) Newswires (6) Syndicated media[34] (6)	Anthropology and Archaeology (1) Astronomy (5) Engineering Sciences (1) Environment and Ecology (1) Health Sciences (5) Science and Technology (7) Zoology (3)
Beeld	63	News (60) Briefs (1) Opinion (2)	Elsabe Brits (30) Elise Tempelhoff (19) No Byline (6)	Original story or original based on lead (61) International newspapers (1) Newswires (1)	Anthropology and Archaeology (5) Astronomy (7) Energy (2) Engineering Sciences (1) Environment and Ecology (33) Health Sciences (9) Palaeosciences (3) Physics (1) Zoology (2)

[34] Science articles (and images) sourced from Wikimedia Commons

The Citizen	45	News (38) Briefs (4) Opinion (2) Feature (1)	No Byline (28) Amanda Watson (4)	Original story or original based on lead (12) Newswires (30) Syndicated media[35] (3)	Astronomy (1) Energy (3) Engineering Sciences (1) Environment and Ecology (26) Health Sciences (8) Science and Technology (2) Zoology (4)
	409				

Table 3: A summary of the number of science items published by content type, byline, news source organisation and theme

6.1.1 Quantity of science items across titles

A total of 409 science items was recorded from 1 August 2018 – 31 October 2018, which averages approximately four science items published per day across titles. This is less than half of the 994 articles found across 15 titles over a three month period by van Rooyen *et al* (2002), although it must be considered that the Stellenbosch study used a broader definition of science, and included three additional newspaper titles.

In this study, there was at least one science item published every day over the 92 days under review, with *Beeld (63)*, *The Saturday Star (63), The Star (59), Business Day (50) and The Citizen (45)* publishing the most number of science items. Whilst the *Saturday Star* followed many science-related issues like the contamination of the Vaal River or the conservation of large mammals, these items included multiple angles and perspectives including legal proceedings and political matters. Any news item that did not include a strong science angle, or feature science as a main topic or theme was not included in this study.

Of the 409 science items published, 255 (62%) were published in daily newspapers, 29 (7%) in a weekly newspaper and 125 (31%) in weekend newspapers over the three month period.

6.1.2 Science items by content type

[35] Three articles lifted from *The Conversation* – Botswana, Namibia hotspots (11 October 2018), Vaal catfish can cause cancer (25 October 2018), Transplant is game changer (5 October 2018)

The majority of the science items published were news items, with the remaining comprising mainly of opinion pieces, briefs[36] and features.

The *Mail & Guardian* and *The Sunday Independent* carried the most number of opinion pieces[37] and commentary analysis[38], whilst *The Sunday Times* published the most number of feature stories[39], typical of weekly and weekend newspapers.

The Sowetan published the most number of profile[40] news stories and like the *Daily Sun,* told science stories through profiling people who had achieved in science – for example, those who had won science competitions or who were succeeding in the engineering sciences.

6.1.3 Prominent themes

The themes reflected in the table below featured prominently across titles during the three months under review. In total, 409 items were catalogued as per the criteria defined in 3.1.5 above.

Rank	Top 10 Themes	Total no of items	Percentage of total science coverage
1	Environment and Ecology	165	40%
2	Health Sciences	96	24%
3	Science and Technology	32	8%
4	Zoology	27	7%
5	Astronomy	23	6%
6	Energy	23	6%
7	Anthropology and Archaeology	17	4%
8	Engineering Sciences	12	3%

[36] Briefs are short articles or newsbytes, usually only a few paragraphs long, often used to fill space in newspapers

[37] An editorial piece written by an individual that expresses his/her personal opinion around an issue

[38] Analytical pieces around a particular issues usually written by a member of the editorial staff

[39] A feature story is described as a lengthier pieces that explore multiple angles of a story or an issue

[40] Articles written about a particular person that usually highlights that personal achievements

9	Palaeosciences	7	2%
10	Food and Nutrition Sciences	2	0%
10	Physics	2	0%
11	Agricultural Sciences	1	0%
11	Botany	1	0%
11	Earth Sciences	1	0%
	Total	**409**	**100%**

Table 4: Top 10 themes by rank, quantity and percentage of science coverage

6.1.3.1 Natural sciences feature the most

Science items focusing on the environment and ecology, including climate change and conservation featured most prominently in the majority of publications, with three sub-themes recurring over the three months: water pollution, conservation and climate change.

This exposure can largely be attributed to the numerous articles authored by science journalists Elise Tempelhoff, Sipho Kings and Sheree Bega who focused on the pollution of the Vaal River[41], the impact of the contaminated water on societies living along the banks of the Vaal River, and the potential for a national catastrophe if the polluted water was not cleaned. These journalists followed the stories of scientists, academics, local activists and residents through community meetings, public demonstrations, scientists' evaluations and engagement with local, regional and national authorities until the issue reached resolution in Parliament, when the President of the Republic of South Africa committed sufficient funds and agreed for the South African National Defence Force to clean up the river[42].

Similarly, Elise Tempelhoff, Tamar Kahn and Sheree Bega championed conservation in the fight against rhino and elephant poaching through regular coverage, particularly of poaching incidents in the Kruger National Park and the Ezemvelo National Park, during the three month period.[43]

[41] Vaal sewage spills killing rivers, *Saturday Star*, 6 October 2018

[42] SANDF to clean up the Vaal, *Beeld*, 25 October 2018

[43] Less rhino poaching in past year, *Saturday Star*, 22 September 2018

The data also reflects that Elsabe Brits, Shaun Smillie and Sipho Kings reported regularly on the impact of climate change[44], often using the United Nation's Intergovernmental Panel on Climate Change[45] report as a basis, as well as leads from environmental non-governmental organisations.

Mandi Smallhorne's series on the "Our Land"[46] project featured across News24's newspapers including *Rapport* and *City Press*, including articles that focused on climate change and agriculture[47]. These were extensive, in-depth double page spreads that explored these science issues in detail.

6.1.3.2 Health Sciences are very topical

There were a large number of items pertaining to the health sciences across titles. More non-communicable diseases and diseases of lifestyle were covered during this period than communicable diseases. For example, there were more science items relating to diabetes, cancer, endocrinology and the chance of dying from a stroke than there were articles pertaining to HIV/AIDS or malaria. Reproductive health[48] was also disproportionately covered through various sub-topics across titles.

Issues related to tuberculosis research[49] featured prominently given the Minister of Health, Aaron Motsoaledi's role as the leader of the global Stop TB Strategic Initiative[50]. The Minister is a strong proponent for eradicating tuberculosis in South Africa and other countries, and is regularly quoted on this topic.

Motsoaledi is also the strongest advocate of the proposed Control of Tobacco Products and Electronic Delivery Systems Bill (2018) that seeks to curtail the marketing of tobacco products in South Africa. Only articles related to scientific research around the proposed tobacco legislation are quantified in this study.

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[44] Catastrophe is at hand, *Beeld*, 9 October 2018

[45] The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change

[46] Wake up! Things are going to change, *Rapport*, 26 August 2018

[47] Be prepared: it's getting hotter and drier, *City Press*, 9 September 2018

[48] IVF can help couple choose baby's sex, *The Star*, 9 October 2018

[49] Vaccine trial has promise, *The Star*, 1 October 2018

[50] The Stop TB Strategic Initiative is a partnership between the World Health Organization and the Global Fund which seeks to eliminate TB in 13 countries by 2030

Another issue that was covered prominently was the Constitutional Court ruling on 18 September 2018[51] that allows for the private use of cannabis by individuals in South Africa, which resulted in numerous articles being published in the media around this matter. Surprisingly, the majority of the coverage focused on the jubilation of cannabis users, the legal arguments pertaining to the ruling and the opinions of various groups of people, with very few news items actually exploring the science of cannabis, its properties and its potential impact on people. There was one exception - the South African Society of Psychiatrists is published prominently across titles, warning of the potential negative impacts of the use of cannabis amongst adolescents and teenagers in particular, thus dominating the public conversation in this respect.[52]

Articles on mental health related to depression, anxiety and suicide were published regularly across titles, especially in the wake of the passing of Professor Bongani Mayosi, a prominent cardiologist and deputy vice-chancellor of the University of Cape Town who took his own life, and HHP, a renowned local celebrity who also passed away after years of suffering from depression. Only articles explaining the scientific aspects of mental health conditions like anxiety and depression are captured in this study.[53]

6.1.3.3 Science and Technology policies are prevalent

A final version of the new draft paper on Science, Technology and Innovation was released by the Minister of Science and Technology, Mmamoloko Kubayi Ngubane, during which time she penned multiple articles pertaining to new policies.[54] There were many other policy issues that surfaced during this period, including the lack of funding for research in South Africa[55] and the role of women in science, technology, engineering and mathematics. The latter topic included contrasting perspectives of the role of women in science. On the one hand, a female Nobel prize-winner[56] was lauded for her breakthrough work in physics whilst on the other, adverse references pertaining to the role of women in engineering[57] were made by the CEO of the South African Institute for Civil Engineering, who subsequently lost his job because of the intolerable remarks.

[51] Dagga ruling will have side effects, *The Citizen*, 25 September 2018

[52] Fears of health effects of dagga, *The Star,* 26 September 2018

[53] Anxiety can destroy your life, *Mail and Guardian*, 19 October 2018

[54] Science, technology and innovation - key catalysts for growth, *The Star*, 2 October 2018

[55] SA's research bodies under financial strain, *Business Day*, 28 September 2018

[56] Laser trio win Nobel prize for physics, *Business Day*, 3 October 2018

[57] Engineering body CEO quits, *The Saturday Star*, 8 September 2018

6.1.3.4 Energy is part of the mix

The proposed Integrated Resource Plan[58] released in 2018 by Jeff Radebe, the Energy Minister of South Africa, resulted in several articles related to South Africa's energy mix being published, especially in the *Business Day*[59]. There was then a flurry of public exchanges between government officials, coal producers, renewable energy proponents, non-governmental organisations and corporations in the public sphere as to the appropriate future energy mix for South Africa. The benefits of nuclear energy also featured prominently in the *Sunday Independent.*

6.1.4 News values and factors that make some science items more newsworthy than others

It is essential to study news values because it "goes to the heart of what is included, what is excluded, and why" some news is given precedence over others and it also "makes news selection more transparent" (O'Neill and Harcup 2009). News values are factors that make news valuable but the value of news increases based on the number of news factors present in the article as well as "the intensity of these factors" (Badenschier and Wormer 2012). For example, the more people whose lives are impacted by an event in close proximity to the readers of a newspaper, the higher the news value of the event is considered to be.

Following an analysis of the 409 science items that form part of this study, the following news values and factors are found to make science items more worthy of publication: world-firsts, contentious issues, exclusive items, the proximity to an event or news item, items that are relevant and in the public interest and science items accompanied by superb visuals.

6.1.4.1 Research and world-firsts make the news

Four world-firsts were published in newspapers during this period – lion cubs grown through artificial insemination[60], a liver transplant from an HIV+ mother to her HIV- baby[61], a new trial that saw stool transplants help malnourished children[62] and the first South African operation on a slipped disc using non-invasive surgery[63]. Astronomy, and especially the NASA probes

[58] Integrated Resource Plan (2018) is a proposal released by the National Department of Energy that outlines the proposed energy mix for South Africa

[59] Public to finally have say on energy plan, *Business Day*, 22 August 2018

[60] The lion and the lab, *Sunday Times*, 2 September 2018

[61] First HIV+ Liver transplant heralds a new era, *Sunday Independent*, 7 October 2018

[62] One man's faecal waste is another man's elixir, *Sunday Times*, 22 August 2018

[63] Alternative to spinal op, *The Citizen*, 4 October 2018

sent close to the Sun[64], and new aspects of the Square Kilometre Array[65],[66] project featured regularly in both the *Daily Sun* and *Beeld* during the period under review. The weekend newspapers printed the most number of features, including several exclusives based on research, including a new study that demonstrates the negative impact of sugar sweetened beverages on poor people.[67]

6.1.4.2 Contentious issues are covered over protracted periods

Several controversial matters pertaining to science, and especially those related to proposed legislation, resulted in debate on the pages of the newspapers.

The pollution of the Vaal River especially after raw sewage was found flowing in the water, resulted in major disputes between scientists, academics, residents and activists on the one side, fighting against local, provincial and national government representatives and official authorities on the other. The concerns pertained to the levels of contamination of the Vaal River water, the impact of the contagion on the flora, fauna and overall ecosystem, and the natural and socioeconomic impact on humans. There was also disagreement between the Emfuleni municipality responsible for the sanitation works project and several ministries including the national departments of water and sanitation, environmental affairs and cooperative governance, as to who was responsible for the lack of maintenance and resolution of the problem.

This issue was covered extensively in the *Saturday Star*, *Beeld* and the *Mail & Guardian* over the three months and the news items included the views of a range of activists, scientists, community organisations, academics, environmentalists, lawyers and public sector representatives. It was finally addressed in Parliament and partially resolved by the President of the Republic of South Africa who allocated funding for a clean-up project to be undertaken by the South African National Defence Force[68].

The proposed Integrated Resource Plan released by the Energy Ministry also resulted in a number of science items related to the recommended energy mix for the country. Various arguments for and against the use of coal-powered stations, renewable energy and nuclear

[64] Nasa launches sun probe, *Daily Sun*, 13 August 2018

[65] The Square Kilometre Array is the largest radio telescope ever built and will produce science that changes our understanding of the Universe.

[66] A unique optical sight to be found in SA, *Beeld*, 12 September 2018

[67] Lifestyle that can kill, *Sunday Times*, 7 October 2018

[68] Military to help clean up the Vaal River, *Rapport*, 28 October 2018

energy were published, which included a focus on the impact of various energy sources on the environment. Many of these deliberations featured on the pages of the *Business Day*[69] newspaper.

A third issue that was intensively debated centred around the conservation of Africa's wildlife and particularly those animals that are at high risk of being poached, like elephants[70], rhinoceros[71] and abalone[72]. The "war" on local and international poaching syndicates was largely propagated by conservationists, non-governmental organisations, game rangers, SANParks[73] employees and even by the South African Police Services and government officials.

The controversy surrounding a draft Tobacco Bill[74] that seeks to regulate the tobacco industry (including e-cigarettes and vaping products), and to remove branding on all tobacco products at point of sales counters, amongst other regulations, erupted between tobacco manufacturers, the producers of e-cigarettes and vaping products, trade unions and pro-choice lobby groups on the one hand and the national department of health, and the National Council Against Smoking on the other. Whilst there are mentions of the impact of smoking on individuals, this issue was contentious, but was not documented as it did not meet the definition of science as specified in the methodology of this study.

6.1.4.3 No marked exclusives, but some reservation for weeklies and weekenders

There were no science items marked as exclusive in any of the newspapers studied during the three month period. However, the weekly and weekend papers carried the majority of exclusive science items written by science journalists or published them first before the dailies. Claire Keeton's feature story on why honeybees are thriving in South Africa[75] or Sheree Bega's story on how poisoned fish in the Klip River can cause cancer[76] are examples of such exclusives.

[69] Public to finally have say on energy plan, *Business Day*, 22 August 2018

[70] Helping elephants dodge the bullets, *Saturday Star*, 8 September 2018

[71] Genetic hopes flicker for rhino, *The Star*, 25 September 2018

[72] It's too late, this thing is nearly finished, the *Mail & Guardian*, 25 September 2018

[73] South African National Parks is a leading conservation public entity

[74] Draft Control of Tobacco Products and Electronic Delivery Systems Bill (2018)

[75] Honeybees having a wild time, *Sunday Times*, 7 October 2018

[76] Klip River fish can cause cancer, *Saturday Star*, 27 October 2018

The daily newspapers also tend to cover breaking news based on events that occur during the week when scientific journals lift embargoes. The first intentional HIV+ liver transplant in South Africa[77] story was published after a media conference at the University of the Witwatersrand and was carried first by the dailies. Similarly, the public release of information from the University of Pretoria on the artificial insemination of lion cubs[78] resulted in coverage in the daily newspapers.

Profiles of scientists, inventors and innovators[79] or their work[80], as well as opinion pieces[81] and editorials[82], and investigative assignments are usually exclusive items to specific titles. The article on the environmental and social impact of sewerage flowing into rivers and homes in Boipatong[83] is one such example. In total 45 (11%) of the 409 total items analysed are classified as exclusive items.

6.1.4.4 Relevant and in the public interest

The majority of science items can be described as relevant to the general South African reader and can be found to be in the public interest. For example, all the contentious issues described above, including the contamination of the Vaal River or the prevention of non-communicable diseases can be categorised as useful, germane information from which readers and the general public will benefit. The latter is often an outcome of translational research[84], or demonstrations of science with impact[85]. Even the science items related to discovery research[86], like the palaeosciences[87], new space missions[88] and astronomy[89] are

[77] HIV mother donates part of liver to save child, *Business Day*, 5 October 2018

[78] Pair of AI cubs make history, *Beeld*, 3 September 2018

[79] New frontier for super North-West scientist, *The Sowetan*, 29 October 2018

[80] SA inventor's robot disarms explosives, *The Sowetan*, 4 October 2018

[81] Peaceful use of nuclear technology, *Sunday Independent*, 19 August 2018

[82] Water problems need fixing first, *Business Day*, 16 August 2018

[83] Health compromised by Boipatong sewage stench, *Saturday Star*, 6 October 2018

[84] Translational research refers to applied research or research that builds on discovery research to produce useful outcomes. For example, it can change government policies or result in nee therapies.

[85] New Draft White Paper on Science, Technology and Innovation for SA (2018)

[86] Discovery research is defined as new research that changes disciplinary thinking

[87] Fossil bed of dinosaur bones found in Eastern Cape, *Beeld*, 25 September 2018

[88] NASA launches space mission, *Daily Sun*, 13 August 2018

[89] Project aiming to unlock secrets of the Universe, *Saturday Star*, 18 August 2018

relevant, as they seek to help readers learn about themselves and the world around them so that they can advance themselves and society.

6.1.4.5 Local dominates, while international fills the gaps

Over half (51%) of the 409 science items analysed, refer to news or events emanating from South Africa, related to South Africa, or those that impact on South Africans as depicted in the table below. The term “local” categorises all science items related to South Africa whilst “international” refers to science news that emanate from, or impact on, countries beyond the South African border. “Glocal” refers to science items that make reference to both South African and international science news items.

Title	Glocal	International	Local	Total
Beeld	6	30	27	**63**
Business Day	9	10	31	**50**
City Press	3	1	11	**15**
Daily Sun	3	10	10	**23**
Mail & Guardian	4	14	11	**29**
Rapport	1	0	6	**7**
Saturday Star	8	32	23	**63**
Sunday Independent	1	5	13	**19**
Sunday Times	1	0	20	**21**
The Citizen	9	19	17	**45**
The Sowetan	0	1	14	**15**
The Star	4	31	24	**59**
Total	**49**	**153**	**207**	**409**
Total percentage	**12%**	**37%**	**51%**	**100%**

Table 5: The amount and percentage of local, international and glocal news contained in newspapers from 31 August 2018 – 31 October 2018

The *Sunday Times* and *Rapport* are the two newspapers which included mainly local science items, whilst the *Saturday Star* and *Beeld* published the most international science items during the period under review. The latter are also the titles that publish the most science items overall.

The briefs or short news sections in newspapers, also known as fillers, contain substantial international science news sourced from newswires and international newspapers, often referencing research, new knowledge and breakthroughs and innovation.

The Sowetan publishes more science items focusing on rural areas than other newspapers, sometimes based on stories from remote areas via a rural content generation service. For

example, a story about the teenagers who made electricity from cow dung[90] in the Free State featured prominently in *The Sowetan*. Similarly, the *Daily Sun* covers a wide range of science items from across South Africa, usually in profile format, like the success story of a woman working in engineering in Mpumalanga[91].

6.1.4.6 Prominence

The general perception that science items do not usually make it to the front pages of newspapers remains true, as is evidenced in this study. However, it is refreshing to note that science news items made it to the front pages of two newspaper titles. *Beeld* carried six science front page news stories during the three month period under review, including those related to the polluted Vaal River[92], climate change[93], and conservation and wildlife[94] whilst *Business Day* published two front page science items on the pollution of the Vaal River[95] and the proposed integrated energy plan[96] respectively.

Several science issues are also published in the editorial columns of some newspapers. For example, during the period under review, *Business Day* carried two editorials reflecting on water[97] and clean energy[98]. Similarly, the *Mail & Guardian* published an editorial on climate change[99], *City Press* an editorial on the importance of investing in research[100] and *Beeld* an editorial on the cleaning up of the Vaal River[101].

6.1.4.7 Science features throughout newspapers

Science items are found throughout the various sections of newspapers. Although the majority of the science items are published in the news section of the main body, and longer

[90] Invention wins judges hearts, *The Sowetan*, 5 October 2018

[91] Khuls makes vehicle electrics a girl thing, *Daily Sun*, 15 August 2018

[92] Nowadays we are scared of the Vaal, *Beeld*, 17 October 2018

[93] Climate will be warmer, drier and beer will be scarcer, *Beeld*, 16 October 2018

[94] Pair of AI cubs make history, *Beeld*, 3 September 2018

[95] Departments deny fish mortality and raw sewage link, *Business Day*, 13 August 2018

[96] Cleaner power is a win for Ramaphosa, *Business Day*, 28 August 2018

[97] Water problems need fixing first, *Business Day*, 16 August 2018

[98] Let's talk about our energy plan, *Business Day*, 28 August 2018

[99] We must act to save the world now, *Mail & Guardian*, 12 October 2018

[100] Make scientific research matter, *City Press*, 16 September 2018

[101] Vaal River challenges feel bigger, Tito, *Beeld*, 26 October 2018

items in the feature and opinion sections, almost all daily newspapers incorporate science items as fillers. For example, the metro section in newspapers in the Independent News Limited stable generally retrieves science news, usually based on research, from international newspapers like *The Daily Mail* (UK) or newswires. Content is also sometimes shared within media houses. For example, the five part series titled “Our Land” is published in *City Press* and *Rapport*, with some aspects also featuring in *Beeld* and the *Daily Sun*, all part of the same news company, Media24.

Science features in the business sections of newspapers particularly when the items relate to the impact of climate change, the environment, and energy, on the economy, and especially when science items refer to the carbon footprint of companies or the cost of poaching on tourism. Evidence of such examples are found in the number of articles printed in the *Business Day* after the publication of the draft Integrated Resource Plan for South Africa was announced in August 2018.

Many profiles of entrepreneurs, women and the youth in science feature in the jobs and careers section of *The Sowetan*. Similarly, the *Daily Sun* shares science news stories and achievements through telling the stories of individuals, but also has two weekly regular sections – *Tell Me* and *Wellbeing* – dedicated to science and health news respectively. The *Mail & Guardian*, through its Bhekisisa Health Journalism Unit also has a regular double spread feature focusing on an important health issue almost every week.

6.1.4.8 No visible patterns pertaining to positionality

This study does not seek to explore how science content is represented on the pages of newspapers. However, a superficial review does not establish any discernible patterns with regards to the position of science items in the newspaper or on a page, the length of the article, the size or placement of the headline, and the use of blurbs, pull-out quotes and sub-headings.

6.1.4.9 Visuals and Captions

Of the science items that are analysed as part of this study, 66% contain images, whilst 34% do not. There are no discernible patterns across titles pertaining to the use of images and visual aids, aside from ascertaining that the weekend and weekly newspapers use more images and infographics to accompany feature stories than do dailies. For example, the *Mail & Guardian* publishes a double page spread focusing on a particular issue weekly through

Bhekisisa[102], which contains three to four stories or sections including fact sheets, infographics accompanied by three to four images. Whilst science items in daily newspapers may include images, these are used on a limited scale, with no more than one or to found alongside a science item.

Title	Image	No image	Sum
Beeld	48	15	63
Business Day	29	21	50
City Press	11	4	15
Daily Sun	19	4	23
Mail & Guardian	22	7	29
Rapport	4	3	7
Saturday Star	48	15	63
Sunday Independent	15	4	19
Sunday Times	21	0	21
The Citizen	20	25	45
The Sowetan	2	13	15
The Star	30	29	59
Total	**269**	**140**	**409**
Percentage	**66%**	**34%**	**100%**

Table 6: The representation of visual material accompanying science items in South African newspapers from 1 August 2018 to 31 October 2018

6.1.4.10 Tone

The science items collated, catalogued and analysed over the three months, were sorted into three categories that broadly describe the tone of each science item. The three categories are described as follows:

Category	Definition
Alarming	All science items that are contentious, that raise concerns that include a call to action to fix a problem or issue, or that may have a negative impact on society are placed in this category.
Factual	Science items that are described as informative, educational, neutral, sometimes quirky and/or enlightening are located in this group.

[102] The Bhekisisa Centre for Health Journalism is a non-profit organisation the provides health journalism content services largely to the *Mail & Guardian* newspaper

Inspirational	All science items that express an element of hope or optimism, and that are motivational in some form are included in this category.

Table 7: A description of the three categories used to catalogue science items from 31 August 2018 – 31 October 2018

Based on the results tabulated below, the tone of the majority of science items (64%) can be described as factual, informative or neutral; 22% as alarming, concerning or contentious; and 14% as inspirational, hopeful or optimistic.

Two statistics are worthy of analysis - The *Daily Sun* and *The Sowetan* publish the most number of science items categorised as "inspirational', perhaps because of the number of motivational profiles produced that emphasise the success and achievements of entrepreneurs, women and young people, or items described by Petit (1997) as a "mental escape from the daily diet of human disaster".

On the other hand, *Beeld* and *The Saturday Star* publish the most number of "alarming" science items, which can be attributed to the emphasis of these newspapers on tackling science issues related to the contamination of the Vaal River and the conservation of the environment, amongst other aspects.

There are multiple examples of science items across all three categories, as well as the nuances pertaining to the tone of each science item, expounded on in **Appendix A**.

Title	Alarming	Factual	Inspirational	Sum
Beeld	20	39	4	63
Business Day	9	33	8	50
City Press	4	9	2	15
Daily Sun	1	11	11	23
Mail & Guardian	10	18	1	29
Rapport	0	6	1	7
Saturday Star	21	35	7	63
Sunday Independent	1	13	5	19
Sunday Times	3	14	4	21
The Citizen	10	32	3	45
The Sowetan	3	2	10	15
The Star	7	49	3	59
Total science items	**89**	**261**	**59**	**409**
Total percentage	**22%**	**64%**	**14%**	**100%**

Table 8: The representation of the tone embodied in science items in South African newspapers from 1 August 2018 to 31 October 2018

6.1.5 Internal and external actors that influence the publication of science

According to Stromback and Karlsson (2011) various sets of “internal and external actors” shape media content and the news, including journalists and editors; media owners; advertisers; audiences and sources.

6.1.5.1 Producers and suppliers of science news content

Science news content is constructed by science journalists and reporters who cover science, or sourced via newswires, international newspapers or syndicated media[103] sources.

6.1.5.1.1 The top six science journalists

The data reflects that newspapers like *Beeld*, the *Mail & Guardian*, the *Saturday Star* and *Business Day* have journalists dedicated to beats like science and the environment. These journalists produce the most number of original science news items, and science news items based on leads from journals, universities, research institutions and non-governmental organisations. These journalists include Elsabe Brits and Elise Tempelhoff at *Beeld*, Tamar Kahn at *Business Day*, Sipho Kings and Matthew du Plessis at the *Mail & Guardian* and Sheree Bega at the *Saturday Star*.

It is evident from the analysis that these top six journalists consistently cover particular areas of science. For example, Elsabe Brits from *Beeld* covers a range of science items, but also a high proportion of science items related to archaeology, anthropology and the palaeosciences. On the other hand, Tamar Kahn from *Business Day* writes for a business audience and focuses on the impact of science and environmental issues, like the impact of the proposed Integrated Energy Plan on jobs, businesses and the economy.

Elise Tempelhoff, Sipho Kings and Sheree Bega cover environmental news extensively and from the articles that they have published, seem to have an extensive network of sources, both accredited, official sources and unofficial secondary sources, including residents, academics, activists and local and international non-governmental organisations. The latter are regularly quoted on issues related to the Vaal River, and include SANParks[104] representatives who frequently feature in science items related to conservation, and rhino and elephant poaching.

[103] Hybrid media models like *The Conversation* see academics and journalists partner to develop factual news that is accessible to lay publics.

[104] South African Parks, the body responsible for managing South Africa's national parks

6.1.5.1.2 Reporters who cover science

There are also reporters who regularly cover science news stories, although this is not their specific beat. In the three months under review, these reporters included the likes of Shaun Smillie for the Independent Media Limited Group; Claire Keeton, Shanthini Naidoo and Tanya Farber for the *Sunday Times* and freelancer Mandi Smallhorne for her features in *City Press* and *Rapport* all of whom have authored at least three science items during the three month period under review.

6.1.5.1.3 Newswires and international newspapers

A significant number of science news stories, many of which do not have a byline, are sourced from newswires like ANA[105] Reuters[106], AFP[107], AP[108] and Xinhua[109] as well as international news partners like *The Daily Mail* (UK) and *The Washington Post*. These science items are usually fillers that appear as news briefs in newspapers. *The Sowetan* sources many rural success stories from the Government Communications and Information Services[110] newswire and rural community news content generators. Newspapers in the Independent Media news stable carry a number of items from *The Daily Mail UK* and ANA, which covers a number of news items focusing on South African government achievements.

6.1.5.1.4 Syndicated Media

Longer stories and opinion pieces are also lifted from international newspapers and media houses like *The Conversation*[111] that syndicate content, and publish news in partnership with experts and researchers, usually attached to a university or research institution. The *Daily*

[105] Africa News Agency

[106] Reuters is an international news organisation, part of Thomson Reuters with 200 locations around the world

[107] Agence France-Presse is the oldest international news agency headquartered in Paris, France

[108] Associated Press is a US-based news agency founded in 1846

[109] Xinhua News Agency or New China News Agency is an official state-run press agency of the People's Republic of China founded in 1931

[110] Climate change education empowers female farmers, *The Sowetan*, 14 August 2018

[111] *The Conversation Africa* is an independent source of news and views from the academic and research community, delivered directly to the public.

Sun also sources science items from Wikimedia Commons[112] and the NASA[113] press office[114].

6.1.5.2 Organisations that influence the publication of science

There are five distinct organisational types that serve as content originators to the South African newspapers. These organisations provide the news subsidies, leads, media releases, invitations, events and tip-offs to the first line of gatekeepers in newspapers.

6.1.5.2.1 Universities and research institutions

There is a steady supply of science content to newspapers from local research-intensive institutions like the universities of Cape Town, Witwatersrand, Stellenbosch and Pretoria, often through some form of news subsidy like a lead, a media conference or a media release. For example, the University of the Witwatersrand held a media conference on 4 October 2018 to announce the intentional transfer of a piece of liver from an HIV+ mother to her HIV- baby, which was subsequently covered by most daily newspapers[115]. Research items from global universities generally filter through via the international newspapers as newswires described in 6.1.4.1.3 above.

Similarly, organisations involved in scientific research, be they industrial, like the Centre for Industrial and Scientific Research[116] or exploratory in nature like the Square Kilometre Array[117] or NASA[118], generate regular science content for newspapers.

Academic papers published in accredited journals like *The Lancet*[119] and *Nature Communications*[120] are also used as sources of science content. For example, an academic

[112] Musk does it again! *Daily Sun*, 10 October 2018

[113] National Aeronautics and Space Administration based in the United States

[114] Secrets of the sun! *Daily Sun*, 12 September 2018

[115] HIV mother donates part of liver to save child, *Business Day*, 5 October 2018

[116] The Centre for Scientific and Industrial Research is an example of such an institution

[117] SA to search for dark energy, *Beeld*, 23 August 2018

[118] Nasa launches sun probe, *Daily Sun*, 13 August 2018

[119] Not event one drink a day is safe, *Beeld*, 30 August 2018

[120] First farmers ate peas and cheese, *Beeld*, 4 October 2018

article in *The Astrophysical Journal* about the discovery of a strange planet found 20 light years away[121] was the source of a story later published in *Beeld* in August 2018.

6.1.5.2.2 Official government sources and parastatals

Many of the contentious issues in newspapers emanate in the media after the publication of news reports related to proposed legislation like the draft tobacco bill[122], the proposed energy bill[123] and the draft paper on science, technology and innovation[124], often including comment or statements from the respective ministers or state officials[125,126].

During the period under review, many official reports and statements from the National Department of Environmental Affairs[127] and the National Department of Water and Sanitation[128] also served as a source of science content for newspapers.

6.1.5.2.3 Local and international organisations

Climate change is reported widely across the titles under review in this study. With over 24 mentions of the United Nation's Intergovernmental Panel on Climate Change[129] report released in October 2018, it is evident that several newspapers, including the *Saturday Star* which published *Climate change apocalypse*[130], relied on the information contained in this report to write their science news stories. Reports from the World Economic Forum, the National Budget Speech and Statistics South Africa, amongst other data sets and reports, also serve as a source of science content for newspapers.

6.1.5.2.4 Non-governmental organisations (NGOs) and community-based organisations (CBOs)

[121] Strange planet found 20 light years away, *Beeld*, 10 August 2018

[122] Draft Control of Tobacco Products and Electronic Delivery Systems Bill (2018)

[123] Draft Integrated Resource Plan (2018)

[124] Draft White Paper on Science, Technology and Innovation (2018)

[125] Cabinet sees energy plan, *The Citizen*, 22 August 2018

[126] Leave research funds alone, *City Press*, 16 September 2018

[127] Claws out over DEA jumping gun on leopard hunting, *The Saturday Star*, 18 August 2018

[128] Council blamed for sewage spillage into Vaal River, *The Star*, 15 August 2018

[129] The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change

[130] Climate change apocalypse, *Saturday Star*, 13 October 2018

The contamination of the Vaal River was a major story that ran across titles throughout the three month duration of this study. A range of environmental community-based organisations like the Save the Vaal Action Group are quoted regularly across titles and serve as sources of new developments around this issue on a regular basis[131]. Similarly, the *Saturday Star*, *Beeld* and the *Mail & Guardian* use the reports and comments of non-governmental organisations dedicated to conservation like Greenpeace[132], Elephants Without Borders[133] and TRAFFIC[134], as sources of information about pollution and conservation, in addition to tip-offs and information from insiders in the Kruger National Park[135] and the Ezemvelo Wildlife Reserve[136].

6.1.5.2.5 Professional associations

The South African Society of Psychiatrists[137] emerges as an organisation that made a significant impression across newspaper titles during the period under review, through raising awareness around the scientific issues related to the impact of cannabis on individuals. Examples are found in articles titled *What dagga does?*[138] and *Dagga may harm mental health*[139]. There are several other examples of similar organisations that comment in their respective areas of expertise.

6.1.5.2.6 The elite and powerful make the news

In this study, 93% of the science items included elite or powerful social actors, as indicated in the table below[140]. Three of the four Sunday papers and *The Citizen* carried only expert views, generally quoting researchers and scientists, professionals, CEOs, ministers and government officials across the majority of science items.

[131] The Vaal remains up shit creek, *Mail & Guardian*, 24 August 2018

[132] Satellite shows how dirty South Africa's air is, *Beeld*, 30 October 2018

[133] Elephants without borders sees 87 elephant carcasses in Botswana, *Beeld*, 5 September 2018

[134] Harvesting horn hurts not only rhino, *The Star*, 1 October 2018

[135] Long trek to new home, *The Citizen*, 21 August 2018

[136] Genetic hopes flicker for rhino, *The Star*, 25 September 2018

[137] The South African Society for Psychiatrists is an association of mental health professionals specialising in psychiatry

[138] What dagga does? *City Press*, 23 September 2018

[139] Dagga may harm mental health, *The Star*, 27 September 2018

[140] Extracted from Appendix A

The Sowetan and the *Daily Sun* adopted unique approaches through profiling young women, the youth and entrepreneurs in science and engineering. The *Saturday Star, The Star* and *Beeld* quoted activists and civil society representatives frequently, in addition to using official quotes and statements from representatives of government, the corporate sector, professionals and academics.

Title	Yes	No	Sum
Beeld	60	3	63
Business Day	49	1	50
City Press	15	0	15
Daily Sun	17	6	23
Mail & Guardian	28	1	29
Rapport	7	0	7
Saturday Star	60	3	63
Sunday Independent	19	0	19
Sunday Times	17	4	21
The Citizen	45	0	45
The Sowetan	10	5	15
The Star	55	4	59
Total	**382**	**27**	**409**
Percentage	**93%**	**7%**	**100%**

Table 9: The representation of the elite and powerful in science items in South African newspapers from 1 August 2018 to 31 October 2018

6.1.7 Summary of the quantitative research findings

The data demonstrates that science items are found across all titles and in all sections of the newspaper, but that the quantity and depth of science coverage is uneven. Four titles stand out as leaders in science coverage that tackle major science issues over time - *Beeld*, the *Saturday Star*, *Business Day* and the *Mail & Guardian*. They are incidentally the titles that between them have six permanent science journalists (including environmental journalists).

The majority of science items are news articles published in daily newspapers (62%), and are either original science items conceptualised and written by science journalists, or written based on a lead from a news subsidy (media release or event) or a lead from an individual (like an activist or scientist) or an institution (like a university or non-governmental organisation). The elite and powerful, and especially researchers and scientists, feature in the news regularly.

The science themes that receive the most coverage are in descending order: environment and ecology (including pollution, conservation and climate change); health sciences; science

and technology; zoology; astronomy; energy; anthropology and archaeology; engineering sciences; the palaeosciences and food and nutrition sciences, and physics, in joint tenth place.[141] The natural sciences feature the most, particularly on issues related to climate change and conservation, followed closely by coverage in the health sciences which included many science items on non-communicable diseases, tuberculosis and mental health matters. Articles related to science and technology and science promotion are prevalent, as are articles focusing on the new energy bill. Research and world-firsts definitely make the news as well as contentious issues related to conservation, water pollution and South Africa's energy mix.

Most of the science items published in the three months under review can be described as relevant and in the public interest, and are based or related to news or events that take place in, or impact on South Africa.

Science content is generated through science journalists, reporters who cover science regularly, newswires and international newspapers, and syndicated media. Organisations that influence the publication of science[142] include universities and research institutions, government departments, international organisations, professional associations and non-governmental organisations that provide a steady supply of information to newsrooms.

The weekly and weekend newspapers ran the most number of features and exclusive science stories. This study does not focus on how science in represented in the press, although a cursory overview indicates that most of the science items are represented factually, in a neutral tone. Whilst science features throughout the newspaper, there are no visible patterns pertaining to positionality although science news items did make it to the front pages of *Beeld* six times and to the front of the *Business Day* twice. Four newspapers also ran columns by the respective editors on issues related to science.

Badenschier and Wormer (2012), Dick (2014) and Caple and Bednarek (2013) agree that access to good visuals influences the publication of a science item. The data reflects that 66% of science items are accompanied by images.

6.2 Qualitative Analysis

The qualitative data was gathered following interviews with twelve science journalists, communicators and editors. As described in the methodology section, the interviews provide

[141] See 6.1.3 and 6.2.1

[142] See 6.1.5.2

both in-depth insight into how newsrooms function under operational constraints from the perspective of science journalists, editors and communicators, and how decisions are made by various gatekeepers with regards to the selection and assessment of science items for publication. The qualitative data further provides an understanding of the broader environmental context through which the quantitative data can be interpreted. Quantitative data cannot fully explain "journalistic news decisions" (Harcup and O'Neill 2016), making a qualitative component of the research essential.

Following an analysis of the responses from the twelve respondents as recorded in **Appendix C**, the significant findings are condensed and summarised in the following categories: the science themes that feature prominently in the news, the internal and external actors that shape the science news agenda, the values and factors that influence why some science items make the news over others and the perceptions of the respondents related to the role of the media in making science accessible in a developing democracy.

6.2.1 Science themes that feature regularly in the news

In trying to determine "what is included, what is excluded, and why?" (Harcup and O'Neill 2009), respondents provided varied perspectives, when asked about their views on which science themes feature prominently in the press, and why.

The importance of the "the daily lived experience" cannot be overlooked and science that people can relate to is often selected for publication (Farber 2018). Popular science topics which have a "human face or champion" are more likely to be published as "people are more likely to read an article about the impact of sugar on their body rather than read about quantum physics."

Health always makes the news due to the fear factor as "everyone is scared to die or to be ill" (Brits 2018). She adds that stories related to the environment, climate change, water and food security, genetics, astronomy, new discoveries in the palaeosciences and communicable diseases like HIV and TB make the news.

Science items relating to climate change and global warming are important as they are vital for our collective futures (Ritchie 2018), as is the local angle in any science story (Kahn 2018). "Wicked" stories on climate change and water are popular as are stories related rhino or lions (Joseph 2018). She also cites the palaeosciences and new discoveries and innovations in South Africa as science themes likely to be covered.

Dramatic discoveries close to home and stories that give hope are cited by Ritchie (2018) and Anetos (2018) as topics likely to make headlines. People love reading about dinosaurs,

hominids and quirky stories (Smillie 2018) as well as climate change, health, wildlife and human origins (Mouton 2018). The public are interested in their origins because “it speaks to people’s fascination with their past and where they come from” (Berger 2019).

Health, environmental news and human development articles related to the social sciences especially those that include statistics like the census, are also good sources of news according to Inglis (2018) and Gower (2019).

Topics that do not become news are those related to internal institutional achievements; staged media events; a launch of a launch; institutional appointments and claiming an international discovery as a South African achievement because there was one South African on the team” (Wild 2018).

6.2.2 The news values and factors that influence how science makes the news

The “social construction of news” and the “constraints imposed by organisations” are two factors that influence the publication of news (Schudson 1989). The availability of resources and time, the environment in which they work, the “social, educational, ideological and cultural influences on journalists”, their level within the organisation and the audiences that they serve, are all factors that influence how journalists select news (Harcup and O’Neill 2017).

Other factors that influence the publication of news include commercialisation, resources, audiences, news subsidies, sources and production processes according to Stromback *et al* (2012), a view put forward by Weaver *et al* (2007) who describe news values as a “reflection of organisational, sociological and cultural norms combined with economic factors”.

Studying news values is “one of the most important areas of journalism studies” (Harcup and O’Neill 2009) and “who selects the news for whom, in what medium and by what means (and available resources) is as important as the news values of a particular story” (Harcup and O’Neill 2017).

Hall (1973) describes news values and the “news sense” of journalists as “opaque” and difficult to explain, a perspective augmented by Tuchman (1972) who defines news judgment as “sacred knowledge” and the factor that distinguishes newspaper reporters and editors from others. They bemoan this innate selection capacity of journalists which while valuable, selects only a fraction of news for publication. A list of 14 news values was presented to the twelve respondents, to determine which values they felt were vital in influencing the publication of science news. Some of the key findings are reflected below.

6.2.2.1 Factors that make some science items more worthy of publication than others

Science news items that are exclusive, breaking news, world-firsts or focused on contentious issues that impact on the "lived experiences" and lives of people, are more likely to be published than other news items, according to the majority of respondents in this study. Two journalists disagree – Brits (2018) argues the science should not be exclusive and that the more people who have access to the knowledge or research, the more it will benefit society. Joseph (2018) feels that science should be properly researched rather than be subject to the daily news cycle hype.

Access to credible, authoritative sources, and stories involving scientists, researchers or experts have a higher chance of being selected for publication than a factual, neutral science story. All journalists and editors agree that science news items that are in the public interest, relevant to audiences and in close proximity to readers, are worth considering for publication. The magnitude of the science items also determines if it is likely for such news to be selected for publication.

This is in contrast to the views of science communicator Inglis (2018), who feels that editors act according to a national developmental agenda.

There is some dissonance around stories that include an element of surprise or entertainment, dramatic stories and stories involving the celebrities.

Good visual material is seen as a key news value that greatly increases the chances of science items being published.

According to Farber (2018), the key practical factors that influence the publication of science news are the news values in terms of the daily lived experience, the ability of the public relations practitioner to sell the angle of the story and the value of some science disciplines above others. "For example, research on sugar and lifestyle and diet and its effect on the body will be more interesting to people than quantum physics. People like science they can relate to, imagine in the physical world, and that which affects their lives."

Ritchie (2018) concurs: "Science, if handled well, can provide incredible content for newspapers. In the case of *The Star* we only have to think about *Homo naledi* and before that Little Foot. The problem starts with resources, pulling someone off the general news diary of crime, council, courts and breaking stories to spend time with researchers and then negotiating for enough space to do justice to the story. You also have to find a reporter who really wants to do the story, not everyone is interested in the subject or, if they are, have the

writing skills to match their passion. The newspaper's job is to make the science accessible, relevant and, quite frankly, fascinating for the reader."

6.2.2.2 Resource, time and space constraints

Newsrooms in South Africa are facing tremendous constraints (*State of the Newsroom Report 2017: Fakers and Makers*), with journalists and editors under significant pressure to publish more content in real time across platforms. Due to resource constraints (Muchendu 2005), there is a real risk that new, important scientific research may be ignored and that society may remain in the dark regarding innovative scientific developments (Badenschier and Wormer 2012).

Time, space constraints and resources are the dominant factors that influence the selection of news for publication (Mouton 2018). This view is supported by the majority of the respondents as some of the critical factors that determine whether a story is covered or not. When making a decision as to whether to carry a science story, a news editor would ask the following four questions: "Do we have time to turn the story around? Do we have space to carry the story? Do we have someone in the newsroom to actually do the story? Are there any other more important stories on which we should be focussing?" (Mouton 2018).

Time constraints

In print, limited space and format constraints mean that news selection is increasingly more important (Shoemaker and Vos 2009). The age of "fast news" has also beset most newsrooms, with desk-bound journalists "editing press releases and wire stories" to feed the 24 hour news cycle (Wild 2018).

Space constraints

Journalists often complain of sub-editors interfering in their work, strapping incorrect headlines across their stories, introducing inaccuracies, supplementing their work with irrelevant images and reducing important stories to newsbytes. Smillie (2018) explains that print sub-editors often cut stories without consultation which sometimes leads to inaccuracies. He cites an example where an article that he wrote on hominids is accompanied by a headline that speaks of an "ape man", an archaic term that is scientifically inaccurate and no longer in use.

Resource constraints

Budgetary constraints, the lack of resources for travel purposes and the juniorisation of newsrooms impacts on what news is actually published (Smillie 2018). The juniorisation of

newsrooms and continuous retrenchments result in inexperienced journalists being dispatched to cover complex stories (Farber 2018). She further laments that these journalists often do not understand the research and do not have the ability to make technical information accessible to lay publics without dumbing it down.

No science desks or science beats

Due to resource constraints, journalists nowadays write across beats and platforms, which means that they are never experts in a particular area.

There is increasing pressure on journalists to cover a wider variety of news, without the luxury of "having science as a dedicated news beat" (Mouton 2018). Journalists often have to be taken off other beats to follow science stories, in which they may not even have an interest or understanding (Ritchie 2018).

Whilst the majority of the respondents see the value in beat reporting, most agree that beat reporting is almost non-existent. Wild (2018) says that she was retrenched as a science reporter because she was a "nice to have". The drastic changes in newsrooms have occurred over the last decade or so (Mouton 2018). "Ten years ago we sometimes had two reporters for one beat, as well as night shift reporters, now there are no specialists left".

There are no science desks left at newspapers in South Africa, and very few permanent full-time science journalists[143]. Whilst there are still dedicated science and environmental reporters at newspapers like *Beeld*, *Business Day,* the *Saturday Star* and the *Mail & Guardian* and reporters who cover science regularly in newspapers even if it is not there specific beat, many science news items are now sourced from international newspapers and newswires[144].

6.2.2.3 Science news is sacrificed at the expense of hard news

Claassen (2011) states that science news is often relegated at the expense of other genres, evidence which is provided through both the quantitative and qualitative analysis of this study. All twelve respondents agree that science is often sacrificed at the expense of hard news. Science is often seen as "soft news" which science journalists have to dress up to sell to news editors (Farber 2018).

[143] South African Science Journalists' Association (2018)

[144] See 6.1.5.1

South African science often makes international front page headlines but the same does not happen within South Africa's borders (Brits 2018). She further claims that science news rarely makes it to the front pages of the newspaper, aside from new palaeontological discoveries or stories related to astronomy (discovery research).

Brits (2018) elaborates: "I have seen instances where South African science news has made front page news overseas, but not here, to my extreme frustration. Our own stories are not deemed newsworthy enough but foreign countries realise the potential. We would rather put sport, politics and violence on page 1. Science news rarely makes it to page1, unless it is negative news, and possibly when sex is involved. The majority of stories I could manage to get onto the front page were palaeontology from Wits, which I felt was taken for granted and news editors and editors still did not grasp the true uniqueness of our palaeontological landscape, and then stories about the SKA and MeerKAT. South Africa, in general, has not released the power of science and technology, which is a tragedy."

Science communicator Robert Inglis (2018) concurs that the best way to share a South African science news story is to distribute it via an international newswire, from which the South African media then pick it up.

Journalists have to champion science in the newsroom in order to fight for an upfront position in the newspaper (Ritchie 2018). The "fear of science" by news editors is one of the main reasons as to why science news is often dropped or slashed (Smillie 2018).

Berger (2018) indicates that his experience has been different, as he has had his discoveries published on the front pages of newspapers in South Africa and abroad. However, he qualifies that this may be the exception rather than the norm for print media. Berger's visibility (Joubert and Guenther 2017) and credibility also increases the news value of articles in which he may feature.

6.2.2.4 Dissonance between professional news values and news that is published

There is a fundamental distinction between how news is sourced, assessed, selected and published on the one hand and what journalists believe is newsworthy and how it should ideally be published on the other.

Newsworthiness is only one factor that determines how prominently a story will be covered (Shoemaker 2006). With Cohen (2006), she makes a distinction between "news and news selection" – news that is socially constructed and actually published (a commodity) versus the "criteria of news values and newsworthiness" – the subjective, cognitive mental

judgments made by journalists when selecting news (Donsbach 2004, Caple and Badnarek 2013, Shoemaker 2006). This is an important distinction as Shoemaker and Cohen (2006) found in a global study where “a disconnection between what people think is newsworthy and how prominently newspapers display the stories” is observed. Lichter *et al* (1986) profess that news in the United States is of a liberal nature as the journalists at elite media houses who write the news reports themselves hail from liberal backgrounds, an opinion discounted by Robinson and Sheehan (1983), Gans (1979) and some of the respondents in this study.

Just over half of the science journalists and editors interviewed in this study agree that there is a disconnection between their professional news values and the news that is ultimately published. In one instance a journalist felt pressured to find a human interest angle or a celebrity when the “science on its own is delicious enough”. Three of the respondents indicate that the culture of the newsroom also influences what stories make the news.

Mouton (2018) explains his experience at *Beeld* as one where there was dissonance between the values of the reporter and that of the audience. “While the staff were more liberally inclined, they wrote for a more conservative audience and fed the audience what they thought they wanted to read”. At *The Times,* stories are “sexed up”, especially the front page “splash”, which resulted in internal ambiguity, as he feels strongly that stories do not need to be dramatised.

6.2.3 Understanding the internal and external actors that influence the publication of science news

The “social realities that can be observed at the point of news production” (Schudson 2009) or the juncture at which journalistic values and professional values intersect with the demands of audiences, advertisers, journalists, editors, news generators and cultural traditions is important to study in order to better understand how science becomes news.

6.2.3.1 Setting the science news agenda

In a world in which “science is vulnerable to abuse and distortion, particularly for political purposes” (Kizer 2017) it is important to understand how the science news agenda is set and to determine what or who tells the public what to think about (Cohen 1963). Whilst Lippmann (1922) advances that the news media are responsible for the “pictures in our heads”, the influence of the news media on the public agenda is probably best demonstrated by McCombs and Shaw (1972), who found that “in choosing and displaying news, editors, newsroom staff, and broadcasters play an important part in shaping political reality”.

The highly competitive, fast-paced news environment sees the science news agenda influenced by three sets of actors according to Farber (2018). She lists these as scientists and science communication departments at universities and research institutions, news editors who can "quickly spot a news angle" and journalists who can distill news from technical scientific journal papers or press releases.

The science news agenda is predominantly driven by research institutions and universities, either by the scientists themselves or through science communicators (Mouton 2018). He adds that whilst journalists may believe that they drive the science news agenda "this is far from the truth".

The South African media is largely reactive and lacks investigative journalism, especially into science (Kahn 2018), a view lamented by Wild, Brits, Farber and Mouton (2018) who agree that very few science story ideas actually originate from journalists themselves. According to Joseph (2018), there is not much of a science culture in South Africa and science is often not interrogated or researched as "it is merely seen as a filler for the paper". She adds that the only science that really makes the news are "big discoveries, medical breakthroughs, and quirky stories with catchy headlines".

South Africa is not a science literate country (Wild 2018) and politics, crime, corruption, sport and celebrities dominate the front pages of news, which often displaces science to the middle pages of newspapers (Anetos 2018)[145], a view long-held by Claassen (2011).

Inglis (2018) adopts the view of Gieber (1964) that news editors make decisions based on their institutional priorities, a view supported by Wild (2018) that the science news agenda is largely shaped by what news editors like to read.

6.2.3.2 Journalists and news editors as gatekeepers

Schudson (1989) decries "journalists' professed autonomy", a view advanced by Stromback and Karlsson (2011) who found that journalists still considered themselves to be "driving news production".

The "degree of autonomy" given to a journalist, the organisation's values, the organisation within which the journalist works and the type of journalism practiced determines how much "editorial capital" a journalist holds (Schultz 2007).

Whilst the first theory relating to gatekeeping was developed by Kurt Lewin (1947), it was applied by White (1950) and Gieber (1964) to journalism. White's study found that journalists

[145] Pericles Anetos, response to questionnaire, November 2018

were “highly subjective” and that news selection occurred based on their “experiences, attitudes and expectations”. On the other hand Gieber (1964) observed that “the goals of production, bureaucratic routine and interpersonal relations within the newsroom” influence how news is selected. The theories of White (1950) and Gieber (1964) as described in Schudson (1989) apply today, with an emphasis that news items are “not simply selected but constructed” by various gatekeepers.

The results of the qualitative research indicate that it is a combination of both the subjective experience of the journalists and editors and the newsroom operations that influence the selection of news.

Three of the twelve respondents say that they base their news selection on their “journalistic experience”, whilst four respondents believe that they have an inherent understanding of what constitutes news based on their experience and expertise. Three others indicate that it comes down to the impact on people and whether the issues are in the public interest. Mouton (2018) says that before pursuing a story he always asks why anyone should care, a view supported by Wild (2018) who believes that a story that has the “so what” factor is more likely to be pursued.

The first line of gatekeeping is the science journalist who makes a decision depending on the pitch made by science communicators or scientists, assesses whether the story is accessible and then tries to convince the news editor, the second gatekeeper, that the story is worthy of publication (Farber 2018).

The majority of science journalists and editors interviewed agree that the news editor is the most important gatekeeper who influences what science or news is eventually published (Mouton 2018). After the morning news conference, the news editor decides which stories will be covered for the day, compiles the news diary and presents it to the senior editorial team (third gatekeeper). News editors are gatekeepers and “without their buy-in, a story won’t get published” (Wild 2018), as news editors are the “final arbiters” and decision-makers (Anetos 2018).

If the story is not in the diary, it will not make it to the paper the next day and if the news editor deems it unimportant, the story is scrapped, delayed or held off for the weekend papers (Mouton 2018). The news editor also decides which stories are lead stories, and which are secondary or shorter stories. The final copy is usually revised by the sub-editor, who serves as the fourth gatekeeper.

There are mixed views from the respondents about the levels of influence that journalists have in newsrooms. The culture of the newsroom, subscription to hierarchical models and

the seniority and experience of journalists are some of the factors that speak to the levels of influence that journalists have in persuading editors one way or another (Anetos 2018).

Smillie (2018) elaborates: “A big decider for me is if the story is local. Publications are more likely to use wire copy, which is often cheaper than paying a freelancer. As a freelancer I need to find a news outlet that will go for the story. A lot also depends on the news editor or editor I am pitching too. The story does have to be relevant to the readership of the publication and provide a good narrative. It also comes down to how easy I can explain the science to the readers.”

All science journalists and editors interviewed believe that they have a fair amount of autonomy over what they write provided that they pitch their stories well and that they are prepared for sub-editors to change the content and headlines at times. Whilst Wild (2018) feels that she had complete autonomy, Brits (2018) says that she feels that her autonomy was somewhat reduced over time. In the writing and content compilation of the story, journalists are mostly autonomous, although the news editor will prescribe general parameters within which to work (Mouton 2018).

Editors who are interested in the importance of science declare that they “push science stories” through, including Joseph (2018) and Ritchie (2018).

6.2.3.3 Sources

The influence of sources

The power of sources that feed information to newspapers is lamented by Schudson (2003) although Molotch and Lester (1974) state that newspapers reflect “the practices of those who have the power to determine the experiences of others”. These are views furthered by Stromback and Karlsson (2011) who submit that various sets of “internal and external actors” shape media content and the news, including sources. The duo add that not all sources are equal, especially in relation to experts and commentators who express their views on scientific issues. Stromback *et al* (2012) warn against professional source organisations and powerful and elite scientists and scientific publications. So, too, does FitzPatrick (1999) who encourages both scientists and science journalists to “re-evaluate the criteria they use to judge the newsworthiness of science stories”.

In *News and News Sources: A Critical Introduction* (2001), Manning proffers a framework for understanding the relationship between journalists and sources in the newsroom in liberal democratic societies. He advances that the power of governments, corporates, advertisers,

audiences and the elite in society must be scrutinised as these powerful social actors have the ability to “set agendas” and “control information”.

A study by Fishman (1980) found that “the world is bureaucratically oriented for journalists” as government officials “provide a reliable and steady source of news”. In addition Tuchman (1978) describes that “sources” and networks are valuable assets of journalists. The nuances of a particular story and how it is represented also impacts on the influence of the story (Hallin 1986).

The credibility of sources

Government officials, powerful individuals, the societal elite and corporate leaders are newsworthy “accredited” sources who provide a steady flow of news that feeds the hungry news cycle (Hall *et al* 1978). These influential people and the institutions that they represent are known as authoritative “primary definers” of the news (Fishman 1980). However, there is an increasing number of secondary or unofficial sources like activists and community-based organisations that can become primary sources of information over time, as determined by Muchendu (2005) in a study of sources related to the HIV/AIDS pandemic in South Africa. This is a view strongly advocated by Corner and Schlesinger (1991) who argues that secondary and unofficial sources can be influential.

People are more interested in science if they believe in the press and if they trust sources and experts being cited (Takahashi and Tandoc 2016). Yeo et al (2018) demonstrate this phenomenon in a study focusing on the documentary *An Inconvenient Truth* in which they demonstrate the use of people in authority, in this case, US politician Al Gore, who encouraged people to better engage with the information related to climate change that was presented in the programme.

The “experts” including academics, researchers and scientists, are often pronounced as “disinterested, objective and authoritative” (Hall *et al* 1978) and are given precedence by the news media over secondary sources in what Ward (1995) describes as a phenomenon in which “news privileges the privileged”.

Knowledge experts, trusted contacts, co-authors and experts with different views are often used as sources but time constraints often result in journalists calling on credible sources that are trustworthy (Brits 2018). Sources must be knowledge experts, high ranking officials with authority or senior academics that can be trusted (Wild 2018).

Wild (2018) adds: “I want them to be an expert, to be able to comment authoritatively. It helps if they are senior academics or officials. I wouldn’t, for example, quote a postgraduate

researcher. For particularly controversial stories, trust also plays a large role. I would go to sources who I've spoken to a number of times and with whom I have a working relationship. I consider source relationships to be a fundamental part of science journalist (especially in such a country with a relatively small science system), and this also influences my source selection."

Access to sources

In this study, access to sources in real time is described as crucial by Ritchie (2018) and Smillie (2018) as well as those who can easily explain how their research makes a difference in the world (Kahn 2018). These views are supported by the majority of respondents, some of whom suggest that access to sources may be the deciding factor as to whether a story is pursued. Scientists also often do not understand how news cycles and deadlines work (Farber 2018).

Sources that provide news subsidies

Sources that provide "news subsidies" or measures that make it convenient for news organisations to cover the news should be treated with caution (Kiernan 2006). "News subsidies" are described as "any measures taken by source organisations to make it convenient for news organisations to cover the news" (Brighton and Foy 2007). These include professional sources like news events, media releases, media conferences and public relations material.

The provision of "information subsidies" is one way in which official sources gain status (Gandy 1982). In an analysis of how the press reported on HIV/AIDS in South Africa, Shepperson (2000) found that most reports were based on leads and news subsidies and that "there were very few journalists who conceived their own stories based on primary information".

All but one respondent in this study believed that news subsidies made their jobs easier. The majority of the respondents viewed media releases and media conferences as a means to alert them to a story, as aids to assist them in writing an article, and as material to supplement a story. This is correlated in the results of the quantitative study.

Most of the respondents said that they preferred exclusive leads as opposed to media releases, with one exception by (Brits 2018) who declares that it is important to distinguish between media releases from public relations agencies and those from universities and research organisations.

6.2.3.4 Scientists and science communicators as content generators

Schudson (1978) describes public relations as an industry that developed after the First World War as an intercessor between the public and private sectors on the one hand and the media on the other, with practitioners understanding how to create content that can pass gatekeepers in media organisations. According to Muchendu (2005), institutions are also "investing in media training" for employees.

The majority of the science journalists and editors interviewed describe their relationships with scientists and science communicators as "professional" and see them as valuable sources of information, as knowledgeable experts and "enablers" who try to make science accessible to the publics.

Science communicators or public information officers usually pass on a tip or story, which if deemed newsworthy, is then pursued (Farber 2018, Wild 2018). Farber (2018) provides the following advice to science communicators: "Science communicators can do the following to better their chances of getting science into newspapers- offer exclusives instead of sending out a blanket press release to all and sundry, include a visual where you can so journalists can picture the story in its published form, offer academics in-house training on how to explain their research in a compelling and accessible way and offer exclusive follow-ups to those who you believe are doing a good job at reporting on the research at your institution."

Having worked both as journalists and science communicators, Gower (2019) and Mouton (2018) are confident that science communicators are gradually influencing decision-making in newspapers. Due to resource constraints and no dedicated science reporters, journalists and news editors are increasingly sourcing stories from newswires, research institutions, universities, and non-governmental organisations according to Gower (2019).

Berger (2019) concurs that the more a public information officer offers to a media house upfront, the more likely it is that the story will be covered. He adds that newspapers need new information in accessible formats that appeal to journalists, news editors and audiences, like "brilliant images, infographics and for online and broadcast media, excellent video material". He decries that journalists and news editors often do not understand the scientific processes like peer review and embargoes, which sometimes results in tension, a sentiment also shared by Brits (2018).

Bureaucracies cater for the media by "providing a reliable and steady supply of the raw materials for news production" Schudson (2003). Journalists sometimes tweak press releases and use it with "minor alterations" and an additional quote or two from an expert, which is not best practice (Gower 2019). For example, a science news release issued by

Stellenbosch University was used verbatim by a media house in February 2019[146], which resulted in the South African Science Journalists' Association seeking to raise this matter with the editors of the newspaper.

6.2.3.5 Advertisers and audiences

Advertisers and audiences sway what makes the news, especially for the commercial media, as journalists have to continuously consider how to cultivate audiences that advertisers want to reach (Stromback *et al* 2012; Caple and Bednarek 2015). A recent study by Cornia *et al* (2018) exposes "a new norm" that sees the integration of commercial and editorial activities in major media houses as a win-win situation - to better serve audiences and to keep media houses profitable. This advances the longstanding view of Hamilton (2004) that "profit triumphs over the importance of news". This is contrary to earlier studies by Gans (1979) who found that journalists did not know or care much about their audiences.

However, contrary to the majority view stated above, three quarters of the respondents in this study indicate that advertising does not directly impact on news selection, with most respondents indicating that they have no contact with the advertising departments at their newspapers. All stories have to be relevant to the newspaper's audience (Ritchie 2018) but also to the "journalist, news editor and publication editor" (Smillie 2018).

6.2.4 The role of the media in creating a science-literate society

6.2.4.1 Providing quality science information based on facts

The media have an important role to play in developing an informed public (Dahlgren 2009 and Gumede 2014), a function that is becoming increasingly imperative in a young democracy like South Africa where science is expected to play a crucial role in inclusive development through science engagement[147]. This is in a broader global context where open societies are progressing towards open access science and knowledge sharing[148].

In this study, all twelve respondents to the questionnaire share the view that the media have a role to play in keeping the public informed and educated. "Every bit of knowledge can play a role in making [South Africa] a better country" (Farber 2018)[149]. In an era of "fake news" an

[146] Your health may be at risk from your daily shower, *Times Live*, 13 February 2019

[147] Draft White Paper on Science, Technology and Innovation (2018)

[148] Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003)

[149] Tanya Farber, response to questionnaire, South Africa, October 2018

uninformed public is susceptible (Smillie 2018)[150] and there is thus a need to share quality information based on facts at a time when news is "diluted, dumbed down, and riddled with unsubstantiated claims" (Brits 2018)[151].

6.2.4.2 Making science accessible to the public

Scientists, science journalists and science communicators are all responsible for making science accessible to multiple publics according to Berger (2019)[152], a highly visible scientist in South Africa (Joubert and Guenther 2016) who is increasingly publishing in open access journals, and allowing diverse multidisciplinary teams from around the world to participate in science in real time.

Mouton (2018)[153] concurs that science is in the public interest and must be shared, particularly around issues related to public health, the environment, climate change and social justice because it informs our past and in the case of climate change and global warming points out the way for our future (Ritchie 2018)[154]. However, science journalists in particular have a critical role to play in making science accessible and serving as a conduit or transmitter of science between scientists and the public, as science journals are often inaccessible to the lay person (Smillie 2018).

6.2.4.3 Sharing quality science news to inform, educate and empower citizens

All twelve respondents agree that the media have a fundamental role to play in empowering citizens in a developing democracy. Scientific knowledge and literacy allows people to make informed decisions about their lives and bodies so that they are not susceptible to the rhetoric of "politicians and populists" (Wild 2018)[155] in a world in which fact and science are becoming increasingly threatened by rhetoric and bluster (Joseph 2018)[156]. This is important as science creates an environment in which empirical evidence and data become highly valued over opinions disguised as news (Farber 2018).

[150] Shaun Smillie, response to questionnaire, South Africa, November 2018

[151] Elsabe Brits, response to questionnaire, South Africa, October 2018

[152] Professor Lee Berger, personal communication, South Africa, January 2019

[153] Schalk Mouton, response to questionnaire, South Africa, December 2018

[154] Kevin Ritchie, response to questionnaire, South Africa, November 2018

[155] Sarah Wild, response to questionnaire, South Africa, November 2018

[156] Natasha Joseph, response to questionnaire, South Africa, October 2018

Media representatives are well-placed to raise awareness and to keep the public informed through public debate and engagement, including connecting academia to the public and private sectors, civil society and private citizens and other social actors (Inglis 2018)[157], all important tenets of the draft White Paper on Science, Technology and Innovation released for public comment in 2018.

6.2.4.4 Holding scientists and research institutions to account

Science should be transparent and scientists should be held accountable because the majority of scientists work for publicly funded institutions and should account for how taxpayers' money is utilised (Kahn 2018,[158] Gower 2019)[159]. The media must challenge narratives, advance critical questioning around science and review the impact of science, research and new knowledge in society (Inglis 2018). Whilst Berger (2019) agrees with these sentiments, he states that journalists and news editors often do not understand scientific processes, embargoes, peer review processes and the incremental process of inquiry, a sentiment shared by Brits (2018).

7. Discussion

The aim of this study was to determine which key news values and factors impact on how science is selected for publication and what this means in terms of the newsworthiness of science reporting in the South African press. It further sought to establish the science themes that were frequently published in the news, and particularly to determine as a response to O'Neill and Harcup's (2009) questions, what science items were included, what were excluded and why. The role of the media in making science accessible in a developing democracy also formed a critical component of the study.

Drawing on Schudson's (2003) theories related to the sociology of news production and the "social realities" at the point of news production (Schudson 2009), this study examined the intersection of news values and the factors that impact on publication, with the demands of various internal and external actors, and the influence of key stakeholders, including sources and gatekeepers, in determining how science makes the news.

A systematic quantitative analysis of the South African English and Afrikaans daily, weekly and weekend newspapers over a three month period provided insight into what science was

[157] Robert Inglis, personal communication, South Africa, October 2018

[158] Tamar Kahn, response to questionnaire, South Africa, October 2018

[159] Prim Gower, personal communication, South Africa, January 2019

published in the news and what was excluded, and identified the important news values that made some science items worthy of publication[160].

However, a study of news values only provides a partial understanding of what influences journalistic decisions in newsrooms (Harcup and O'Neill 2016), and it was therefore prudent to garner the perceptions of science journalists, science communicators and news editors in order to better understand which news values influence the publication of science in newspapers and how decisions in the newsrooms are made[161].

Following an analysis of the quantitative and qualitative data[162], the following important determinations were made that serve as a response to the initial questions posed in this study.

7.1 Science themes that make the news

The quantitative research[163] clearly demonstrates that the following science themes receive the most coverage in the South African press: environment and ecology; health sciences; science and technology; zoology; astronomy; energy; anthropology and archaeology; engineering sciences; the palaeosciences and food and nutrition sciences, and physics, in joint tenth place.[164] Research, exclusives, breaking news and world-firsts definitely make the news[165] as well as contentious issues or matters that include some form of drama[166].

The selection of these themes is supported by the feedback obtained through the qualitative research[167] which explains that the science themes that are selected are based on what people relate to and what audiences deem to be important. For example, Farber (2018) indicates that audiences want science news that impacts on their "daily lived experience", whilst Brits (2018) makes a case for the importance of publishing more about the health sciences. This could explain why there are more articles published on the pollution of the

[160] See 6.1 and Appendix A

[161] See 6.2 and Appendix B

[162] See section 7

[163] See 6.1

[164] See 6.1.3

[165] See 6.1.4

[166] See 6.1.4

[167] See 6.2.1

Vaal River, which impacts on multiple communities, and why there are a large number of articles focusing on diseases of lifestyle.

Climate change and global warming are considered important themes because of the importance of our survival in the future (Ritchie 2018), and issues which speak to the impact on people and which feature regularly in the media.

Three key observations are important in this discussion.

First, there are a limited number of science items focusing on HIV/AIDS and malaria across newspaper titles, although non-communicable diseases feature readily[168]. The only communicable disease to receive attention is tuberculosis, with much of the coverage in this field driven by the Minister of Health, Dr Aaron Motsoaledi, who is also the head of the StopTB! Global Initiative.[169] Science items on non-communicable diseases including cancer and cardiovascular diseases are predominant and tie in to many science items related to nutrition, exercise science and diseases of lifestyle. Reproductive health also receives significant attention.

Second, the release of draft legislation by government on tobacco, energy and science and technology, generated a significant number of science items. For example, the *Business Day* published eight science items on energy as the proposed legislation was made available for public comment. Similarly, there was a flurry of articles following the ruling by the Constitutional Court, allowing for the private use of cannabis by individuals in South Africa. Whilst the coverage did not include a substantial number of science items, it did generate several opinion pieces from the South African Society for Psychiatrists warning against the potential mental health effects of continuous cannabis use[170].

An analysis of the coverage of science in *The Sowetan* and *The Daily Sun* brought to the fore two interesting trends. The first was a focus on engineering and the inclusion of a high number of science items on astronomy lifted from international news wires. Both newspapers also featured a number of profile stories of young people, women and entrepreneurs in particular who were successful in their respective scientific fields. Many young female farmers are profiled as well as new trends in agricultural science.

[168] See 6.1.3

[169] The StopTB! Global Initiative seeks to end TB in some countries in the world by 2030

[170] Dagga may impact on mental health, *The Star*, 27 September 2018

Finally, there are a large number of health matters pertaining to mental health and the effects of the proposed tobacco legislation which surfaced during the period of this study. These items are not included as they did not include a strong science angle.[171]

7.2 News values and factors that impact on the publication of science

It is essential to study news values because it "goes to the heart of what is included, what is excluded, and why" some news is given precedence over others and it also "makes news selection more transparent" (O'Neill and Harcup 2009).

The majority of respondents (80%) agree that science news items that are exclusive, breaking news, world-firsts or focused on contentious issues that impact on the "lived experiences" and lives of people, are more likely to be published. Two journalists disagree – Brits (2018) and Joseph (2018) believe that science should be democratic, and therefore not exclusive, and should not succumb to the news cycle hype. The data shows that 45% of science items published could be deemed as exclusive.

Science news items of great magnitude, which are in the public interest, relevant to audiences and in close proximity to readers, also have a better chance of being selected for publication. Over half (51%) of the science items analysed, pertain to news or events emanating from, related to or impacting on South Africans[172] and a further 12% including both South African and global mentions. Proximity is therefore an important news value that impacts on news selection.

Access to credible, authoritative sources are seen by the majority of respondents as a "deal-breaker" and a strong determinant that influences news publication.

Good visual material is seen as a key news value that greatly increases the chances of science items being published. The quantitative data reflects that 66% of science items are accompanied by images, with more images and graphics featuring in weekend and weekly newspapers than daily newspapers[173].

Whilst this study does not focus on how science in represented in the press, a cursory overview indicates that the majority of the science items (64%) are represented factually, in a neutral tone.

[171] See 6.1.3

[172] See 6.1.4

[173] See 6.1.4

There are mixed views as to whether quirky stories, dramatic articles or entertaining science items involving celebrities is newsworthy.

Two factors are worthy of greater discussion.

7.2.1 Prominence

The general perception that science items do not usually make it to the front pages of newspapers remains true, as is evidenced in this study. However, science news items did make it to the front pages of *Beeld* six times and to the front of the *Business Day* twice whilst this study was undertaken. Four newspapers also ran columns by the respective editors on issues related to science[174].

7.2.2 Resource, time and space constraints

Resource, time and space constraints are recurring issues of concern that were particularly expressed by journalists and editors in this study.[175] Journalists have to produce more stories in real time and have multiple deadlines to meet in one day (Mouton 2018)[176]. The print format brings with it its own space constraints, resulting in the rigorous editing of stories by sub-editors that sometimes change the meaning of stories (Smillie 2018)[177] or shift the "soft science stories" to the middle pages of newspapers (Farber 2018)[178].

The juniorisation of newsrooms is brought up repeatedly as a major problem that impacts on the quality of the science journalism (Farber 2018). Junior journalists often do not understand specialist research and cannot make technical information accessible to lay publics.

There are no science desks left at newspapers in South Africa. According to Mouton (2018) and Wild (2018), science journalists are no longer valued and there are no longer any specialists left in the field. A concerning observation is that three of the respondents in this study, two of whom are renowned top science journalists in South Africa, were retrenched or left their permanent jobs in 2018.

[174] See 6.1.4

[175] See 6.2.2.2

[176] Schalk Mouton, response to questionnaire, December 2018

[177] Shaun Smillie, response to questionnaire, November 2018

[178] Tanya Farber, response to questionnaire, October 2018

7.3 Internal and external actors that influence the publication of science news

"Various internal and external actors shape media content and the news, including journalists and editors; media owners; advertisers; audiences and sources" (Stromback and Karlsson 2011). Based on the research undertaken in this study, the following observations are worthy of discussion.

7.3.1 Beat journalists influence the publication of science news

This study demonstrates that beat journalists dedicated to science, influence the number of original science news items published in newspapers. These journalists also track and cover pertinent science issues over time.

There is a direct correlation between the number of permanent, dedicated science journalists employed by newspapers and the number of science items that are published in South African newspapers. The two newspapers that published the most number of science items[179], namely *Beeld* and *The Saturday Star*, both have dedicated science journalists who write extensively across a range of science matters. These newspapers also carried science news reports on their front pages[180] and in their editorial columns[181].

The six science journalists[182] who write the most number of original science news items are beat journalists who hail from four newspapers – *Beeld*, the *Saturday Star*, the *Mail & Guardian* and *Business Day.* These journalists either produce their own original science articles, or write stories based on leads from science journals, universities, scientists and researchers, official sources and non-governmental organisations[183].

This group of journalists also pursue critical science issues over time. For example, the pollution of the Vaal River was covered substantially in all four newspapers over a three month period, until the matter was resolved, as were issues related to conservation, energy and climate change[184].

[179] See 6.1.3

[180] Nowadays we are scared of the Vaal, *Beeld*, 17 October 2018

[181] Vaal River problems feels bigger, Tito, *Beeld*, 26 October 2018

[182] See 6.1.5

[183] See 6.1.5

[184] See 6.1.3

7.3.2 Reporters value open science, but exclusives are coveted

Reporters who regularly pen science feature articles, who sometimes freelance, but who are not solely dedicated to writing about science, tend to have their work published in weekly and weekend newspapers[185]. The weekly and weekend newspapers ran the most number of features and exclusive science stories during the period under review[186].

There is stiff competition to secure exclusive news items. The majority of respondents in this study agreed that providing journalists with exclusive science news increased the chances of publication of the science news item[187].

This is juxtaposed against the views of the same respondents, the majority of whom believe that the media have an important role to play in fostering a science-literate, informed society, through democratising science and making science accessible to multiple publics[188]. The exception was made by Brits (2018)[189] who argues that science should not be exclusive to a particular audience.

The above provides an example of the dissonance experienced by journalists who believe in an ideal, but who often have to succumb to the practical realities of the newsroom. Other examples include journalists who are forced to dramatise science in order to sell it to news editors, or to write for conservative audiences, even though they may have liberal leanings. There are mixed views amongst journalists as to their perceived level of autonomy in newsrooms and their levels of influence, which are often curbed by newsroom culture and constraints, hierarchies and other practical factors.

7.3.3 Tension between scientists, science communicators and journalists remain

There are three sets of internal and external actors that influence the publication of science in South African newspapers - scientists and science communicators, science journalists, and editors (Farber 2018)[190].

The journalists and editors interviewed in this study indicate that they enjoy “professional relationships” with science communicators and scientists, who are valuable sources of

[185] See 6.1.3

[186] See 6.1.4

[187] See 6.2.2

[188] See 6.2.4

[189] Elsabe Brits, response to questionnaire, October 2018

[190] Tanya Farber, response to questionnaire, October 2018

information and “enablers”[191] who provide what Schudson (2003) describes as a “steady supply of the raw materials for production”.

However, some journalists claim that scientists do not understand how newsrooms operate, how news filters through several gatekeepers before publication, and the numerous constraints faced by the media, particularly with regard to the lack of resources in newsrooms and time and space constraints.

Similarly, some science communicators and scientists assert that journalists do not understand scientific processes like academic publishing, the importance of peer review, the incremental process of research and knowledge creation and the respect for international embargoes[192].

There is an opinion that scientists and science communicators are gradually influencing science content in South African newspapers (Mouton 2018, Gower 2019)[193].

7.3.4 Gatekeepers who influence the science news agenda

There are differing views on who drives the science news agenda. Schudson (1989) decries journalists’ “professed autonomy” in the newsroom, a perspective advanced by Schultz (2007), who espouses that journalists hold different levels of “editorial capital” and “degrees of autonomy” depending on the context in which they work, the newsroom within which they operate and the journalism practiced in the institution.

The Gieber (1964) versus White (1950) debate as to whether newspaper employees make decisions based on their institutional priorities or their subjective choices is relevant when determining how science is selected for publication in South African newspapers.

The results of the qualitative study indicate that a combination of both the subjective experience of journalists and editors, combined with the contextual aspects of the newsroom, influence the selection of science news.[194] According to the majority of the journalists and editors interviewed in this study, science journalists are the first gatekeepers who decide on whether a pitch or story is worthy of publication (Farber 2018)[195] whilst the

[191] See 6.2.3

[192] See 6.2.3

[193] See 6.2.3

[194] See 6.2.3

[195] Tanya Farber, response to questionnaire, October 2018

news editor is the most important gatekeeper (Mouton 2018)[196], without whose consent "the story won't get published" (Wild 2018).[197] Two former editors indicate that some journalists champion science in newsrooms and actively fight for space for science stories (Ritchie 2018)[198].

In this study, there are mixed perspectives on how much autonomy journalists have in newsrooms. Some indicated that they enjoyed considerable autonomy, whilst others lament that the levels of autonomy vicissitudes over time, depending on the newsroom culture, the senior editorial team in place and the prescriptions and constraints of production processes.[199]

7.3.5 Sources

Sources that supply information to the media are described by Schudson (2003) and Gans (1979) as those who hold the real power over the media. Whilst a full discussion on the individuals and organisations that influence the publication of science is detailed in 6.1.4.2, the opposing views of Hall *et al* (1978) and Corner and Schlesinger (1991) are particularly relevant to trends in the South African press today.

The "accredited, authoritative, official sources" usually from powerful and elite institutions are described by Hall *et al* as those who are called on regularly to provide comment or to feature in the news media. The evidence garnered through the quantitative and qualitative components of this study, demonstrate that this is still the case, with 93% of science items featuring elite representatives of society[200].

However, there is a shift towards the media incorporating secondary sources as described by Corner and Schlesinger (1991), including the voices of activists, community-based organisations, non-governmental organisations and other civil society representatives, particularly on science issues that have a direct impact on communities.

This is most evident in the articles pertaining to the pollution of the Vaal River, where manifold voices are presented across newspaper titles to proffer various understandings of

[196] Schalk Mouton, response to questionnaire, December 2018

[197] Sarah Wild, response to questionnaire, October 2018

[198] Kevin Ritchie, response to questionnaire, November 2018

[199] See 6.2.3

[200] See 6.1.3

the issue.[201] Other examples would be the first hand account of an abalone poacher published in the *Sunday Times* about why he poaches abalone[202] or a piece by Denis Beckett in *The Star* that explains why some individuals from rural communities in Limpopo become rhino poachers.

This supports a study by Muchendu (2005) that found that unofficial or secondary sources can become primary sources of information over time, based on a perspective by Corner and Schlesinger (1991) who argue that secondary and alternative sources can be very influential.

7.3.6 Organisations that influence the publication of science

Science content is generated in four ways in newspapers – through science journalists, reporters who cover science regularly, newswires and international newspapers and syndicated media[203]. Organisations that influence the publication of science include universities and research institutions, whilst government departments, international organisations, professional associations and non-governmental organisations also provide a steady supply of information to newsrooms[204].

There is a growing trend for news to be sourced from international newspapers and newswires. The quantitative research demonstrates that more than 37% of the science coverage in South African newspapers emanates from international newspapers and newswires, and that much of this coverage is based on research from universities and research institutions abroad.[205]

7.3.7 Advertisers

Whilst a recent study by Cornia *et al* (2018) exposes “a new norm” that sees the integration of commercial and editorial activities “to better serve audiences and to keep media houses profitable”, three quarters of the respondents in this study indicate that advertising does not directly impact on news selection, with most respondents having no contact with the advertising departments at their newspapers[206]. This means that the selection of science

[201] Vaal sewage spills killing rivers, *The Saturday Star*, 6 October 2018

[202] First-hand account from an abalone poacher, *The Sunday Times*, 23 September 2018

[203] See 6.1.5.2

[204] See 6.1.5.2

[205] See 6.1.5.3

[206] See 6.2.3.5

news for publication is not easily swayed by the need for advertising revenues in the newspapers surveyed.

7.4 The role of the media in making science accessible in a developing democracy

The majority of the respondents in the study believe that the media have a vital role to play in creating a science literate society[207], in providing quality science information based on facts[208], in making science accessible in a developing democracy[209] and in sharing quality science news to inform, educate and empower citizens[210]. The majority of science journalists and editors also believe that the media has a role to play in holding scientists and research institutions to account, because they are often funded through the public coffers[211].

8. Conclusion

This study demonstrates that science news items feature unevenly across the South African daily, weekly and weekend newspapers. These science items are written by science journalists and reporters who cover science, or are sourced from international newspapers, newswires and alternative media houses.

The number of dedicated science journalists impacts on the coverage of science items in a newspaper, both quantitatively and qualitatively. Six of the top science journalists in South Africa who generate the most number of science news items, work at four newspaper titles, although two of them have since left these newspapers.

Whilst scientists and science communicators are increasingly influencing science news content, there are still strong gatekeeping controls in place at newspapers. Access to credible, expert sources is a major aspect that influences the publication of science items, although the use of secondary and unofficial sources is slowly increasing. The exclusivity of a science item and its proximity and relevance to the public are also key factors that determine if science makes the news.

[207] See 6.2.4

[208] See 6.2.4.1

[209] See 6.2.4.2

[210] See 6.2.4.3

[211] See 6.2.4.4

Some of the factors that impact on the publication of science news include the lack of resources, and time and space constraints, especially as journalists have to service multiple titles across a number of platforms on a daily basis.

The results of this study supports Schudson's (2003) theory pertaining to the sociology of news production and his definition of "social realities" (2009) in that the intersection of professional news values of journalists, combined with contextual realities, impact on how news is selected for publication. The outcomes also confirm the views of Stromback and Karlsson (2011) that the publication of science is influenced by the demands of various internal and external actors, more so for science communicators, journalists, editors, sources and gatekeepers than for advertisers and audiences.

In the context of science coverage in the South African press, the study also answers the questions of Harcup and O'Neill (2009), as to what is included, what is excluded, and why? The top ten science themes that feature in the media are environment and ecology; health sciences; science and technology; zoology; astronomy; energy; anthropology and archaeology; engineering sciences, the palaeosciences and in joint tenth place - food and nutrition sciences.

Finally, the research concludes that by the account of journalists and editors themselves, that the media has a vital role to play in creating a science literate society and making science accessible in a developing democracy, through the press.

9. Reference List

Allan, Graham and Skinner, Chris (eds). 1991. *Handbook for Research Students in the Social Sciences*. UK: Falmer Press.

Allan, Stuart. 2009. Making Science Newsworthy: Exploring the Conventions of Science Journalism. In *Investigating Science Communication in the Information Age: Implications for Public Engagement and Popular Media*. Oxford: Oxford University Press.

Allern, Sigurd. 2002. Journalistic and commercial news values: News organisations as patrons of an institution and market actors. Nordcom Review 23: nos 1-2.

Audit Bureau of Circulation. 2017. *Report 90.0 – 4th quarter 2017 release.* Charles Beiles, Johannesburg: Audit Bureau of Circulation, http://www.abc.org.za/Notices.aspx/Details/59

Badenschier, Franziska and Wormer, Holger. 2012. Issue selection in science journalism: Towards a special theory of news values for science news? In *The Sciences' Media*

Connection – Public Communication and its Repercussions. Sociology of the Sciences Yearbook 28. USA: Springer.

Bakari, Sayef. 2017. Why is South Africa still a developing country? PhD diss., University of Tunis.

Bauer, Martin, Ragnarsdottir Asdis, Rudolfsdottir Annadis and Durant, John. 1995. *Science and technology in the British press 1946-1990: a systematic content analysis of the press.* London: The Science Museum.

Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities. October 2003. Berlin. https://openaccess.mpg.de/Berlin-Declaration

Benson, Rodney and Neveu, Erik. 2005. *Bourdieu and the journalistic field.* Cambridge: Polity Press.

Berger, Guy. 2002. Theorising the media-democracy relationship in southern Africa. *The International Journal for Communication Studies* 64: no 1.

Bourdieu, Pierre and Wacquaint Loic. 1992. *An Invitation to Reflexive Sociology.* Chicago: University of Chicago Press.

Breytenbach, Karen. 2005. Media moving to 'juniorisation of newsrooms'. Interview with Joe Thloloe, Chairperson of the South African National Editors' Forum. *Independent Online*, May 2005. https://www.iol.co.za/news/politics/media-moving-to-juniorisation-of-newsrooms-240348

Brighton, Paul and Foy Dennis. 2007. *News Values.* London: Sage.

Bucchi, Massimiano and Mazzolini, Renato. 2003. Big science, little news: Science coverage in the Italian Daily Press, 1946–1997. *Public Understanding of Science* 12: no 1.

Burns, Nancy and Grove, Susan. 2001. *The Practice of Nursing Research, Conduct, Critique, and Utilization*. US: Saunders.

Caple, Helen and Bednarek, Monika. 2013. *Delving Into the Discourse.* Oxford: Reuters Institute for the Study of Journalism.

Castells, Manuel. 2010b. The rise of the network society. *The information age: economy, society and culture* 1.

Claassen, George. 2011. Science and the media in South Africa: Reflecting a 'dirty mirror'. *Communicatio* 37: no 3.

Clark, Fiona and Illman Deborah. 2006. A Longitudinal Study of the New York Times Science Times Section. *Science Communication* 27: no 4.

Cohen, Bernard. 1963. *The press and foreign policy.* USA: Princeton University Press.

Cornia, Alessio, Sehl Annika and Nielsen, Rasmus Kleis. 2018. 'We no longer live in a time of separation': A comparative analysis of how editorial and commercial integration became a norm. *Journalism*. London: Sage.

Corner, John and Schlesinger, Phillip. 1991. Editorial. *Media, Culture & Society* 13: no 4.

Curran, James. 2005. The future of journalism. *Journalism Studies* 11: no 4.

Curran, James and Gurevitch, Michael. 2005. *Mass media and society: 4th edition*. London: Hodder Arnold.

Daniels, Glenda. 2018. Journalist bloodbath: New beat research to find out what happens to journos and journalism. *The Media Online.* July 10.

Dahlgren, Peter. 2009. *Media and Political Engagement: Citizens, Communication and Democracy*. New York: Cambridge University Press.

Dearing, James and Rogers, Everatt. 1996. Agenda-Setting: Communication Concepts 6. London: Sage.

De Lanerolle, Indra. 2016. The message is the medium: fluid public-making in South African social media. First draft. University of the Witwatersrand, Johannesburg.

Department of Science and Technology South Africa's Annual Report. 2017. Pretoria. http://www.dst.gov.za/images/DST-AR-2017-WEB.pdf

Dick, Murray. 2014. Interactive Infographics and News Values. *Digital Journalism* 2: no 4.

Donsbach, Wolfgang. 2004. Psychology of News Decisions: Factors Behind Journalists' Professional Behavior. *Journalism* 5: no 2.

Edelman. 2018. The 2018 Edelman Trust Barometer Global Report. Chicago: Edelman, http://cms.edelman.com/sites/default/files/2018-2/2018_Edelman_Trust_Barometer_Global_Report_FEB.pdf

Ekblad, Nils. 2013. Newsworthiness in science: A content analysis of science news in Swedish Prime Time Television 2009-2011. Masters diss., Stockholm University.

Ericson, Richard, Baranek Patricia and Chan, Janet. 1989. *Negotiating Control: A study of News Sources.* Toronto: University of Toronto Press.

European Union's Declaration to allow for Open Access to Scientific Knowledge by 2020. European Union Commission. 2012. Brussels. https://ec.europa.eu/digital-single-market/en/news/open-access-scientific-knowledge

Finlay, Alan., ed. 2017. *State of the Newsroom 2017: Fakers and Makers*. Johannesburg: Wits Journalism. http://wits.journalism.co.za/wp-content/uploads/2018/03/906-STATE-OF-THE-NEWSROOM-2018-REPRINT-V2.pdf

Fishman, Mark. 1980. *Manufacturing the news.* US: University of Texas Press.

Fitzpatrick, Susan. 1999. What makes science newsworthy? *The Scientist* 13: no 23.

Franklin, Bob. 2004. *Packaging Politics. Political communications in Britain's media democracy.* London: Arnold.

Fuchs, Christian. 2014. *Social media: A critical introduction*. London: Sage.

Galtung, Johan and Ruge, Mari Holmboe. 1965. The structure of foreign news. *Journal of Peace Research* 2, no: 1.

Gandy, Oscar. 1982. *Beyond Agenda Setting: Information Subsidies and Public Policy*. New Jersey: Ablex Publishing.

Gans, Herbert. 1979. *Deciding What's News: A study of CBS evening news, NBC nightly news, Newsweek, and Time*. New York: Vintage Books.

Gieber, Walter. 1964. News is What Newspapermen Make It. *People, Society and Mass Communication*, edited by Dexter, Lewis and White, David. New York: Free Press.

Goldenberg, Edie. 1975. *Making the Papers: The Access of Resource-Poor Groups to the Metropolitan Press.* Washington: DC Heath and Co.

Guenther, Lars and and Weingart Peter. 2018. Promises and reservations towards science and technology among South African publics: A culture-sensitive approach. *Public Understanding of Science* 27: no. 1.

Gumede, William. 2014. South Africa's media and the strengthening of democracy. *Rhodes Journalism Review* 34.

Giodarno, Sara and Chung, Yi-Lin. 2018. The story is that there is no story: Media framing of synthetic biology and its ethical implications in the *New York Times* (2005–2015). *Journal of Science Communication* 17, no: 3.

Hall, Stuart. 1973. The determinations of news photographs in *Cohen and Young.* London: Sage.

Hall, Stuart. 1980. *Culture, Media, Language*. London: Hutchinson.

Hansen, Anders. 1994. Journalistic practices and science reporting in the British press. *Public Understanding of Science* 3.

Harcup, Tony and O'Neill, Deidre. 2001. What is news? Galtung and Ruge revisited. *Journalism Studies* 2, no: 2.

Harcup, Tony and O'Neill, Deidre. 2016. What is News? *Journalism Studies* 18 no: 12.

Herman, Edward and Chomsky, Noam. 1988. *Manufacturing consent: The Political Economy of the Mass Media*. New York: Pantheon Books.

Jensen, Klaus. 2002. *The Qualitative Research Process*. *A Handbook of Media and Communication Research: Qualitative and Quantitative Methodologies.* London: Routledge.

Joubert, Marina and Guenther, Lars. 2017. In the footsteps of Einstein, Sagan and Barnard: Identifying South Africa's most visible scientists. *South African Journal of Science* 113: nos 11-12.

Kiernan, Vincent. 2006. *Embargoed Science*. Urbana: University of Illinois Press.

Kizer, Zachary. 2017. Not a scientist: how politicians mistake, misrepresent, and utterly mangle science. *Journal of Science Communication* 17: no 1.

Lewin, Kurt. 1947. Frontiers in group dynamics II: Channels of group life, social planning and action research. *Human Relations* 1.

Lewis, Justin and Cushion, Stephen. 2009. Towards a `Foxification' of 24-hour news channels in Britain? An analysis of market-driven and publicly funded news coverage. London: Sage.

Lippmann, Walter. 1922. *Public opinion*. New York: Macmillan.

Lynch, John and Condit, Celeste. 2006. Genes and Race in the News: A Test of Competing Theories of News Coverage. *American Journal of Health Behaviour* 30: no 2.

Manning, Paul. 2001. *News and News Sources: A critical introduction*. London: Sage.

McChesney, Robert. 2008. *The Political Economy of the Media: enduring issues, emerging dilemmas*. New York: Monthly Review Press.

McCombs, Maxwell. 2004. *Setting the agenda: the Mass Media and Public Opinion*. Cambridge: Polity Press.

McCombs, Maxwell. 2006. A look at agenda-setting: past, present and future. *Journalism Studies 6*: no 4.

McCombs, Maxwell, Shaw Donald and Weaver, David. 2014. New directions in agenda-setting theory and research. *Mass Communication and Society* 17: no. 6.

McCombs, Maxwell, and Shaw Donald. 1972. The agenda-setting function of mass media. *Public Opinion Quarterly* 36.

Merriam, Sharan. 1998. *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey-Bass Publishers.

Miller, David, Kitzinger, Jenny, Williams, Kevin and Beharrell Peter. 1998. *The Circuit of Mass Communication*. London: Sage.

Molotch, Harvey and Lester, Marilyn Lester. 1974. News as Purposive Behavior: On the Strategic Use of Routine Events, Accidents, and Scandals. *American Sociological Review* 39: no. 1.

Muchendo, Carole. 2005. Sourcing of HIV/AIDS Treatment News: a case study of selected South African Print Media. Masters diss., University of the Witwatersrand.

National Research Foundation. 2018. National Research Foundation Strategy 2020. Pretoria: Department of Science and Technology and the National Research Foundation, http://www.nrf.ac.za/sites/default/files/documents/NRF%20Strategy%20Implementation.pdf

National Research Foundation. 2018. National Research Foundation's Science Engagement Strategy. Pretoria, http://www.nrf.ac.za/science-engagement

Nelkin, Dorothy. 1997. Risk and the Press. *Industrial Crisis Quarterly* 1: no 2.

Nelkin, Dorothy and Lindee, Susan. 1995. *The DNA mystique: The gene as a cultural icon.* WH Freeman: New York.

Nevill, Glenda. 2018. 'Journalist bloodbath': New Beat research to find out what happens to journos and journalism. Interview with Dr Glenda Daniels. *The Media Online*, July 10. http://themediaonline.co.za/2018/07/journalist-bloodbath-new-beat-research-to-find-out-what-happens-to-journos-and-journalism/

O'Neill, Deidre and Harcup Tony. 2009. News values and selectivity in *The handbook of journalism studies.* London and New York: Routledge.

Ostgaard, Einar. 1965. Factors influencing the flow of news. *Journal of Peace Research* 2.

Patelis, Korinna. 2000. The political economy of the internet. *Media organisations in society*. UK: Hodder Education Publishers.

Petit, Christophe. 1997. Covering earth sciences in *A Field Guide for Science Writers*. New York: Oxford University Press.

Phillips, Angela. 2015. *Journalism in Context*. London: Routledge.

Rensberger, Robert Lamar. 1997. Covering science for newspapers in *A Field Guide for Science Writers*. New York: Oxford University Press.

Rensberger, Robert Lamar. 2009. Science journalism: Too close for comfort. *Nature* 459: 7250.

Richardson, John. 2007. *Analysing newspapers: An approach from critical discourse analysis*. London: Palgrave Macmillan

Robinson, Michael and Sheehan, Margaret. 1983. *Over the Wire and on TV: CBS and UPI in Campaign '80*. New York: Russell Sage Foundation.

Rogers, Everett and Dearing, James. 1988. Agenda-Setting Research: Where Has It Been, Where Is It Going? *Annals of the International Communication Association* 11: no. 1.

Ruhrmann, Georg. 1997. *Science, media, and public opinion. Perspectives for the university 2000: Reform effort of universities to more efficiency.* Germany: Luchterhand. (translated)

Science International Accord on Open Data in a Big Data World: Open Science in Africa and in South Africa. 2016. Committee on Data of the International Council for Science. Pretoria http://www.codata.org/news/151/62/Open-Science-in-Africa-and-in-South-Africa

Shepperson, Arnold. 2000. HIV/AIDS Reporting in South Africa: An analysis of the response of the press. South Africa: Beyond Awareness Campaign, Department of Health.

Schudson, Michael. 2003. *The Sociology of News.* WW Norton: New York.

Schudson, Michael. 2009. *Four approaches to the sociology of news revisited. Mass communication research methods.* London: Sage.

Schultz, Ida. 2007. The Journalistic Gut Feeling. *Journalism Practice* 1: no 2.

Schwab, Klaus. 2017. *The Fourth Industrial Revolution.* US: Crown Publishing Group.

Shoemaker, Pamela. 2006. News and newsworthiness: A commentary. *Communications* 31.

Shoemaker, Pamela and Cohen Alan. ed. 2006. *News around the world: content, practitioners and the public*. New York: Routledge.

Shoemaker, Pamela and Reese, Stephen. 1996. *Mediating the message: theories of influences of mass media content.* New York: Longman.

Shoemaker, Pamela and Vos, Tim. 2009. *Gatekeeping Theory*. London: Taylor and Francis.

Singer, Eleanor. 1990. A question of accuracy: How journalists and scientists report research on hazards. *Journal of Communication* 40: no. 4.

Staab, Joachim Friedrich. 1990. The role of news factors in news selection: A theoretical reconsideration. *European Journal of Communication* 5, no: 4.

Stromback, Jesper; Karlsson Michael and Hopmann David. 2012. *Determinants of news content: Comparing journalists' perceptions of the normative and actual impact of different event properties when deciding what's news*. Journalism Studies 13, nos: 5-6.

Stromback, Jesper and Karlsson Michael. 2011. Who's got the power? Journalists' perceptions of changing influences over the news. 2011. Journalism Practice 5, no: 6.

Struthers, Helen and Harber, Anton *et al*. 2010. *Reporting the South African HIV Epidemic.* Johannesburg: Jacana.

Takahashi, Bruno and Tandoc, Edson. 2016. Media sources, credibility, and perceptions of science: Learning about how people learn about science. *Public Understanding of Science* 25: no. 6.

Thloloe, Joe. 2005. Media moving to juniorisation of newsrooms. *The Star*. May 5.

Toner, M. 1997 Introduction in *A Field Guide for Science Writers*. New York: Oxford University Press.

Tuchman, Gaye. 1972. Objectivity as Strategic Ritual: An Examination of Newsmen's Notions of Objectivity. *American Journal of Sociology* 77: no 4.

United Nations Declaration on Open Access to Information. 2016. United Nations, Geneva. http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-access-to-scientific-information/

United Nations International Covenant on Civil and Political Rights. Article 19 of the UN's International Covenant on Civil and Political Rights. 1976. Geneva. https://www.ohchr.org/en/professionalinterest/pages/ccpr.aspx

van Rooyen, Carine. 2002. A report on science and technology coverage in the SA print media. Masters diss., University of Stellenbosch.

Ward, Ian. 1995. *Politics of the Media.* Sydney: Macmillan.

Weaver, David; Beam, Randal; Brownlee, Bonnie; Voakes, Paul and Wilhoit, Cleveland. 2007. *The American Journalist in the 21st Century: U.S. News People at the Dawn of a New Millennium.* New Jersey: Lawrence Erlbaum Associates.

White, David. 1950. The "Gate Keeper": A Case Study in the Selection of News. *Journalism and Mass Communication.* London: Sage.

Wilcox, Sarah. 2003. Cultural Context and the Conventions of Science Journalism: Drama and Contradiction in Media Coverage of Biological Ideas about Sexuality. *Critical Studies in Media Communication* 20: no 3.

Wisker, Gina. 2001. *The Postgraduate Research Handbook.* New York: Palgrave Houndmills.

Wittebols, James. 1995. News and the Institutional Perspective: Sources in Terror Stories. *Canadian Journal of Communication* 20: no 1.

Yeo, Sara; Binder, Andrew; Dahlstrom; Michael, and Brossard, Dominique. 2018. An inconvenient source? Attributes of science documentaries and their effects on information-related behavioral intentions. *Journal of Science Communication* 17: no 2.