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THE ROLE OF KEY ROLE PLAYERS IN SCIENCE COMMUNICATION AT SOUTH AFRICAN HIGHER EDUCATION INSTITUTIONS: AN EXPLORATORY STUDY

by

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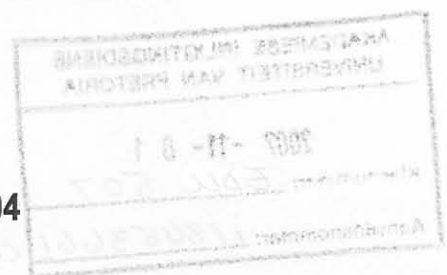

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Give people facts
and you feed their minds for an hour,
but awaken their curiosity and they feed their own minds for a lifetime

Jules Henri Poincaré

Declaration

I declare that the Doctoral thesis, which I hereby submit for the degree PhD (Communication Management) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at another university.

Elsabé Conradie

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Abstract

South Africa, as a developing country, depends on science and technology to support industries to reach informed decisions and be competitive in the international marketplace. However, most people cannot distinguish between scientific, non-scientific and pseudo-scientific subjects. To distinguish between these categories of subjects and to emphasise the importance of science communication, it is necessary to communicate science to various stakeholders: schools, government, decision-makers, the general public and the media.

An understanding of science makes the task of the role players in science – and especially the communication of science to the general public – even more imperative. The role players in science communication have to ensure that the message of science successfully reaches the general public (literate and illiterate; urban and rural societies; young and old) to ensure prosperity and the enhancement of a sustainable environment. The key role players in science communication in South Africa can be identified as *scientists*, who are the source or sender of the science message; *communication specialists at higher education institutions (HEsI)*, who fulfil a mediation function to convey the message of science to all stakeholders; and *South African journalists*, who are the final distributors of the message to all stakeholders (the recipients of the science message). There is, however a fourth key role-player in science communication, and that is the *executive management of HEIs*, since they should provide the communication specialists at their institutions with the trust and empowerment to distribute the message of science to journalists in order for these messages to reach the general public.

Science communication is still a new and vague concept to many South Africans. Limited research has been conducted on the key role players in science communication; the specific role of communication specialists at HEIs in science communication; and the relationship between the different key role players. However, in many countries, including South Africa, various studies have been conducted on public attitudes towards science, which is in general positive.

The problem identified in this study is that although science communication is regarded as a priority in South Africa, science messages are not effectively reaching the general public. There are several possible reasons as to why the general public is not well informed about science. One is that scientists find it difficult to simplify scientific facts so that they are understandable to the layman. Another reason is the lack of a proper relationship of trust and mutual understanding between scientists and journalists, resulting in inaccuracies in science articles that appear in newspapers, magazines and on television. A third reason is that communication specialists at HEIs, who are supposed to take

responsibility for media liaison, experience a lack of trust and empowerment by their executive management to liaise with stakeholders, including the media, at their own discretion. According to De Beer (2001:84), the executive management at HEIs do not empower their communication specialists to discuss matters with the media without the involvement of the executive management. A fourth reason is a lack of training in the writing of science articles, which results in an inaccurate coverage of science in the media. Therefore, the role of communication specialists at HEIs is very important. Communication specialists have to build a bridge between an institution's management, scientists and the media as stakeholders of HEI.

The general research aim of this study is to investigate the relationship between key role players in science communication and to determine the role that they play in science communication. Following the general research aim, six objectives are stated: Firstly, to determine the importance of science communication amongst key role players in science communication (executive management, scientists, communication specialists) at HEIs in South Africa, as well as journalists in the South African media. Secondly, to determine if a relationship of trust and mutual understanding exists between key role players in science communication in South Africa. The third objective is to determine if the role of communication specialist is a role of strategist, manager or technician in the facilitation of science communication at HEIs in South Africa. Fourthly, to determine the extent of training provided at universities and technikons in South Africa for scientists, communication specialists and journalists to enable them to write science articles. The fifth objective is to investigate the coverage of scientific topics in articles in the South African mass media. The final objective is to analyse the content of articles on science in selected South African media from 1 March to 31 May 2004 and to compare the results of this study with a study conducted by Van Rooyen in 2002 (Van Rooyen, 2002).

The empirical component of the study supplements the theoretical component. In Phase 1, a quantitative, exploratory survey research was done to establish the role of communication specialists in science communication at HEIs in South Africa. In Phase 2, content analysis was used to analyse the content of scientific articles in selected print media over a period of three months. Van Rooyen (2002:21) invited researchers to repeat the study she conducted in 2002 at regular intervals. Therefore, based on the invitation of Van Rooyen, Phase 2 of this study was conducted, using the same criteria, method and time frame as Van Rooyen had done. Comparisons of the results of the two studies are provided.

The main conclusions of the study were:

- Although science communication is regarded as important by the key role players in science communication, not enough is being done by South African HEIs to promote the importance of

science to the general public, including the literate and illiterate; urban and rural; young and old people, to ensure a sustainable environment.

- There is not a proper relationship of trust and mutual understanding between the key role players in science communication.
- Communication specialists are regarded as managers, as opposed to strategists or merely technicians, in science communication, but they are not always empowered to act efficiently as facilitators in the mediation process between scientists and the media.
- There is a lack of proper training for scientists, communication specialists and journalists in science writing or science journalism in South Africa.
- The coverage of science in the media has not improved much since Van Rooyen's study was conducted in 2002.

Recommendations regarding the management of science communication can be summarised as follows. South Africa needs a national forum to conduct an audit and formulate a structured, reasoned national science communication action plan for South Africa. More feedback should be given to the science communication community about who should receive funding and what projects should be funded. The Government of South Africa should encourage higher education institutions to organise public debate sessions where scientists and the general public can discuss controversial issues regarding science and research in an open forum.

Furthermore, scientists should be encouraged to provide information to communication specialists so that they can distribute science messages to all stakeholders. Communication specialists should create and support a science writers' network in South Africa; develop and promote databases of science writers and media-friendly scientists; collect science articles from scientists and prepare them for publication together with supporting visuals; facilitate linkages and collaboration with corporate sectors; participate in international networking; and conduct visits to expert programmes.

It is imperative for communication specialists, scientists and journalists to receive training to optimally fulfil their roles in science communication. Communication specialists should have writing skills to be able to assist scientists and journalists to create messages about science acceptable and understandable to the literate and illiterate; urban and rural; young and old people of South Africa. A course or degree in science journalism is therefore imperative.

To enhance coverage of science in the media, science ideally needs to be integrated into popular, peak-time programmes such as local dramas, historical and other documentaries, talk shows, and

even soap operas. All mediums should be considered, including radio, television and the Internet to communicate science to the general public.

Opsomming

Suid-Afrika, as 'n ontwikkelende land, maak staat op wetenskap en tegnologie om ondersteuning aan industrieë te bied om ingeligte besluite te kan neem en mededingend in die internasionale mark te wees. Meeste mense kan egter nie onderskei tussen wetenskaplike, nie-wetenskaplike of pseudo-wetenskaplike onderwerpe nie. Ten einde tussen hierdie onderwerpskategorieë te onderskei en om die belangrikheid van wetenskapskommunikasie te beklemtoon, is dit noodsaaklik om wetenskap aan verskeie belanghebbers te kommunikeer: skole, die regering, besluitnemers, die algemene publiek en die media.

'n Begrip van wetenskap maak die taak van die rolspelers in wetenskap – en veral die kommunikasie van wetenskap aan die algemene publiek – selfs meer onontbeerlik. Die rolspelers in wetenskapskommunikasie moet verseker dat die wetenskapsboodskap die algemene publiek suksesvol bereik (geletterd en ongeletterd; stedelike en landelike gemeenskappe; oud en jonk) om welvaart te verseker asook die versterking van 'n volhoubare omgewing. Die kernrolspelers in wetenskapskommunikasie in Suid-Afrika is wetenskaplikes, as die bron van die wetenskapsboodskap; kommunikasiespesialiste by hoër onderwysinstellings met 'n media-funksie om die wetenskapsboodskap aan belanghebbers oor te dra; asook Suid-Afrikaanse joernaliste as die finale verspreiders van die boodskap aan alle belanghebbers (die ontvangers van die wetenskapsboodskap). Daar is egter 'n vierde kernrolspeler in wetenskapskommunikasie, naamlik die uitvoerende bestuur van hoër onderwysinstellings. Hulle behoort die vertroue en bemagtiging aan die kommunikasiespesialiste, verbonde aan hulle instellings, te bied om die wetenskapsboodskap aan joernaliste te versprei, sodat hierdie boodskappe die algemene publiek effektief kan bereik.

Vir baie Suid-Afrikaners is wetenskapskommunikasie op hierdie stadium nog 'n nuwe en vae begip. Beperkte navorsing is gedoen rondom die kernrolspelers in wetenskapskommunikasie; die spesifieke rol van kommunikasiespesialiste by hoër onderwysinstellings in wetenskapskommunikasie; asook die verhouding tussen die verskillende kernrolspelers. In baie lande egter, Suid-Afrika ingesluit, is verskeie studies uitgevoer wat betref die openbare beskouinge oor wetenskap wat, oor die keper beskou, positief is.

Die probleem wat in hierdie studie geïdentifiseer is, is dat hoewel wetenskapskommunikasie as 'n prioriteit in Suid-Afrika beskou word, wetenskapsboodskappe nie die algemene publiek effektief bereik nie. Daar is verskeie moontlikhede oor hoekom die algemene publiek nie goed oor wetenskap ingelig is nie. Een is dat wetenskaplikes dit moeilik vind om wetenskaplike feite sodanig te vereenvoudig dat dit verstaanbaar is vir die leek. 'n Ander rede is die gebrek aan 'n behoorlike verhouding van vertroue

en wedersydse begrip tussen wetenskaplikes en joernaliste, wat uitloop op onjuisthede in wetenskaplike artikels wat in koerante, tydskrifte en op televisie verskyn. 'n Derde rede is dat die kommunikasiespesialiste by hoër onderwysinstellings, wie veronderstel is om verantwoordelikheid vir mediaskakeling te neem, 'n gebrek aan vertroue en bemagtiging vanaf hulle uitvoerende bestuur ervaar om met belangegroepe, insluitende die media, volgens eie diskresie te skakel. Volgens De Beer (2001:84), bemagtig die uitvoerende bestuur by hoër onderwysinstellings nie hulle kommunikasiespesialiste om aangeleenthede met die media te bespreek sonder dat die uitvoerende bestuur betrokke is nie. 'n Vierde rede is 'n gebrek aan opleiding wanneer dit kom by die skryf van wetenskaplike artikels, wat aanleiding gee tot onjuiste dekking van wetenskap in die media. Die rol van kommunikasiespesialiste by hoër onderwysinstellings is derhalwe geweldig belangrik. Kommunikasiespesialiste moet 'n brug bou tussen 'n instelling se bestuur, wetenskaplikes en die media, as die belanghebbers van hoër onderwysinstellings.

Die algemene navorsingsdoelwit van hierdie studie is om die verhouding tussen kernrolspelers in wetenskapskommunikasie te ondersoek, en om te bepaal watter rol hulle in wetenskapskommunikasie speel. Na aanleiding van die algemene navorsingsdoelwit, word ses oogmerke gestel: Eerstens, om die belang van wetenskapskommunikasie tussen kernrolspelers in wetenskapskommunikasie by hoër onderwysinstellings in Suid-Afrika (uitvoerende bestuur, wetenskaplikes, kommunikasiespesialiste), sowel as joernaliste van die Suid-Afrikaanse pers te bepaal. Tweedens, om te bepaal of 'n verhouding van vertroue en wedersydse begrip tussen kernrolspelers binne wetenskapskommunikasie in Suid-Afrika bestaan. Die derde oogmerk is om te bepaal of die rol van kommunikasiespesialis 'n rol is van strateeg, bestuurder of tegnikus in die fasiliteringsproses van wetenskapskommunikasie by hoër onderwysinstellings in Suid-Afrika. Vierdens, om te bepaal wat die mate van opleiding is wat deur universiteite en technikons in Suid-Afrika gebied word aan wetenskaplikes, kommunikasiespesialiste en joernaliste, ten einde hulle in staat te stel om wetenskaplike artikels te skryf. Die vyfde oogmerk is om die dekking van wetenskaplike onderwerpe in artikels in die Suid-Afrikaanse massamedia te ondersoek. Die finale oogmerk is om die inhoud van artikels oor wetenskap in geselekteerde Suid-Afrikaanse media vanaf 1 Maart tot 31 Mei 2004 te ontleed en om die bevindinge van hierdie studie te vergelyk met 'n studie wat deur Van Rooyen in 2002 (Van Rooyen, 2002) uitgevoer is.

Die empiriese komponent van die studie vul die teoretiese komponent aan. Tydens Fase 1, is 'n kwantitatiewe, verkennende opname gedoen om die rol van kommunikasiespesialiste in wetenskapskommunikasie by hoër onderwysinstellings te bepaal. Tydens Fase 2, is van inhoudsontleding gebruik gemaak om die inhoud van wetenskaplike artikels in geselekteerde, gedrukte media oor 'n tydperk van drie maande te ontleed. Van Rooyen (2002:21) het navorsers uitgenooi om die studie wat sy in 2002 onderneem het, met gereelde intervalle te herhaal. Derhalwe, gebaseer op

die uitnodiging van Van Rooyen, is Fase 2 van hierdie studie uitgevoer, met gebruikmaking van dieselfde kriteria, metode en tydsraamwerk as Van Rooyen. Vergelykings tussen die twee studies word gebied.

Die vernaamste gevolgtrekkings van die studie was:

- Hoewel wetenskapskommunikasie as belangrik beskou word deur die kernrolspelers in wetenskapskommunikasie, doen Suid-Afrikaanse hoër onderwysinstellings nie genoeg om die belangrikheid van wetenskap by die algemene publiek te bevorder nie, insluitend by geletterd en ongeletterd; stedelik en landelik; jonk en oud, om 'n volhoubare omgewing te verseker nie.
- Daar bestaan nie 'n behoorlike verhouding van vertroue en wedersydse begrip tussen die kernrolspelers in wetenskapskommunikasie nie.
- Kommunikasiespesialiste word gesien as bestuurders, in teenstelling met strateë of bloot tegnici in wetenskapskommunikasie, maar hulle word nie altyd voldoende bemagtig om op te tree as fasiliteerders in die bemiddelingsproses tussen wetenskaplikes en die media nie.
- Daar is 'n gebrek aan gepaste opleiding vir wetenskaplikes, kommunikasiespesialiste en joernaliste wat betref wetenskapsjoernalistiek of die skryf van wetenskap in Suid-Afrika.
- Die dekking, wat aan wetenskap deur die media verleen word, het nie veel verbeter sedert Van Rooyen se studie in 2002 onderneem is nie.

Aanbevelings rakende die bestuur van wetenskapskommunikasie kan as volg saamgevat word. Suid-Afrika benodig 'n nasionale forum om 'n oudit te doen en 'n beredeneerde, nasionale wetenskapskommunikasie aksieplan vir Suid-Afrika te formuleer. Groter terugvoer behoort aan die wetenskapskommunikasiegemeenskap gegee te word oor wie befondsing behoort te ontvang en watter projekte befonds behoort te word. Die Suid-Afrikaanse regering behoort hoër onderwysinstellings aan te moedig om openbare debatsessies te organiseer waar wetenskaplikes en die algemene publiek omstrede kwessies binne 'n ope forum kan bespreek, wat betref wetenskap en navorsing. Verder behoort wetenskaplikes aangemoedig te word om inligting aan kommunikasiespesialiste te verskaf, sodat hulle wetenskapsboodskappe aan alle belangegroepe kan versprei. Kommunikasiespesialiste behoort 'n wetenskapskrywersnetwerk in Suid-Afrika te skep en te ondersteun, databasisse van wetenskapskrywers en media-vriendelike wetenskaplikes te ontwikkel en te bevorder; wetenskaplike artikels vanaf wetenskaplikes in te samel en voor te berei vir publikasie saam met ondersteunende visuele materiaal; skakeling te fasiliteer asook samewerking met korporatiewe sektore; internasionaal te netwerk; en besoeke te bring aan gesaghebbende programme.

Dit is gebiedend noodsaaklik vir kommunikasiespesialiste, wetenskaplikes en joernaliste om opleiding te ontvang ten einde hulle onderskeie rolle in wetenskapskommunikasie optimaal te vervul.

Kommunikasiespesialiste behoort oor skryfvaardighede te beskik, sodat hulle in staat is om wetenskaplikes en joernaliste by te staan om boodskappe oor wetenskap te skep wat aanvaarbaar en verstaanbaar is vir diegene wat geletterd of ongeletterd is; stedelik of landelik; asook oud en jonk in Suid-Afrika. 'n Kursus of graad in wetenskapsjoernalistiek is derhalwe van die uiterste belang.

Om wetenskapsdekking in die media te verhoog, benodig die wetenskap ideaal-gesproke om opgeneem te word in gewilde, spitstyd programme soos plaaslike dramas, historiese en ander dokumentêre films, geselsprogramme, en selfs sepieverhale. Alle media moet oorweeg word om wetenskap aan die algemene publiek te kommunikeer, insluitende radio, televisie en die Internet.

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Chapter 1

Orientation and background

1.1 INTRODUCTION AND BACKGROUND

The *White Paper on Science and Technology* of the Department of Science and Technology of South Africa (Department of Arts, Culture, Science and Technology, 1998) contains a vision for science, engineering and technology (SET) where the barriers of ignorance are broken down and a society evolves that understands and values SET, as well as the key role that SET can play in ensuring national prosperity and a sustainable environment. It was the vision of the Department of Science and Technology (DST) to create a special period in 1998 during which much of the attention of the public and the media focused on SET. Seven years later, it is still a priority in South Africa to communicate science to the community, to both the literate and illiterate; urban and rural; young and old segments of society. The Department of Science and Technology was established in 1996 and although the name does not reflect engineering, the purpose of the Department is to oversee these three priority fields in South Africa.

The implications of the White Paper of the South African government are that everybody in South Africa, especially the younger generation and children, should be informed about SET. Understanding SET is a necessity, since SET touches everyone's lives. From medicine and transport to computers and mobile phones, the pace of scientific, engineering and technological development is rapid and seemingly inexorable. South African communities' opinions of these developments vary, as is only to be expected.

Within South African society, some people are enthusiastic about change; some are sceptical of the ability of the South African government to regulate science; and others have no interest in science at all. SET, as described by the South African government, is regarded as one concept. Although only the term science is used, it in fact includes engineering and technology as well. The term science does not only refer to the natural sciences, but also includes social and educational sciences. Since the government of South Africa has made it a priority to improve the understanding of natural sciences by the general public, the emphasis in this study is on natural sciences.

The South African government's encouragement to enhance an understanding of SET makes the task of role players in science, and especially the communication of science to the general public, even

more imperative. The role players in science communication have to ensure that the message of science successfully reaches the literate and illiterate; urban and rural societies; old and young people to ensure prosperity and the enhancement of a sustainable environment. Because of the urgency to understand SET, various associations have been established globally, including the National Association of Science Writers in the United Kingdom. The National Association of Science Writers is among the leaders in providing guidelines to scientists and journalists in writing science articles that non-scientists can understand. According to the National Association of Science Writers (2001), the present generation has access to more knowledge, leisure, travel and entertainment than any generation in history, due to the contributions of research scientists and engineers.

However, although topics referring to science are increasingly covered in the mass media, highly technical and sometimes biased articles often dominate the scene. Therefore, to prevent incorrect messages from reaching the non-scientific community, a good relationship must be established between scientists, communication specialists and journalists. Since science is only one of the issues on which South African journalists have to report, it would benefit scientists to have good relations with the journalists from the various media. Good relationships between scientists from higher education institutions (HEI)[1] and communication specialists, as well as between communication specialists and journalists, will ensure that more science topics are covered in the media, including household magazines and newspapers.

Many areas of science have the potential to be visually attractive, which could result in more science experiments being presented not only in magazines, but also on television. This would, however, require communication specialists and journalists to be given the opportunity to accompany scientists on field trips or receive invitations to watch an experiment being performed, resulting in more information on research being available to convey to the various stakeholders, including education, commerce and industry, government and the general public.

Communication specialists in the study are defined as public relations officers, liaison officers, managers and directors in marketing and communication divisions and/or units at HEIs. They are the communicators, or in many cases the spokespeople, of HEIs. Communication specialists should mediate between scientists, who provide the scientific facts; and the media, which distribute the messages of science. Communication specialists should ensure that simplified and comprehensible,

[1] HEI refers to universities and technikons that offer education to students who have passed the Grade 12 school level.

but accurate science facts ultimately reach all segments of society: literate and illiterate; urban and rural communities; young and old people.

In South Africa, unlike other countries with many technical colleges, the core of scientists is centred at HEIs, resulting in the focus on HEIs in this study. The main focus of universities and technikons is on education and research. It is, therefore, the responsibility of universities and technikons in South Africa to ensure that scientists at these institutions, who are the source of science, receive attention from the media, which should distribute the science message via communication specialists at HEIs, who are the facilitators mediating the flow of science messages to stakeholders. The key role players in science communication in South Africa can thus be identified as the scientists, who are the source of the science message; communication specialists at HEIs, who are the facilitators who fulfil a mediation function in conveying the message of science to stakeholders; and South African journalists, who are the final distributors of the message to all stakeholders, including the literate and illiterate; urban and rural societies; young and old people, who are the recipients of the science message. Executive management at HEIs form the fourth key role-player, since they should provide the trust and empowerment to other role players to distribute the message of science.

HEIs in South Africa have an organisational structure consisting of various faculties, each with their own departments. Scientists in different fields of speciality are located in these faculties, including faculties such as natural sciences, engineering, health sciences and social sciences. Besides the faculties, HEIs also have other divisions responsible for the operational issues of the HEI, including a corporate communication and/or marketing division. Although the marketing and/or communication division is supposed to take responsibility for communication to stakeholders and media liaison, there seems to be a lack of trust and understanding, which are elements of a successful relationship, amongst the key role players in science communication.

Often communication specialists are not empowered by executive management to liaise with stakeholders of HEIs at their own discretion. Scientists sometimes prefer to communicate directly with the media and have on several occasions caused embarrassment to their institutions, because they are not always trained to react to journalists' questions (Nelkin, 1995:35). They either make statements that should not have been conveyed to the media, or they are misinterpreted – and misquoted - by journalists. The role of communication specialists at HEIs is therefore important to build a bridge between the executive management of HEIs, scientists and the media in order for the science message to reach all relevant stakeholders, including the literate and illiterate in both urban and rural

areas, as well as the old and young people of South Africa. However, to achieve successful science communication, it is imperative to define the essence of science communication.

1.2 ESSENCE OF SCIENCE COMMUNICATION

Science communication is broadly defined to include communication among scientists on the one hand and mediated communication from scientists to the public on the other hand (Trumbo, 1999:410). The latter, therefore, refers specifically to conveying messages of science-related issues to the non-scientific population. The scientific process is a lengthy, formal method of investigation, with careful structures designed to minimise the publication of 'wrong' results. Goodfield (1981) noted that there is a reluctance among scientists to popularise scientific data through the media. Priest (1998) noted that maintaining the integrity of science representation involves training the general public and the professional community in information literacy.

Such messages should be simplified to enable the general public, literate and illiterate, urban and rural, as well as very young children, to understand the purpose and benefits of science. Activities, awareness programmes, vocal and printed messages to simplify hard science – these all constitute the core of science communication. To convey science information to the general public in a simplified, yet accurate way is the purpose of science communication. Science communication and the communication of science are terms that will be used regularly and in an interchangeable manner in this study.

1.3 BENEFITS AND RISKS OF SCIENCE

The potential benefits and drawbacks of scientific developments are debated in many different forums, including the media, government, academia and the general public. The expectations of society (i.e. the general public) have also changed in recent years, as people are no longer satisfied with statements about scientific discoveries, experiments or developments only. They require explanations of why a statement was made. Institutions, therefore, have to operate in a much more demanding environment in which they are carefully scrutinised as targets.

As identified by Askew (1997), several factors are thought to have contributed to the benefits and risks of science. Both sides of the story need to be communicated to the general public to enable them to participate in public debates and keep them informed on issues that might affect their daily lives. The general public needs to know how new scientific developments can contribute to enhancing their health and safety. At the same time, however, they also need to be aware of the risks these

developments might contain for their health and safety. Numerous sources were used to compile the following list of benefits and risks of scientific developments:

- The globalisation of business and the speed and ubiquity of communication mean that local events no longer just have local meanings and consequences. Fax and Internet provide means of communication that are open to anyone, not just the most sophisticated. Other benefits of science can be seen in the development of new technology, for example DVDs, cell phones and multimedia, as well as several inventions by scientists, such as cloning, genetically modified organisms and DNA testing.
- The general public and governments continuously expect higher standards in health, safety and environmental matters.
- A decline in the influence of traditional leaders (the church and the state) has left a moral vacuum and a general cynicism towards most institutions. This has created a climate for the rise of sophisticated and successful pressure groups, which have adopted ethical stances, understood the importance of emotion as well as logic, and utilised the speed and effectiveness of communication in pursuit of their objectives.
- In a challenging national and global environment, issues can quickly turn into crises. For example, disposable nappies have been attacked as a major cause of waste disposal problems; mobile phones have been alleged to cause brain tumours; and the discharge of waste into river systems in a Third World country has rapidly become an international political issue.
- Furthermore, Hlywka, Reid and Munro (2003) remark that the introduction of biotechnology-derived foods into global commerce through advances in scientific technologies has resulted in a greater scrutiny of the regulatory measures in place to ensure the continued safety of man's food supply. Although the safety of foods derived through biotechnology is evaluated against the standard of safety applied to all foods in general, prior to acceptance into the market, there remains a degree of uncertainty among some consumers and regulators regarding the potential long-term effects on human health.
- Added to the list are the drawbacks of scientific development, including the risks involved in new developments such as cloning. Certain risks attached to the techniques used in cloning may cause physical or emotional defects. No-one can safely predict whether experiments in cloning will have positive results, because the end results might still include premature death or deformed organisms (Massarani, 2002).

The abovementioned factors and many other possible benefits and risks of SET developments have caused scientists and communicators of science worldwide to realise that communicating science

needs much more attention than it has actually received in the past. In several countries this realisation has resulted in policies on how to enhance an awareness of science communication. Although literature is globally available on the topic, not much research has been conducted on science communication, besides the general public's understanding of science and their attitudes towards science, especially in South Africa.

In the USA, the UK and Australia, as well as many other countries, several programmes and forums were developed to improve the communication of science to all stakeholders, including the general public and the media (Massarani, 2002). These countries are also leading the way in developing science activities for both children and adults. New technology, such as electronic mail (e-mail) and the Internet, greatly assists professionals who discuss science communication within groups by sharing experiences and introducing new initiatives to improve an awareness of science communication worldwide. In South Africa the key role players in science communication situated at HEIs should take the lead in following the global leaders by conveying science to the general public, since science communication has become a priority globally.

1.4 PRIORITY OF SCIENCE COMMUNICATION GLOBALLY

The impact of SET on society today certainly cannot be doubted by anyone. Every country globally faces challenges – not only of understanding the current multiple revolutions in SET, but also of how these revolutions affect the future of humanity and the Earth (National Association of Science Writers, 2001). Within the international scientific community there is an increasing awareness of the duty and responsibility of publicly funded scientists to make their work more accessible to the general public (Joubert, 2001). Worldwide science reporting is moving away from 'celebratory' reports about 'space and dinosaurs' towards debate and issues around the impact of science on society. It is no longer a matter of "Professor, please tell us about this fantastic project," but rather "Explain why you are doing this research, who is funding it, what is your agenda?" (Joubert, 2001).

Research International, based in the UK, is a research organisation conducting research on behalf of other organisations. It found that in the UK there has been a move away from the traditional, limiting image of science and scientists as 'boring', 'white, male and middle class'. In many other countries, too, a need was identified for two-way communication between the general public, including children and the illiterate segments of society, as well as the scientific community. Although teaching and the mass media were identified by international research associations, including Research International, as very important routes through which to communicate science to all societies: the literate and

illiterate, urban and rural, as well as young and old people, scientists expressed concern about the role of the mass media. It was the opinion of many scientists worldwide that the mass media often sensationalised and misrepresented science. Covering science accurately and comprehensively is a complex task. Competent journalists, like competent scientists, need to be trained, supported and inspired. Many science-orientated organisations globally consequently decided to focus on the actual marketing and selling of science as an area of improvement. Programmes are aimed at widening the general public's understanding of science and focusing on access to science education (Research International, 2000:2,3).

The National Association of Science Writers (2001) of the UK agreed with Research International and other research institutions that the promotion of science and the communication of science to the non-scientific public is a priority all over the world. Various countries, such as the UK, Australia and South Africa, have conducted studies to determine how the general public perceives science.
They also tested public attitudes towards science. The results of some of these studies are discussed in Chapter 3. However, since science communication is still a new concept globally, limited research has been conducted on the key role players of science communication and the relationship between these key role players.

1.5 IMPORTANCE OF SCIENCE COMMUNICATION IN A POST-APARTHEID SOUTH AFRICA

The new government of South Africa, which came into power in 1994, made the democratisation of science in the country a priority and promoted the popularisation of science as a key driver of socio-economic advancement. According to Joubert (2001), society was to rediscover science, not merely receive its products.

South Africa, like all other countries, is dependent on SET to support industries in order to reach informed decisions and be competitive in the international marketplace. The South African population should be able to develop opinions on the scientific and technological issues of the day, based on their knowledge of SET. However, most stakeholders cannot distinguish between scientific, non-scientific or pseudo-scientific subjects. For these reasons, communicating SET to various stakeholders, including education, government and decision-makers, commerce and industry, the general public and the media, is a necessity.

1.5.1 Addressing the ignorance of science and the accessibility of science messages in South Africa

Many scientists are already engaged in promoting greater public appreciation and understanding of science, engineering and technology, but many are still unwilling to speak to the media about their work. Scientists have to accept that they must operate within the parameters and news values of the media. If they do not engage the media effectively, people with opposing views (anti-science) might jump at the opportunity to express their views. Silence and avoidance of publicity on the part of scientists would simply fuel the public's ignorance and mistrust of science (Joubert, 2001).

As stated previously, scientists are not the only role players in science communication. Communication specialists are responsible for building relationships with their institutions' stakeholders (of which the media constitute a major one) and they should assist scientists by providing guidelines on how to conduct interviews with journalists.

Communication specialists, as one of the key role players in science communication, have to cultivate a relationship of trust and mutual understanding with the other key role players in science communication, namely the executive management of HEIs, scientists and journalists. The executive management of HEIs have to formulate an overall strategy for communicating the science produced by scientists at their institutions. Scientists are the producers of science and, therefore, the senders of the science message, while communication specialists must facilitate the distribution process of science messages by mediation. It should be the task of communication specialists to simplify the messages to enhance mutual understanding between scientists and journalists, who should assist in conveying the correct science information to all stakeholders of HEIs.

This relationship of trust and mutual understanding between the key role players of science communication, as mentioned above, is imperative to convey positive and correct messages of science to the various stakeholder groups. However, without the stakeholders', and most importantly the general public's, positive attitude towards science and technology, all efforts at communicating science effectively and correctly could be in vain, since stakeholders would not be interested in listening to the message communicated to them. Although little research on the general public's attitude towards science has been performed in South Africa, results of these studies have demonstrated a positive attitude towards science and technology, but the implications of new developments in science and technology are not always fully understood by the general public (Blankley & Arnold, 2000:3).

In a developing country like South Africa, where many people are simply trying to survive, a basic understanding of some aspects of science may mean the difference between life and death. Water purification is one relevant example, since communities in the rural areas have a serious problem to purify water for drinking and cooking purposes. However, although running water from a tap next to the shacks in a township may be a scientist's solution to ensure purified water, the people of a specific community might not agree (Meyer, 2002:31). Resistance to science could even result from cultural differences. For example, many women in rural societies use the opportunity to fetch water from a river close by to have a conversation with other women in that same society, whom they would otherwise not have met.

1.5.2 The role of development communication in science communication in South Africa

In the realm of science communication, South Africa faces the problems of both a First World country, and those of an impoverished continent. Thus, it is important to focus on ways to achieve closer relationships between science, the general public and the media, to the benefit of science and all the people in South Africa. The necessity of mediation (the role the communication specialists can fulfil) between scientists and the general public becomes even more important.

Cultural differences, age differences, illiteracy and long distances from the cities where most of the developments take place (rural areas), play a role and affect the way in which the general public accepts new technologies and science discoveries as conveyed by the media (Meyer, 2002:31). To overcome these problems, development communication was implemented to enable inhabitants of rural areas in South Africa to participate in programmes to improve their daily lives. Development communication assists in bridging the gap between science, society, the media and different cultures. It also aims at participation, integration, collaboration, delegation, linkage, coordination and teamwork (Agunga, 1998:29). According to Malan (1998:52), development communication involves "... all forms of communication that are used for the improvement of an individual, community or country's material, cultural, spiritual, social and other conditions". The aim of development communication is to "... inform and motivate at national and local levels" (Snyman, 2002).

Two main paradigms determine communication in a development situation, namely the dominant paradigm and the new paradigm. In the communication field, these two paradigms are referred to as Development Communication (DC) and Development Support Communication (DSC) respectively.

The new paradigm and the DSC approach support the argument of community-centred development that will ultimately lead to sustainable development (Swanepoel & De Beer, 1997).

According to Agunga (1998:36), since 1989 a number of communication scholars have embarked on improving the professionalism of communication in development. Until 1998, the task of communication for development was left to extension workers, trained more in technical agriculture than in communication. There is a general feeling that project managers and policy administrators are handling the communication function in development poorly.

As early as 1983 Chambers (in Agunga, 1998:36) remarked that the management of rural development remained a 'blind spot' in the sense that there is hardly any institution of higher learning that prepares graduates specifically for development management. It is now 22 years later and the problem has not been solved. HEIs still do not prepare their graduates to communicate or to manage development. Due to a lack of management training, programme managers in a developmental context do not understand the dynamic and complex nature of the development process, nor do they have the communication skills to promote human behavioural change by helping beneficiaries to make appropriate use of the assistance provided (Agunga, 1998:38).

Communication management strategies are criticised from a DSC perspective, since such strategies are preoccupied with the needs of the communicator or the developer (sender), and do not take the needs of the beneficiaries (recipients) into consideration. According to Burger (1998:145), top-down, authoritarian, one-way communication and controlling stakeholders dominate the process by controlling the message, using the mass media from a centralised venue and keeping the power with the initial communicators. This is quite in line with DC-thinking, as stated by Burger (1998:145). In most cases the intention of the communicator or communication planner includes an element of persuasion. A typical DC approach will, therefore, be to diffuse information, but still aim at controlling the information that reaches the community, thereby retaining power. True participation, as suggested by the DSC perspective, however, does not take place, because the beneficiaries do not take final ownership of the message (Burger, 1998:146).

An example of the DC approach can be found in the Masakhane case study where nationwide roadshows were used to explain reasons for payment and to motivate rural societies to pay for their municipal services (Burger, 1998:146). These roadshows offer a suitable example of a DC campaign, mainly because of its inherent top-down communication methods. Other local case studies include the Nkomazi irrigation expansion programme, the Winterveld Development Programme and the Cape

Grassroots community media projects (Burger, 1998:146; Malan & Grossberg, 1998:173). Opposed to the aforementioned three projects, which experienced mostly communication problems, the Tswaing Crater Development Project was a successful project in terms of the communication process, since a facilitator contributed to ensure successful communication between role players.

The Tswaing Crater Project formed part of the Human Sciences Research Council (HSRC) Development Support Communication (DESCOM) programme of 1996 to 1997. The programme aimed to analyse, develop and test communication strategies that are used for community development and empowerment. The facilitator in the project played a crucial role in facilitating between all other role players in order to keep the development process on track and translate messages between the role players (Malan & Grossberg, 1998:173). Over a five-year period, communication at the Tswaing Crater Development Project has proved itself to be an exemplary model for culturally, environmentally and communally sensitive development communication, empowering the community to make its own decisions.

The Tswaing Crater Development Project can also be used as a model for empowering the rest of Africa's uneducated masses. According to Agunga (1998:29), Africa's largely uneducated masses must be empowered if they are to become major role players in the development process. Communication is essential to empowerment. Africa, with the assistance of South Africa and by learning from South Africa's experiences, can develop faster and be more sustainable if communication is given serious attention in the development policies of donor agencies and government leaders. Science communication is imperative to contribute to the development of rural communities. Understanding the importance of science to enhance living conditions is a necessity. In the process of conveying the science message from scientists to illiterate communities, communication specialists can play a vital role to facilitate the translation of scientific facts into simplified messages.

South Africa's government also realised the need of empowering uneducated segments of society and in 2002 South Africa hosted the United Nations World Summit on Sustainable Development (WSSD), known as the Johannesburg Summit. Although the focus was on sustainable development, a few scientists were involved in creating an awareness of science. The Johannesburg Summit has laid the groundwork and pavement for action. Yet, among all the targets, timetables and commitments that were agreed upon, there were no silver bullet solutions to aid the fight against poverty and a continuously deteriorating natural environment (Johannesburg Summit, 2002).

As an implementation-focused Summit, the Johannesburg Summit did not produce a particularly dramatic outcome, but some important new targets were established, namely:

- to halve the proportion of people without access to basic sanitation by 2015;
- to use and produce chemicals by 2020 in ways that do not have significant adverse effects on human health and the environment;
- to maintain or restore depleted fish stocks to levels that can produce maximum sustainable yields on an urgent basis, where possible, by 2015; and
- to achieve a significant reduction in the current rate of loss of biological resources by 2010.

However, it is not only the activities mentioned above that are required to empower rural communities with knowledge on science to improve the quality of their lives. Science must maintain a solid relationship with the society that supports it. Re-forging those ties with South African communities is perhaps the single most important challenge facing science in the immediate future. Educators and journalists have a role to play, but scientists too must recognise that they have a responsibility, according to the US Congress Report (1998).

Although science issues affect society as a whole, not all segments of society voice their opinion on the benefits or risks of scientific developments. Lack of interest, lack of information or lack of access to information can all lead to society feeling excluded from the crucial debates led by politicians on policy formulation, the introduction of new products to the market and the development of new technology that may cause risk to human beings and animals. Although science communication programmes and activities such as science festivals, the National Science, Engineering and Technology Week, various science-related olympiads, as well as competitions and exhibitions of science activities aim to address the lack of knowledge and understanding of science, they still do not always reach all stakeholders, especially people in rural areas, who are the main target groups for these activities.

Further in-depth discussions on development communication and the theories associated with it in addressing a specific stakeholder (for example, rural communities) of an HEI does not form part of this study.

1.6 WHY SHOULD SCIENCE BE COMMUNICATED IN SOUTH AFRICA?

As discussed in the previous sections, it is important to communicate science to ensure prosperity and a sustainable environment in South Africa. However, it is difficult to determine what to communicate

and what to withhold from the community to ensure security and safety. The HIV threat is a good example in this regard: should statistics on how many patients are affected by the virus be communicated to the public, causing major panic worldwide, or should the South African public rather be kept in the dark? To be able to make the best decision on how much science information or results of scientific studies should be conveyed to the public, it is important for South Africa to have a proper SET infrastructure to be able to make decisions to the benefit of everyone in South Africa. For example, the establishment of a discreet scientific board that includes representation from all levels of society and the media would allow the general public to receive correct, important and necessary information about science (Joubert, 2001).

The Australian Department of Industry, Science and Tourism (1996:3-6) suggests the following reasons why scientists all over the world should be allowed to communicate information related to scientific developments:

- to transfer to society or industry the benefits of research;
- to inform policy-makers and leaders about progress that can advance the interests of the community;
- to prepare the public for the advent of new technologies and technological change;
- to share with industry, other scientists and users the findings of research and experience, so they may be combined into a workable technology;
- to bolster economic competitiveness and a lower reliance on imported technological solutions;
- to remedy, and if possible avert, environmental damage caused by the unwise use of technology and resources; and
- to involve the next generation in technological progress appropriate to their evolving society.

In addition to the above reasons, the South African Ciba Foundation Conference report (1987:3) provides several reasons why science should be communicated and promoted in South Africa:

- knowledge of science will result in the electorate making better political decisions;
- understanding the basis of modern science and technology brings economic returns;
- scientific knowledge will eliminate superstition and non-rational views of the universe;
- scientific knowledge defines consequences of behaviour and knowledge will change behaviour; and
- familiarity with the scientific method will lead to a more ethical worldview.

Joubert (2001) argues that in a diverse country such as South Africa, with its 11 official languages and various cultural groups, it is necessary to know what should be achieved and who should be reached with science communication. In her opinion, effective science communication can help in the following ways:

- It can communicate the specialised outcomes of research within the science community itself. Scientists must know about critical areas for development in disciplines other than their own, and be aware of South Africa's role in international collaborative research projects.
- It can gather the support of decision-makers and policy-makers in government and industry, thus ensuring financial and political support for science and technology.
- It can demystify science for people who are not scientists, but who are literate and economically active. The general public should understand enough about science and technology to make informed decisions and improve their quality of life. Their support for scientific research, moreover, is crucial for the growth and expansion of science and technology.
- It can interest young people in career opportunities that ensure the future skills base of the country in science and technology, and enable future entrepreneurs to use science and technology productively.

South African born Mark Shuttleworth is a walking example of how young children can be motivated to become aware of the importance of science. More such examples are required to promote science, especially to the younger generation. All over the world, science can be regarded either as a source of hope or as a threat, and only by communicating it clearly to the public, can the fear of science be reduced (National Association of Science Writers, 2001).

According to Paterson (2004:19), science communication in South Africa is essential, dynamic, challenging, exciting and rewarding. He believes that science communication adds to the quality of life; the quality of the future workforce; public and political support; and the establishment of science as culture and heritage. To demonstrate the essentials of science communication, Paterson (2004:19) summarises the characteristics of science communication, stating what it is and what it is not (see Table 1.1).

Table 1.1: Science communication in South Africa

SCIENCE COMMUNICATION IS NOT	SCIENCE COMMUNICATION IS ABOUT
Promoting an institution	Dialogue
Glorifying science without asking questions	Engagement
One-way flow of information	Respect for audience and context
	Science and how it matters to society
	Scientists as key actors

Source: Paterson (2004:18)

The description of the characteristics of science communication in the above table inevitably suggests the next important element of science communication – the responsible senders of science communication.

As suggested by Joubert (2001), science communication should be the responsibility of everyone involved with science in one way or another. The following are some examples of South African institutions that have representatives acting as practitioners of science communication:

- Government / Government agencies
- South African education institutions
- Science centres and museums
- Science-funding agencies
- Scientific institutions and societies

In South Africa, the Government has specifically tasked the Department of Science and Technology to assist the scientific community, the HEIs, various private and non-governmental organisations, companies, individuals, the media and society at large in promoting, conveying and receiving the message of science.

South African education institutions are encouraged to participate in various roadshows, mobile science demonstrations, science festivals and visits to laboratories and science centres to demonstrate the benefits of science to learners. Various science centres and museums are open to the general public and are located in all the capital cities in the various provinces to convey the importance of science to the whole nation.

Science-funding agencies have been established to provide the necessary funding and contribute to the financial needs of science activities all over South Africa. Scientific institutions and societies are mostly functionaries that assist in providing human resources, material and other assistance with regard to science activities where and when required.

Current science activities and venues in South Africa include the Gateway Discovery Centre Trust, better known as the Discovery Centre, National SET weeks, Sasol TechnoX and SciFest, science centres, planetariums, and mobile science centres, such as the Tsebo Koloing (meaning "technology in motion") truck of the University of Pretoria.

Although these science activities are initiated by government, science organisations, schools, HEIs and scientists, they are not the only ones who are responsible for communicating science. Industry and the media should also contribute towards communicating science to the general public (Joubert, 2001).

According to Joubert (2001) South Africa offers unique opportunities for promoting an interest in, awareness of and curiosity about science. These opportunities include magnificent night skies, environmental diversity and a rich fossil heritage. Archaeology, palaeontology and astronomy are recognised as premium channels for switching on the curiosity of children and luring them into science and technology.

However, there is unfortunately not a sustained, coordinated effort to communicate science, with the result that communication about current science initiatives such as science festivals occurs largely on an *ad hoc* basis. A more sustained and coordinated effort, backed by research, infrastructure and expertise, could put South Africa's science communication on the map.

Practitioners of science communication (scientists, communication specialists and journalists) lack a network and therefore work largely in isolation. Their activities compete with, rather than complement one another, and therefore have little national impact and attract sparse media attention (Joubert, 2001).

1.7 ORIENTATION TO THE RESEARCH PROBLEM

Defining the research problem is perhaps the most important responsibility of the researcher (Dillon, Madden & Firtle, 1993:25). It is the responsibility of the researcher to assure that the problem at hand is defined accurately and precisely.

The problem at hand in this study is that although science communication is regarded as a priority, science messages do not reach the general public effectively. There are various possible reasons why the general public is not well informed about science. One of the reasons is that scientists find it difficult to simplify scientific facts for the layman to understand. Secondly, there is no relationship of trust and mutual understanding between scientists and journalists, resulting in inaccuracies in science articles in newspapers, magazines and television. Thirdly, communication specialists at HEIs, who are supposed to take responsibility for media liaison, experience a lack of trust and empowerment by their executive management to liaise with stakeholders, including the media, at their own discretion. Executive managements at HEIs do not empower their communication specialists to discuss matters with the media without having the executive management involved (De Beer, 2001:84). Fourthly, a lack of training in writing science articles results in inaccurate coverage of science in the media. The role of communication specialists at HEIs is therefore very important. It must be the task of these communication specialists to build a bridge between an institution's management, scientists and the media as stakeholder of HEIs.

For the purpose of this study, a distinction is made between key role players in science communication and stakeholders of HEIs. Stakeholders refer to every person receiving science messages from an HEI, while key role players refer to people involved in the distribution of science messages (i.e. the executive management, scientists, communication specialists at HEIs and the mass media). Since science communication has been identified as a high priority by government, the editors of newspapers must also recognise the importance of science and should pay attention to science when determining the agenda-setting function. Science should be a highly prioritised item on the agenda. Although editors form an integral part of the mass media, for the purpose of this study, only journalists were included, since they are the writers of science articles and are also the first contacts when dealing with the media.

1.7.1 The role of key role players in science communication

In any higher education institution, science is of high importance and it is fully supported by executive management. However, the perception exists that although executive management supports research and science, the communication of science to stakeholders is not regarded as a priority.

According to Dozier *et al.* (1995:128), key to communication excellence and effective science communication is the support of executive management, in other words a management that trusts and empowers its communication specialists to communicate with all stakeholders. Executive management constitutes the outside layer or supporting system of the sender (scientists) and the facilitators (communication specialists) of science communication. It is, therefore, imperative that executive management relies on communication specialists to provide the expertise, knowledge, opinions and behavioural predispositions of all stakeholders of an institution.

Scientists often claim that they do not have the marketing skills and/or personality needed to communicate science to non-scientists. Scientists are originators, and therefore the senders of the science message. They therefore constitute an essential component of the science communication relationship between the key role players.

Communication specialists at HEIs also have a very important role to play in making the work of scientists known to stakeholders, including schools, students and the general public. In other words, the communication specialists are the facilitators in the communication process. It is their duty to mediate the communication process between the originators or senders (the scientists) and the final destination of the message, namely the various recipients. Although communication specialists agree that this is a huge responsibility, members of the executive management of these institutions often obstruct the communication specialist's efforts to communicate with the media, since the communication specialist is not trusted or empowered by the HEI to use his/her own discretion to convey scientific matters.

According to Grunig (1992:485), power comes to communication specialists from different sources. The value that executive management attaches to the communication function is one key way, while the expertise of specialists, leading to increased professionalism, is another.

Another very important component lacking in many educational institutions is trust in communication specialists to act correctly when dealing with the media. Axley (1996:161) states that trust is one of

those qualities that affects almost everything of importance about human relationships. The actions of trusted people have a different meaning than the actions of distrusted people. Distrust taints everything it touches in a team: communication, leadership, decision-making, problem-solving, even a team's very culture, if it persists long enough. Relationships based on "positive" power resources such as trust, liking, respect and love are both more effective and efficient. Such relationships can themselves be excellent motivators to accomplish agreed-upon goals (Axley, 1996:81).

Communication specialists at HEIs are often tasked with the organisation, participation in and management of science activities. They also constitute a very important link between scientists and journalists. Without the communication specialist who is responsible for editing science articles from scientists; establishing contact with journalists of the various media; being responsible for building relationships with stakeholders, the general public and students; and conveying the image of the institution, a relationship between scientists and journalists alone will not be completely successful. Furthermore, an important question to ask is, in their role as facilitators and spokespeople of HEIs, are communication specialists regarded as strategists, managers or technicians in carrying out their task of science communication at their respective institutions? According to Steyn and Puth (2000:20), the strategist role, which is played at the macro or top management level of an organisation, is to constitute a strategic role for the most senior corporate communication specialist responsible for the corporate communication function. In science communication, could it be argued that the executive management should fulfil the role of a strategist?

The manager role, played at the functional, departmental or divisional level of an organisation, is to develop a corporate communication strategy and policy for the organisation. It is the manager's role to decide what should be communicated to stakeholders to solve problems that have developed in the relationship with stakeholders. Could this be the function of communication specialists in science communication?

The same questions could apply to communication specialists at HEIs who are responsible for the science communication plan and strategies to achieve the institution's objectives. If these questions are answered affirmatively, it would be the role of the manager (communication specialists) to implement the standards set by the strategist (the executive management) in developing the relationship with stakeholders. The role of technician is played at the implementation or programme level. This person would be responsible for implementing communication plans or campaigns directed

at the organisation's stakeholders (Steyn & Puth, 2000:20). In science communication, could the communication specialist perhaps also have to play the role of technician?

Although the media can be the channels through which the science message is conveyed, journalists and editors (especially the latter) are also the gatekeepers in the science communication process. As gatekeepers, they decide what information will eventually reach the audience through the mass media. Each individual in society will receive messages from the mass media through filters or frames of reference. These filters may have either a positive or a negative effect on the message received (De Beer, 1998:17).

The role of the editor is to decide which articles will be published and what the main article will be, opposed to the journalist who writes the articles. The editor bases his decision on what will appear in the news on the articles written by the journalist. Therefore, if the journalist writes articles that are not in the interest of the general public or are not understandable by the audience, the editor will not publish the articles. Journalists also fulfil a gatekeeper's function, because they need to determine whether a particular event is newsworthy or not. Should they decide that an event is newsworthy, it is imperative that the facts are correct and are correctly interpreted by the journalists.

Training on how to write science articles that can be understood by the general public is specifically important when a journalist has to report on scientific developments and research results. It is only once scientists, communication specialists and journalists are properly trained in writing science articles, that the integrity of science representation can be maintained (Priest, 1998). Currently there seems to be a lack of training courses in South Africa to enable journalists to write proper science articles.

Unfortunately, some scientists still doubt the ability of journalists to report accurately and responsibly on their work, while journalists complain that scientists are bad communicators, hiding behind jargon. This misunderstanding between scientists and journalists leads to concerns about the relationship (or lack of a relationship) between scientists and journalists. This misunderstanding is also linked to a lack of proper training to enable journalists to write factually correct and reliable science articles. Since neither scientists nor communication specialists or journalists are usually properly trained to perform media interviews with regard to science, facts are skewed or oversimplified when printed in newspapers, which has a negative effect on the recipients (stakeholders). Again, the role of the

communication specialist is highlighted to facilitate a proper relationship by fulfilling a mediation function in the science communication process.

1.7.2 The relationship between key role players in science communication

The end receiver of the science message is the general public or other stakeholders of the HEI, including even the specific HEI's competitors. Since the general public, as one of the stakeholders of the HEI, has been identified by the South African government to be the recipient of science communication, the focus in this study is on the general public as the end recipients of the science communication message. However, the second phase of the study focuses on the mass media, as another stakeholder of HEIs.

The stakeholders are not only the recipients of science communication, who should be provided with information regularly, preferably on an interpersonal basis. It is also important that their input be requested and considered when science communication activities are discussed. This is necessary to ensure a proper two-way flow of information between HEIs and their stakeholders.

Furthermore, it is imperative for communication departments to be aware of the expectations and perceptions of stakeholders before possible problems arise (Steyn & Puth, 2000:203). In any institution, company or organisation[2], communicating with relevant stakeholders remains a critical component of excellent communication departments, especially when specific messages should reach identified stakeholders, such as in communicating science to them.

To enhance the promotion of science communication to all stakeholders, including cultural groups, the literate and illiterate segments of society in South Africa, it is important that a relationship of trust should exist between key role players, namely executive members at HEI, scientists, communication specialists at HEI and journalists. Without a positive and working relationship between these role players, the science message will not reach other stakeholders effectively.

Ledingham and Bruning (2000:178) quote Berko, Rosenfeld and Samovar in defining the term relationship as follows: "The connection that exists when the interactants are aware of each other and take each other into account; there is some exchange of influence and there is some agreement about

[2] Although institution, company or organisation will be used alone or exchanged for one of the other two concepts throughout the study, the use of one will each time refer inclusively to all three.

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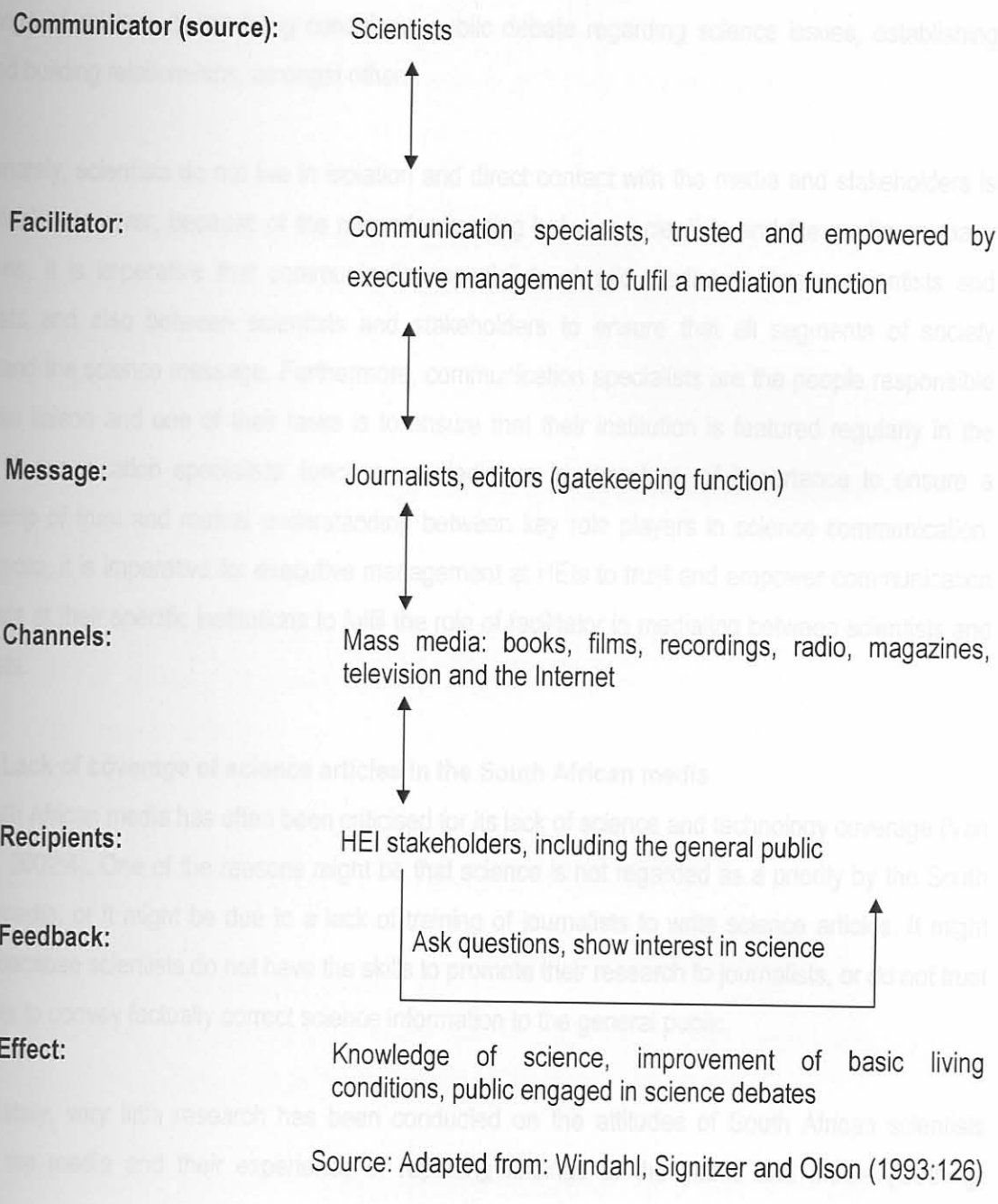
what the nature of the relationship is and what the appropriate behaviours are, given the nature of the relationship."

Because relationships can have a powerful influence on media decisions and perceptions or satisfaction, communication specialists should develop relationship programmes grounded in relationship dimensions such as those of trust, openness, involvement, investment and commitment (Ledingham & Bruning, 2000:169). These relationship programmes must be designed to provide benefit to both the institution and the key public. Borchelt (2002:19) suggests a 'portfolio of trust' including elements such as competence, integrity and dependability, which should be controlled by role players in any successful relationship.

This is not only applicable to this study, but also particularly important in science communication and in the relationship between the key role players, since it suggests that the cornerstone on which relationships are built is trust (Ledingham & Bruning, 2000:169). All role players in science communication at HEIs should, therefore, engage in relationship-building activities, actions and communication.These activities build the role players' credibility, reputation, reliability and dependability, as well as promoting honest communication and active participation in the relationship. However, for many, the relationship between scientist and journalist remains difficult, sometimes even hostile. Overcoming the "us and them" dynamic, therefore, requires commitment from both parties, and communication specialists at HEIs should act as facilitators to improve this relationship.

Figure 1.1 is adapted from a model by Windahl, Signitzer and Olson to illustrate the flow of communication (Windahl, Signitzer & Olsen, 1993:136). Figure 1.1 attempts to accommodate the proposed flow of communication in science communication at HEIs.

Figure 1.1: A proposed illustration of the flow of science communication at HEIs



Source: Adapted from: Windahl, Signitzer and Olson (1993:126)

In Figure 1.1, scientists (as the source) generate science and through the facilitators (communication specialists who mediate the communication process) the message is conveyed to the media. The journalists and editors, who are supposed to distribute the message to the recipients (all HEI stakeholders, including the general public), are also gatekeepers. The editors have the power to decide whether the science message is important enough to be distributed. This decision forms part of the agenda-setting function of editors. The journalists decide on the content of the message (article) and determine what facts to be included. Therefore, it is critical for journalists to receive training in

science writing. Stakeholders, including the literate and illiterate, urban and rural societies, as well as old and young people, provide feedback on the message they have received. The effect should be knowledge of science, better living conditions, public debate regarding science issues, establishing trust and building relationships, amongst others.

Unfortunately, scientists do not live in isolation and direct contact with the media and stakeholders is unavoidable. However, because of the misunderstanding between scientists and the media on many occasions, it is imperative that communication specialists should mediate between scientists and journalists and also between scientists and stakeholders to ensure that all segments of society understand the science message. Furthermore, communication specialists are the people responsible for media liaison and one of their tasks is to ensure that their institution is featured regularly in the media. Communication specialists' function as mediators is, therefore, of importance to ensure a relationship of trust and mutual understanding between key role players in science communication. Furthermore, it is imperative for executive management at HEIs to trust and empower communication specialists at their specific institutions to fulfil the role of facilitator in mediating between scientists and journalists.

1.7.3 Lack of coverage of science articles in the South African media

The South African media has often been criticised for its lack of science and technology coverage (Van Rooyen, 2002:4). One of the reasons might be that science is not regarded as a priority by the South African media, or it might be due to a lack of training of journalists to write science articles. It might also be because scientists do not have the skills to promote their research to journalists, or do not trust journalists to convey factually correct science information to the general public.

Unfortunately, very little research has been conducted on the attitudes of South African scientists towards the media and their experience of reporting findings to the public and media (Gething, 2001:4).

1.8 PROBLEM STATEMENT

The problem in this study is that the message of science is not effectively communicated to the general South African public, including both the literate and illiterate; urban and rural; young and old segments of society, by key role players in science communication, because the relationship between these key role players in science communication in this country has not yet been established as a relationship of trust and mutual understanding.

1.9 CLARIFICATION OF TERMS AND DEFINITIONS

In the previous sections, certain terms and definitions were used, such as science communication, key role players, stakeholders, etc. However, for the sake of uniformity, these terms and definitions have to be clarified.

1.9.1 The relationship between communication, science and science communication

The essence of science communication has been discussed in detail previously in this chapter. However, to summarise, science communication means to convey messages of science-related issues to the non-scientific population, but what is the relationship between communication and science?

In describing approximating or achieving conveyance of a message, the word **communication** is used to refer to an outcome or end-effect (Mody, 1991:41). Another use of the term refers to the process (Axley, 1996:11). The word 'communication' comes from the Latin *communis,* which means 'common'. The word 'community' comes from the same Latin word. The aim of communication as an outcome is to 'make common', to share. Communication is achieved when the sender and the recipient have meaning in common, i.e. when the meaning the sender wanted to share is identical to the meaning the audience receives (Mody, 1991:41).

According to King (2002:1), there is not a single definition for **science**, but science can be described as:

- theory, conjecture, experiment, observation, etc;
- a social construct put together over many centuries by people, each with limited cognitive capabilities, but in a manner following norms and principles.

Fetzer (1993:5) suggests that science aims to discover the laws of nature (such as erosion of ground water tables), which can provide a foundation for empirically testable explanations. It also hints that science is descriptive. Another definition reads: "Science, to put its warrant as concisely as possible, is the organised, systematic enterprise that gathers knowledge about the world and condenses the knowledge into testable laws and principles" (Ridley, 2001:21). Nelkin (1987:21) offers a variation of the definition and describes science as the superior form of knowledge; and those who have reached its pinnacle have some special insight into every problem.

For clarification, in this study science is referred to as any new idea, concept, experiment or product that was in one way or another systematically obtained and tested according to a known and acceptable method that has an influence on society at large. This includes anything from a new mathematical rule to an innovative technological device. **Science communication** can then be seen as sending messages of these new developments to the general public, including children and the illiterate and literate segments of society.

To facilitate the process of science communication, science communication activities and programmes were identified to promote science to the general public. These activities provide hands-on experiences to the general public to explore the application of science by playing, touching and experimenting certain sciences and include, amongst others, the following South African examples:

- Science weeks (where schoolchildren participate in science experiments).
- Science festivals (displays of science experiments, talks and hands-on science experiments open to the general public).
- Science centres (displays of science experiments, hands-on science experiments to play with for groups of schoolchildren and anyone else interested in science).
- Mobile science centres (e.g. the Starbus of the South African Astronomical Observatory and the University of Pretoria's mobile technology laboratory, Tsebo Koloing).

1.9.2 The relationship between all stakeholders and key role players in science communication

In this study, **stakeholders** refer to the general public, composed of non-scientists, government, private companies, the illiterate and literate segments of society, and the media, to name but a few. In comparison, the key role players in science communication include executive managements, scientists and communication specialists at South African HEIs, as well as the media, specifically South African journalists. For the purpose of this study the term **executive management** includes the Rector (Principal) and Vice-Rectors (Vice-Principals) at HEIs in South Africa.

In 1902, Huxley defined scientists as wizards and magicians, socially isolated from society. "The scientist appears akin to the medicine man ... the multitude thinks of him as a being of quasi-supernatural and romantic powers". Today scientists still appear to be remote, but superior wizards, above ordinary people, culturally isolated from society (Nelkin, 1987:14). However, although perceptions of scientists differ, the fact remains that they do such specialised and important work that they operate outside a common intellectual or cultural tradition (Nelkin, 1987:20).

In the present study, the term **scientists** refer to the experts at HEIs who explore, investigate, discover and design new ideas, concepts and devices in the natural, medical and agricultural sciences, as well as in the engineering and technology fields.

A **communication specialist** is defined as the person who is responsible for marketing, internal and external communication, media liaison, public relations and stakeholder relationships within an HEI in South Africa. The **journalist** is the person who writes articles on subjects covering education, environment, health and general news. Science in itself, depending on the type of media, is normally not a category on its own, and in most mass media in South Africa, any science news is categorised according to one of the four categories mentioned above, namely education, environment, health or general news. For the purposes of this study, media also refers to mass media and the two terms are used interchangeably. Mass media implies messages that are distributed to a mass of people at the same time. The words, print media and press both refer to print media, such as newspapers and magazines. Once again, the two terms are used interchangeably.

Editors and journalists are part of the media, since they are the representatives of the media. Editors are the agenda setters, as editors decide which articles should appear in the printed media and which should not, while journalists are gatekeepers, since they decide on the content of a particular article and whether it is newsworthy enough to report on.

Due to the importance of distributing the message of science effectively, a relationship of trust and mutual understanding between all the key role players in science communication is vital.

1.10 AIM AND OBJECTIVES

1.10.1 General research aim

The general research aim of this study is to investigate the relationship between key role players in science communication and to determine the role of the key role players in science communication. The key role players refer to executive management, scientists and communication specialists at HEIs, as well as South African journalists.

Following from the general research aim, six research objectives have been identified. The first objective pertains to how important science communication is to key role players, these being executive management, scientists, communication specialists at South African HEIs and South African

journalists. The second objective addresses the relationship between these key role players. The third involves the role of communication specialists in science communication. Specific focus on the three levels of communication specialists as mentioned above, namely strategists, managers or pure technicians, will contribute to determining the requirement of the role of communication specialists in science communication. The fourth objective addresses the training of scientists, communication specialists and journalists in conveying the science message to other stakeholders of HEIs. The fifth objective pertains to the coverage of science in selected print media in South Africa, while the sixth concerns the content of scientific articles that appeared in selected South African print media over a three-month period. A comparison with a study conducted in 2002 by Van Rooyen (2002:1) is also done. The fifth and sixth objectives are included in the study to determine the success of communication specialists in their relationship with the media. One of the responsibilities of communication specialists is to ensure that science is communicated to the media. If the coverage is sufficient, it will imply that communication specialists have succeeded in their task of building a relationship with the media. For ease of reference, the research objectives are stated next.

1.10.2 Research objectives

- **Objective 1:**

  To determine the importance of science communication amongst key role players of science communication, (executive management, scientists, communication specialists) at HEIs in South Africa, as well as journalists in the South African media.

- **Objective 2:**

  To determine if a relationship of trust and mutual understanding exists between key role players in science communication in South Africa.

- **Objective 3:**

  To determine if the role of communication specialists is a role of strategist, manager or technician in the facilitation process in science communication at HEIs in South Africa.

- **Objective 4:**

  To determine the extent of training provided at universities and technikons in South Africa for scientists, communication specialists and journalists to enable them to write science articles.

- **Objective 5:**
  To investigate the coverage of scientific topics in articles in the South African mass media.

- **Objective 6:**
  To analyse the content of articles on science in selected South African media from 1 March to 31 May 2004 and to compare the results of this study with Van Rooyen's study conducted in 2002.

Cooper and Schindler (2001:14) stated that the term 'empirical' points to the requirement for the researcher to test subjective beliefs against objective reality and have findings open to further scrutiny and testing. In this study, empirical research is used to test the six objectives stated above.

1.11 CONCEPTUAL FRAMEWORK

By stating the general aim in relation to possible sources for solutions, the theoretical and empirical logic of this study is clarified. The nature of the research problem necessitates a brief explanation of the interrelatedness of the domains within which this study falls, as well as the various theories that govern this study. These domains and theories are summarised in Figure 1.2 and are discussed below and later in the study.

1.11.1 Meta-theoretical approach

The meta-theoretical approach applicable to this study is systems thinking within a systems approach.

The systems approach is an abstract perceptual framework that is an exceptionally good aid to understanding and practising communication. The approach identifies the principles common to all systems, the most important of which are wholeness, hierarchy, self-regulation, openness and adaptability (Lubbe & Puth, 1994:41).

The development of the general systems theory is one manifestation of the fundamental changes in the nature of scientific analysis. Rather than investigating the universe in a cause-and-reaction frame of mind, researchers have realised that any cause-and-reaction relationship takes place in a more complex system of relationships. Nothing is analysed in isolation, but in terms of its relationship with others within a larger system (Turner, 1991:118).

These systems of inter-influential happenings indicate that the whole is larger than the sum of its parts. Among the modern scientists, Ludwig von Bertalanffy was the first to advocate a general systems approach. Various other scientists joined in and the groundwork was established for the general systems theory (Turner, 1991:118).

The theories on which the theoretical framework is based in the theoretical part of this study can be summarised as: Science communication as information (information theory, Chapter 2) that has to be communicated to stakeholders (stakeholder theory, Chapter 3) through mediums such as mass communication (mass communication theory, Chapter 2). However, to achieve science communication successfully, strategic science communication planning is required. Therefore, the general theory of excellence in public relations/corporate communication management and corporate communication strategy are discussed in Chapter 4. To conclude the theoretical framework, the roles of the key role players in science communication are discussed in Chapter 5.

1.11.2 World view

According to Steyn and Puth (2000:188): "interactivity implies communication and communication has the natural consequence of relationships". Relationships will last when the needs and objectives of stakeholders are positively matched with the needs and objectives of the institution.

Theories of organisational relationships support the idea that there is a functional connection between the quality of communication – the excellence of public relations – and the nature of relationships between organisations and their stakeholders (Steyn & Puth, 2000:195). According to Dozier *et al.* (1995:82), the excellence study (which is discussed in detail in Chapter 4) should confirm or modify that connection.

Ferguson (in Dozier *et al.*, 1995:83) identifies attributes of relationships to define and measure the quality of an organisation's relationships with stakeholders:

- dynamic vs static relationships;
- open vs closed relationships;
- the degree to which both the organisation and stakeholders are satisfied with the relationship;
- distribution of power in the relationship; and
- the mutuality of understanding, agreement and consensus.

Like all partnerships, stakeholder collaboration is a two-way working relationship that combines the capabilities of partners for their mutual benefit. Since knowledge is such a fluid, intangible asset that can be transferred easily, and since its value increases when it is shared, it provides powerful justification for stakeholder collaboration. Stakeholder collaboration does more than gain resources and political support: it allows joint problem-solving to increase the institution's store of valuable knowledge of scientific developments (Halal, 2000).

Dozier *et al.* (1995:83) and Grunig and Hon (1999:8) suggest that the value of public relations can be determined by measuring the quality of relationships with stakeholders where value indicates trust and credibility.

1.11.3 Domains

The essence of the general aim falls within two domains, namely science communication and strategic communication management.

Dimensions such as the importance of science, the role of each key role-player at HEIs, the specific role of the communication specialist as facilitator of the communication process, the participation of internal and external stakeholders, and the relationship between the role players within the context of the research objectives all point to the two domains of this study.

1.11.4 Theories

The specific theories relevant to this study are explored in chapters 2 to 5. These theories include the communication theory, information theory, mass communication theory, stakeholder theory, the general theory of excellence in public relations/corporate communication management, the gatekeeper theory and, to a lesser degree, the agenda-setting theory.

1.11.5 Major concept

The major concept is derived from the general aim and is thus defined as "the role of key role players in science communication". This concept is further explored in chapters 4 and 5.

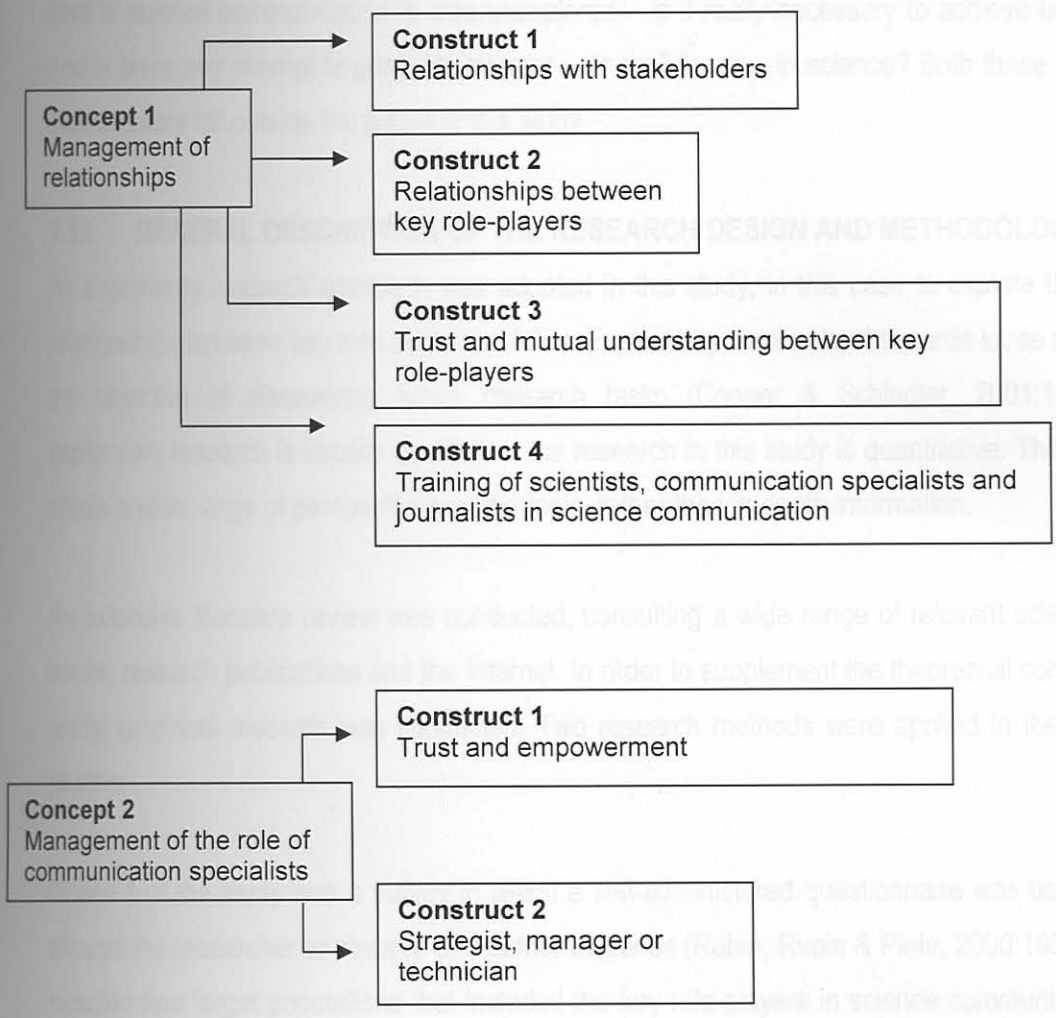
Figure 1.2: Conceptual framework

Meta-theoretical approaches	Systems thinking ⇩ Systems approach	
World view	Relationship management within a communication approach	
Domains	Science communication	Strategic communication
Theories	• Communication theory • Information theory • Mass communication theory • Gatekeeper theory • Agenda-setting theory	• Stakeholder theory • General theory of excellence in public relations/corporate communication management • Corporate communication strategy
Major concept	The role of key role players in science communication	
Concept 1	Management of relationships	
Constructs	• Relationships with stakeholders • Relationships between key role players • Trust and mutual understanding between key role players • Training of scientists, communication specialists and journalists in science communication	
Concept 2	Management of the role of communication specialists in science communication	
Constructs	• Trust and empowerment • Strategists, managers or technicians	

1.11.6 Concepts and constructs

The purpose of academic research is either to develop new theory, or to change or expand existing theory. In this study, communication theories are used to apply existing theory to science communication. Empirical research is applied to measure the building blocks or concepts. Concepts are generally accepted as bundles of meanings or characteristics associated with certain events, objects, conditions, situations and behaviours (Cooper & Schindler, 2001:39). However, a bundle of meanings do not provide a clear framework for research. Therefore, constructs are used to turn these bundles of meaning into an image or idea specifically invented for a given research and/or theory-building purpose (Cooper & Schindler, 2001:41). In this study each concept is linked to the major concept and the constructs derived from these concepts contribute to the empirical investigation of the research objectives. As illustrated in Figure 1.2, two concepts with their constructs are identified. For ease of reference these concepts and constructs are represented in graphic format in Figure 1.3 and are discussed afterwards. Emphasis is placed on the relationship between the key role players, since they are the core elements to communicate science and in their successful relationship the other constructs are intermingled.

Figure 1.3: Conceptual framework underlying this study



1.12 DELIMITATION OF THE STUDY

The study is exploratory in nature due to the fact that limited prior research has been conducted in South Africa on this topic. Since the study focuses only on South African HEIs, the results and recommendations may not be generalised to a wider context.

Stakeholders (recipients of science messages) of HEIs include the general public, consisting of a wide variety of social groups, for example the government, schools, students, the illiterate and literate segments of society, industry, the media and parents, to name but a few. Because the key role players in science communication are also stakeholders of HEIs and due to the fact that this study is exploratory in nature, only key role players as representatives of all stakeholders were included in this study.

The politics of science communication has barely been explored. People must still be empowered to ask the right questions, challenge decision-makers, and hold government accountable. The ultimate goal of science communication is also unexplored – is it really necessary to achieve understanding? And is there any attempt to generate interest – or confidence – in science? Both these questions and their answers fall outside the scope of this study.

1.13 GENERAL DESCRIPTION OF THE RESEARCH DESIGN AND METHODOLOGY

An exploratory research approach was adopted in this study, in this case to explore the role of and relationships between key role players at HEIs. Exploratory studies tend towards loose structures with the objective of discovering future research tasks (Cooper & Schindler, 2001:134). Although exploratory research is usually qualitative, the research in this study is quantitative. The purpose is to obtain a wide range of perspectives on the topic, rather than in-depth information.

An extensive literature review was conducted, consulting a wide range of relevant scientific journals, books, research publications and the Internet. In order to supplement the theoretical component of the study, empirical research was conducted. Two research methods were applied in the two research phases:

Phase 1 of the study was a survey in which a self-administered questionnaire was used, because it allowed the researcher to observe and gather evidence (Rubin, Rubin & Piele, 2000:193). The sample included four target populations that included the key role players in science communication, namely executive management, scientists and communication specialists at HEIs, as well as journalists. Data collection was done by means of an electronic questionnaire survey, with only close-ended questions. Descriptive statistics were used to analyse the data obtained. Results are presented graphically by means of tables and bar charts.

Phase 2 of the study was conducted by means of content analysis. According to Lindenmann (1997:398), media content analysis is defined as the process of studying and tracking what has been written and broadcast, translating this qualitative material into quantitative form through some type of counting approach that involves the coding and classifying of specific messages.

Therefore, the research conducted by the content analysis was quantitative in nature to gain a wide range of perspectives on the topic of science communication. These perspectives included the amount of coverage, local vs foreign sources, coverage according to 'new discoveries' and 'feature' articles, evaluative tone of coverage, use of visuals and infographics, discourse of benefits and risks,

prominence of coverage and weighting of the scientific fields covered. The unit of analysis was science articles for the period 1 March to 31 May 2004. The sampling frame was the printed media, which was divided into three groups: daily newspapers, weekly newspapers and family magazines. Data collection was done by selecting science articles in the selected sampling frame on a weekly basis and compiling a unique electronic database. Data analysis was done by predetermined categories, which were coded to be analysed statistically with the help of an SAS statistical programme. The results are presented in table format and bar charts, and they are compared with a similar study conducted in 2002 (Van Rooyen, 2002:3).

1.14 THE IMPORTANCE OF THE STUDY

Science communication is still a new and vague concept to many South Africans. Limited research has been conducted on the key role players of science communication, the specific role of communication specialists at HEIs in science communication, as well as on the relationship between the key role players.

This study aims to contribute to the body of knowledge in science communication in three ways. Firstly, it describes the current state of science communication and the importance of science communication for South Africa. This is followed by a discussion of the facilitator role of communication specialists in science communication and the value they can add in general regarding the promotion of science communication and the increase in the volume of science communication in the country. Thirdly, an explanation is offered on the relationship between the key role players that can ensure the improvement of science communication in South Africa.

1.15 DEMARCATION OF CHAPTERS

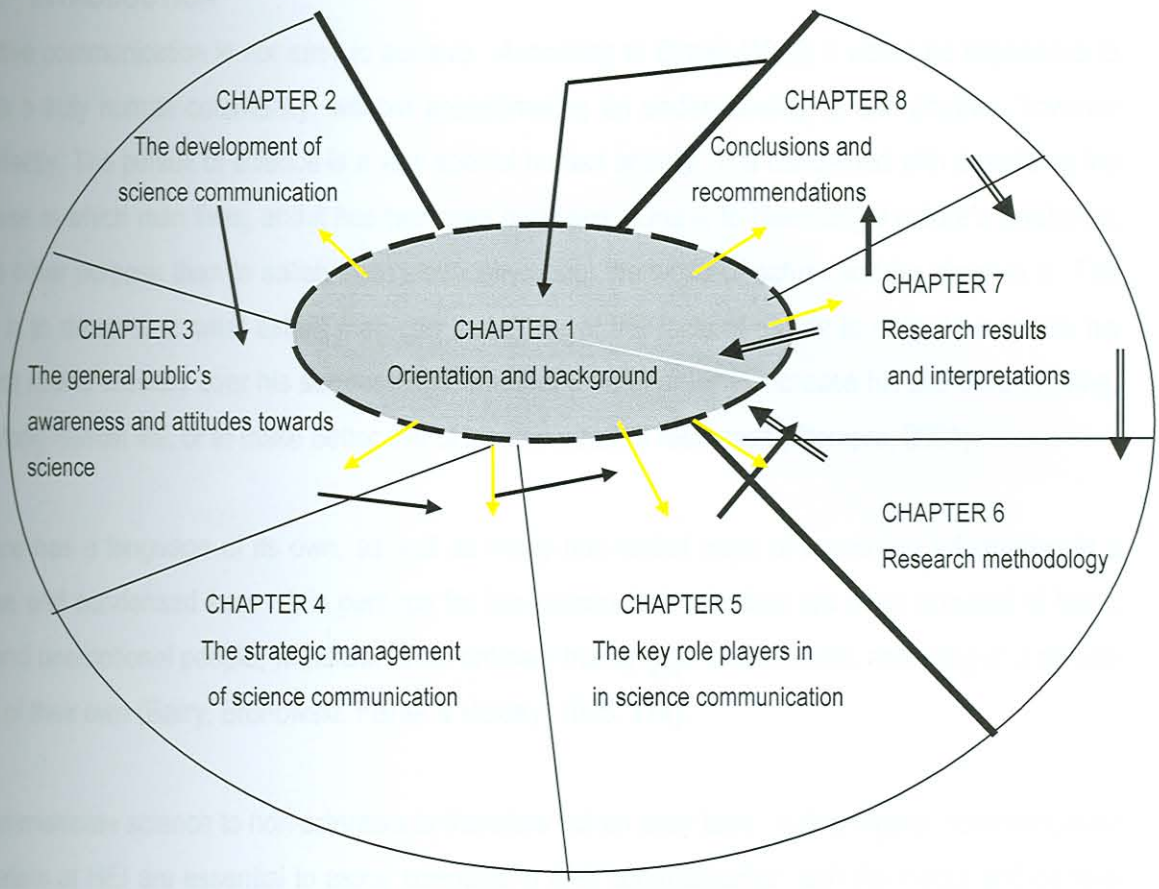
This study comprises eight chapters, including the current chapter. Table 1.2 provides a summary of the demarcation and content of each of the chapters.

Table 1.2: Demarcation and content of chapters

CHAPTER	CONTENT
Chapter 1: Orientation and background	The reader is introduced to the problem that the study investigates. An overview is provided of the research objectives, research design and literature. The conceptual framework underlying the study is also described.
Chapter 2: The development of science communication	Besides the history and development of science communication, the tools for communicating science are also discussed. A description is offered of the theories on which the science communication domain is based, namely information theory and mass communication theory.
Chapter 3: The general public's awareness and attitudes towards science	Previous studies conducted in various countries to analyse the public's attitude towards science are quoted and compared to studies performed in South Africa. The stakeholder theory, which provides an important theoretical base for this study, is also included.
Chapter 4: The strategic management of science communication	Perspectives on communication strategy and its importance in science communication are discussed. The excellence study in public relations and strategic management and the role of communication departments are also explained.
Chapter 5: The key role players in science communication	The role of each of the key role players in science communication is described and their relationship with the media is outlined. The gatekeeper theory and the agenda-setting theory that underpin the theoretical framework are also described.
Chapter 6: Research methodology	The research methodology followed in this study is described in terms of research strategy, design, methods and techniques.
Chapter 7: Research results and interpretations	Results of Phase 1 (the survey), as well as of Phase 2 (content analysis) are provided and interpreted.
Chapter 8: Conclusions and recommendations	Conclusions are drawn from both the theoretical and empirical components of the study. Recommendations for future research are made.

The demarcation of chapters is illustrated visually in Figure 1.4. Chapter 1 is central to the study, since it provides an introduction and background to the study. Chapters 2 to 5 follow in sequential order and represent the theoretical component of this study. Chapters 6, 7 and 8 deal with the research methodology, research results and interpretations, and conclusions and recommendations respectively. There is a constant interplay between Chapter 1 and chapters 6, 7 and 8, as illustrated by the double arrow, as well as between chapters 6, 7 and 8.

Figure 1.4: Demarcation of chapters



Chapter 2
The development of science communication

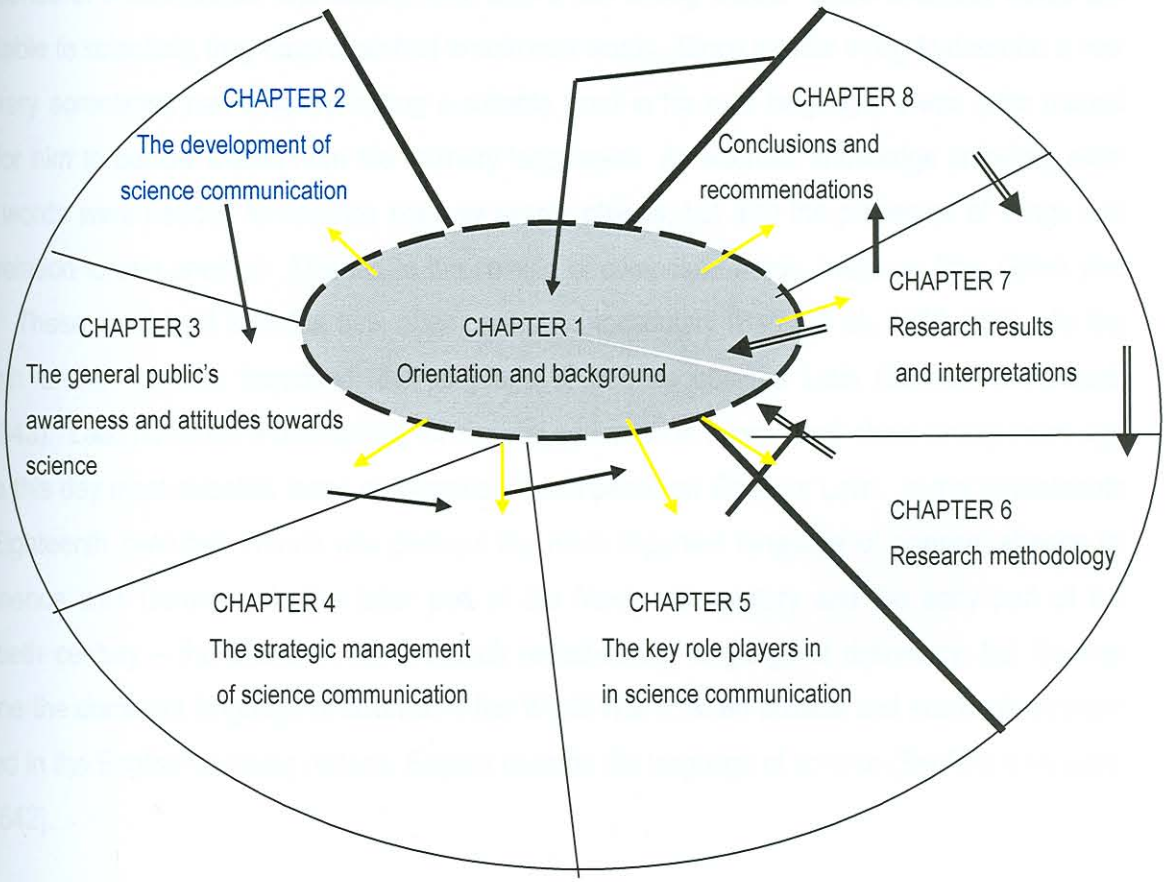
2.1 INTRODUCTION

Effective communication is not easy to achieve. According to Bittner (1988) it would be impossible to act as a truly human community, without approximating an understanding of one another, however imperfectly. The pursuit of science is a very special human activity. It is concerned with describing the universe in which man lives, and it has two main purposes. One is to disentangle nature's mysteries, for no other purpose than to satisfy man's curiosity about the world of nature and his place in it. The other is to discover to what extent man can make use of the facts of nature in order to increase his interest in and mastery over his surroundings, whether it be in order to increase his standard of living, to prolong human life, or to make better use of his raw material resources (Stempra, 2001).

Science has a language of its own, as well as many non-verbal ways of conveying information in a precise and condensed form. It is perhaps for this reason that scientists are often accused of being cold and unemotional people, withdrawn from ordinary human joys and sorrows, and living in a remote world of their own (Barry, Bronowski, Fisher & Huxley, 1965: 174).

To communicate science to non-scientists is therefore not an easy task. In this regard, communication specialists at HEI are essential to assist scientists in their communication with the media and general public in South Africa. Theoretical perspectives are discussed to elucidate the term science communication. Tools and vehicles to convey the message of science are included and finally communication to a mass audience is discussed. Chapter 2 establishes the connection between Chapter 3 (which addresses the awareness of science, engineering and technology) and Chapter 4 (where strategic communication planning is explained). Chapter 1 however remains the pivot of the study throughout. The structure of the study is illustrated in the following figure for ease of reference.

Figure 2.1: Chapter 2 in relation to other theoretical chapters



2.2 UNDERSTANDING SCIENCE COMMUNICATION

Because science concentrates on facts and figures, its language contains no shade of meaning, no humour, no excitement and no lyrical passages of the kind that is found in novels (Rowe, 2000:435). The language of science is in fact dull and even boring to the layman, and it makes no appeal to people who love literature for its own sake. However, its precision gives it one very valuable property, since it can be translated from one language to another without loss of information. This means that the results of scientific research in one country can be made available in any other country. Since scientific research is international, the free exchange of accurate information across national boundaries makes for economy of effort and prevents the same work from being done twice over (Barry *et al.*, 1965:174). Therefore, scientists, for all their restrictive use of words, actually have an advantage over novelists and poets.

Mathematics is an essential part of the language of science. In fact, much research can be reported as a series of mathematical expressions, with only a few linking words. Since everyday words are unsuitable to scientists, they have often had to coin new words. Since a writer trying to describe a new discovery sometimes had difficulty finding a suitable word in his own language, it was quite natural then for him to borrow a term from the ordinary languages. As scientific knowledge unfolded, even more words were needed to describe not only simple objects, but also the properties of things and their relation to one another. This led to the coining of composite words, made up from Greek and Latin. These words still form the bulk of our scientific vocabulary (Barry *et al.*, 1965: 185). As the strength of the Romans increased, the language of science became Latin (Benfield & Howard, 2000:643). Latin remained a prerequisite for medical education in Europe until about twenty years ago and to this day most scientific terms and names are still based on Greek or Latin. In the Seventeenth and Eighteenth centuries French was perhaps the most important language of science, sharing its prominence with German. In the latter part of the Nineteenth century and the early part of the Twentieth century – the Bismarck era – French remained the language of diplomacy, but German became the dominant language of science. After World War II, when political and economic strength centred in the English-speaking nations, English became the language of science (Benfield & Howard, 2000:642).

According to Barry *et al.* (1965:185), a great achievement of the Greeks in science development was that they discovered and proved certain relationships that were true in any situation. For instance, they proved that the three angles of any triangle add up to 180 degrees. This and other relationships make up the science of triangles, or trigonometry, which is still applicable to science and mathematics education today. This science has helped enormously to construct accurate and informative "pictures" of the world, of which the map is the most familiar example. Such pictures are more economical and informative than words or figures.

Over time these relationship illustrations developed further and scientists invented the graph, which illustrates that in any situation one thing varies in relation to another. Graphs help scientists to convey a mass of information to others. It also makes it easier for the scientist to depict his results in a way that makes it easier for him to look at them as a whole and to see whether his experiments reveal a consistent relationship between the quantities that he is measuring (Barry *et al.*, 1965:186).

These developments are still used in science and mathematics teaching at school and HEI. The applications of these scientific languages can be seen in almost all manufactured products used by all

levels of society. To maintain and further the development of these products, science has to be communicated to the general public. An understanding of science will certainly decrease the fear of risks in new scientific products and technologies.

2.3 COMMUNICATING THE LANGUAGE OF SCIENCE

People use mainly two ways in their daily lives to communicate, speak and write. Verbal spoken communication is accompanied by a continuous flow of non-verbal communication, which involves not only the voice (the pitch, tone, speed and quality of speech) but also the face (gaze, facial expression) and the body (the distance one stands from others, spatial orientation of people, posture, gesture, touch, etc.) (Gallois & Callan, 1997:7). In written communication it is much more difficult to detect feelings, emotions and expressions. Unfortunately communication is the topic of much speculation and debate. Broadly speaking, communicational scepticism might be defined as the idea that meaning is to some extent private to each individual, since language is an inadequate instrument for conveying thoughts from one mind to another. Human beings, the sceptic believes, are isolated from one another by the very medium that might be supposed to unite them: language (Farrow, 1996:108).

According to the logician, Gottlob Frege, language "is not governed by logical laws in such a way that mere adherence to grammar would guarantee the formal correctness of thought-transitions"' (Farrow, 1996:108). Successful communication may be threatened by the inability of language to correspond perfectly with thought.

Signals and meanings are two components of communication of which signals are the most fully analysed and understood, compared to meanings which are the least known and the least analysed. Coding is used to analyse meanings. It is decision making, choosing between a figure and ground in a gestalt and these choices involve evaluations and values. According to Smith (1966:406), much of everyday communication is not a simple and direct coding of meanings, but is metacommunication in which the meaning that is coded is just communication going on. Bernstein, (in Smith, 1966:406), pointed out that meaning is embedded in a social system and social systems can generate different codes of meaning. According to Bernstein (in Smith, 1966:406), meanings do not have to be made explicit if a social system is based on intimacy and little social distance, because in such systems there are little noise and little need for redundancy. In a social system where greater social distance exists, meanings have to be made more explicit. Bernstein's "Elaborated and Restricted Codes" demonstrates the situation-behaviour matrix of these codes of meaning and indicates how the meaning is always related to the situation (in Smith, 1996:406). However, these codes are not defined in terms of

vocabulary. The speech system is called elaborated code when it is difficult to predict the syntactic options speakers use to organise their meanings over a representative range of speech. In the case of an elaborated code, the speaker has to select from a wide range of syntactic alternatives, which make it more difficult to make an accurate assessment of the organising elements used at a specific time. With the restricted code on the other hand, the range of syntactic alternatives is considerably reduced and prediction is much more possible. Although the vocabulary is drawn from a narrow range, it is no indication that the code is a restricted one (Smith, 1996:430). In communicating science, Bernstein's restricted codes might be applicable when scientists are communicating with one another, because through the planning procedures the code might not facilitate the verbal expansion of the scientist's discrete intent. When scientists have to communicate with the general public, the code through its planning procedures might facilitate scientists in their attempt to put into words in their purposes, discrete intent and their unique experience in a verbally explicit form (Smith, 1966:430).

Therefore, the scientist has a difficult task in communicating with non-scientists, since she/he must also place his findings on record, and for this purpose she/he uses written communication. This is yet another reason why scientific language and the scientists who use it, appear to the layman to be stilted, pompous and remote from the affairs of everyday life.

Like the stenographer, the scientist has his shorthand – a code that can condense a lot of information into short symbols. Each of the many branches of science has its own code. For example, a reaction between marble and sulphuric acid contains about 400 words, but by using a code in the equation it allows scientists to write all the necessary information in one line. It would be difficult to imagine a more compact way of recording and transmitting information, once the code is known (Barry *et al.*, 1965:189).

During the past four hundred years scientific inquiry has brought to light a huge number of facts. Scientists have described about a million species of animals, over 300 000 species of plants, and several hundred thousand chemical compounds. How can so much information be handled without getting lost in a mass of detail? For this reason scientists have brought millions of isolated facts into shape that makes them understandable and useful by classifying them. Not only has classification of all the known facts about a certain species shown more clearly the similarities and differences in organisms, but a progression from simple forms to more complex ones has also been revealed as the pattern of relationships between organisms has become clearer. It is because the facts of natural history were classified that the discovery of evolution became possible. Thus, the act of arranging

data methodically does more than merely keep the facts tidy. Classification is a way of clarifying what one knows, and it is therefore an essential part of the language of science (Barry *et al.*, 1965:191).

Although science language is a very old language that developed over hundreds of years, the communication thereof to every society all over the world is today even more important than before. The role of communication specialists in the mediation process is equally important to facilitate the communication process between scientists and the general public. Communication specialists should be trained as facilitators between scientists and journalists, which imply communication specialists should receive a basic education in science to enable communication specialists to translate the complex facts of science in simpler formats understandable for stakeholders of HEI.

2.4 HISTORY AND DEVELOPMENT OF SCIENCE LANGUAGE

Language is arguably the most important characteristic of all species. The evolution of language is one of the most intriguing events in the history of life on earth. Until recently, the evolution of language has remained a marginalised topic in both biology and linguistics, seeming to many scientists more fitting for after-dinner speculation than scholarly study. However, remarkable empirical advances in biology, neuroscience and linguistics have led to a rebirth of research on language evolution in the past decade (Fitch, 2002:278).

With the onset of civilisation ten thousand years ago, the generation and application of knowledge began to flourish. Access to knowledge remained the privilege of small elites however. Knowledge has always been interwoven with politics and was strictly controlled by the powerful because scientifically sound ideas had the potential to be explosive. The science community wrote and spoke Latin so no layperson could understand it.

However, from 1667 onwards things began to change when the London Royal Society published a guide to writing scientific papers. It suggested a direct and precise style, no bombastic or foggy sentences, and the use of the language of farmers, craftsmen and tradesmen instead of the jargon of scholars. Twenty years later the first lecture was held in plain German at the University of Leipzig (Goede, 2001:3). The specific German natural scientist became famous because of an extensive tour he made of South America at the beginning of the 19th century – but his message still did not reach everyone. In 1827 Humboldt presented the findings of his studies in Berlin in addition to an absolutely clear and fascinating rundown of almost the entire knowledge of mankind at that time.

Then came the Industrial Revolution. It catapulted people into a new world with a flood of technological innovations, ever increasing speed and profound cultural changes. Trains, automobiles, airplanes, dreams of mobility came true and lured people into becoming frenetic proponents of progress. For more than a century nobody dared to touch science's truth monopoly, that is, until 1945 when two atomic detonations in Japan shocked the world. In the aftermath people began realising that indefinite growth was not possible. Growing poverty, misery and hunger had split the world into a developed and developing world. Man started to realise that the earth's natural resources and energy supplies would only last for another hundred years, and that the deterioration of the environment and the climate was becoming inescapable (Goede, 2001:3).

The reactions to this realisation varied. Goede (2001:4,5) refers to the fact that, on the political level, the Green Party, activist movements like Robin Wood, Green Peace and most recently the globalisation adversaries emerged. The experts at universities suddenly had to abandon their ivory towers and present their research in the market place in order to rebuild public confidence. As a result of this distrust, the news media discovered science and found a new huge platform in newspapers, magazines, radio, television and in the Internet.

However, associated with this discovery there were certain problems. Since scientific language is not common knowledge to the general public, an inevitable barrier arose between science and the public, and this will be discussed in the next section.

2.5 BARRIERS BETWEEN SCIENCE AND THE GENERAL PUBLIC

Although society currently depends on science as never before (also on science activities and assistance of new technology), what scientists do remains an enigma to most people. The language of science is virtually incomprehensible to the layman. To maintain public (stakeholder) appreciation and support, the benefits and grandeur of science have to be translated into the language of everyday people.

The need for accuracy, conciseness and precision has compelled scientists to build up a structure of special languages and codes. There is no doubt that such languages have provided a very efficient means of communication among scientists themselves, but between the scientist and the man in the street, there is a wide gap (Barry *et al.*, 1965:191). In short, there is a failure of communication between the two segments of society.

Barry *et al.* (1965:191) stated the following reasons for the failure of communication between scientists and the public:

- Scientists are usually too absorbed in their work to pause and tell the public what they are doing and why they are doing it. Sometimes, because they are working at problems that have never been solved before, they are somewhat inclined to be superior about their professions and to look down on those who do not understand their kind of work.
- Probably the main reason for lack of communication is that even if scientists are willing to explain themselves, their specialised training often makes it impossible for them to express themselves in simple language.

The man in the street, however, has neither the time nor the specialised training that would enable him to read scientific papers. Instead, he gets his news of scientific developments through newspapers, magazines and television. In this regard the role of communication specialists becomes important to assist scientists translating scientific facts in a comprehendable language that stakeholders can understand. Furthermore, to ensure that the mass media understands the message that scientists want to distribute, communication specialists at HEI are important in their role as facilitators between scientists and the media (Joubert, 2001). Communication specialists, therefore, play an important role to ensure that what scientists are saying is correctly reflected in the media.

2.6 THE BEGINNING OF THE POPULARISATION OF SCIENCE

The historians of science have debated at large both the intellectual problems of establishing the new basis for knowledge and the practical efforts necessary to build an experimental array of instruments and machines. But there is one thing the historians of science persistently ignore or minimise: the immediate use of the technologies discovered by scientists to create a large number of devices for popular entertainment. However, this trend is not part of the history of science itself, and the historians (following in fact the opinion of the distinguished scientists of the time) consider most of the actors of this derivation with some contempt. Two examples of development of the popularisation of science are discussed next.

According to Caro (1997:112,113), Athanasius Kircher (1602-1680) was the most famous scientist of his time. As a Jesuit priest in the service of the Pope in Rome, he received lavish grants from several patrons, especially German princes. Starting in 1660, he had an exclusive agreement with a publisher in Holland for the right to print his best sellers. He is one of the few scientists in history who eventually

made a living selling his books. Kircher was not only one of the first scientists, but also a perfect prototype of a figure well known today in the more established field of science popularisation.

Science was popularised by entertainment shows, books and other forms of entertainment, such as spectacular shows that were set up with profitable commercial intent to reach emotionally innocent and ignorant people with science. From the beginning, the contribution of scientific and technical knowledge to the staging of shows was essential, in fact seminal. The development of an entertainment-oriented society cannot be separated from the progresses of science itself (Caro, 1997:113).

Kircher used his knowledge to stage a variety of optical shows for the Cardinals in Rome. He was not taken seriously by most of his colleagues across Europe because he made extravagant claims (such as the decipherment of hieroglyphs). But besides being one of the first writers of science popularisation books, and a kind of inventor of the principle of using devices derived from scientific apparatus to provide entertainment as in modern science-based theme parks, he was also the founder of the first science museum. The museum housed, in the gallery of the Collegio Romano, a collection of stuffed animals and birds from the New World, which the distinguished European visitors to Rome were eager to see.

Another prominent scientist during the same time was Christiaan Huyghens (1629-1695). He designed the first magic lantern, which he used to project the image from an animated plate through which a skeleton played ball with its head, a scene inspired from a drawing by Holbein. Since the images did not depend on the strength of the sun as a source of light any more, they could be shown anywhere, at any time, in any place. At first the images, painted on glass plates, were designed to produce fear. These images could be animated (the devil could roll his eyes). But the potential of this new "media" for education was quickly realised and was to grow until the end of the 19th century and the advent of the cinematograph (Caro, 1997:114).

As can be seen from the abovementioned developments, professors of science and technical writing have struggled for many years to find new ways to help students learn to organise and present technical information so that lay audiences can understand it. However, effective dissemination is not simply a matter of finding a way to explain complex issues in plain language or using audio-visual technologies to present them. In the following section other tools and vehicles that have developed over time to promote science to the non-scientific public are discussed. The information theory and the

mass communication theory, which provide the base for the use of technological developments to convey the message of science to the mass of non-scientists, are also described.

2.7 THE ROLE OF INFORMATION THEORY IN SCIENCE COMMUNICATION

Science communication is based on the concept of information about science being conveyed from the sender to the receiver of the message. The information theory contributes to the investigation of the various characteristics of physical, biological, social and behavioural phenomena. It is not only a communication theory, but also has important implications for communication and other socio-cultural happenings (Littlejohn, 1992: 34). Although the concept of information has proved difficult to define since it can be viewed in different ways, the central element is probably the capacity to 'reduce uncertainty'. Information is therefore defined by its opposite – randomness or chaos (McQuail, 1994:248).

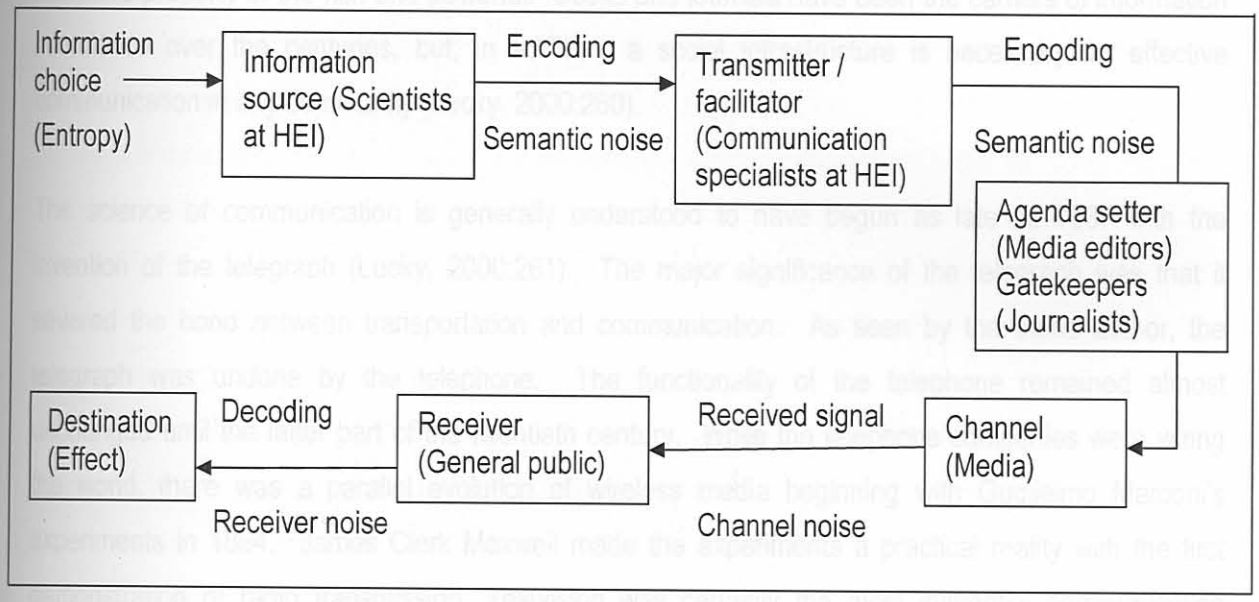
Tichenor, Donohue and Olien (in Jansen van Vuuren, 2002:27) defined information theory as follows: "As the infusion of mass media information into a social system increases, segments of the population with higher socioeconomic status tend to acquire this information at a faster rate than the lower status segments, so that the gap in knowledge between these segments tends to increase rather than decrease."

The insight that led to the development of information theory was the realisation that all the processes, which might be said to convey information, are basically selection processes. The mathematical theory of communication provided an objective approach to the analysis of communication texts. As stated by McQuail (1994:248), the basis for objectivity (quantification) is the binary (yes/no) coding system, which constitutes the basis for digital computing. The information theory is general enough that it can be applied to written languages, musical notes, music, spoken words, pictures and many other communication signals (Severin & Tankard, 1984:43).

The roots of the information theory are intermingled with the basic transmission model, which conceives communication as essentially the intentional transfer of information from sender to receiver, by way of (physical) channels, which are subject to noise and interference. According to this model, communication is judged by the efficiency and effectiveness in achieving the planned 'transfer' (McQuail, 1994:248). It is therefore also applicable in science communication where various channels are used to convey the message of science. In communicating the science message, it is suggested that communication specialists should act as facilitaors to ensure that information is conveyed

correctly, which is not prejudial to HEI and in a way that stakeholders, including the media and general public can understand the intention of the message (Mersham & Skinner, 2001: 24). In Figure 2.2 the communication model adapted from Shannon and Weaver (Tan, 1981:60) demonstrates the relationship between the information theory and the basic transmission model.

Figure 2.2: A mathematical model of communication



Source: Adapted from: Tan (1981:60)

Tan's (1981:60) model was applied to illustrate the flow of communication in science communication. Scientists at HEI who produces the science are the source of information and communication specialists are the facilitators who mediate between scientists and journalists to ensure that scientific facts are correctly interpreted by media editors and journalists. Media editors are the agenda setters who determine which articles should be published, while the journalists act as gatekeepers in deciding if the messages received from scientists and communication specialists are newsworthy enough to write articles about. The media is the channel through which science messages are distributed to the receiver or general public. The destination of the message or the effect of the message on the receivers is determined by the facts of science that reaches the receivers or general public. The agenda setting and gatekeeper theories are discussed in Chapter 5 in more detail.

2.8 THE DEVELOPMENT OF TECHNOLOGY TO COMMUNICATE SCIENCE

In the sixteenth century, science progressed at the pace of the postal system. Often it would take six months for one scientist to learn of the latest results of another. It took even more time for scientists to build on one another's accomplishments (Lucky, 2000:259). After the development of written language,

the next stage of communication was the emergence of postal systems, which could transport that recorded language farther than the loudest voice. Although a postal system provides the rudiments of individual communication, it does not enable broadcast or widespread knowledge dispersal. For that purpose, according to Lucky (2000:260), books have been remarkable social instruments, and they have remained unchanged in concept from nearly the time written language arose until today. The printing media made possible the widespread dissemination of books, which had previously been the exclusive property of the rich and powerful. Books and journals have been the carriers of information in science over the centuries, but, in addition, a social infrastructure is necessary for effective communication in any community (Lucky, 2000:260).

The science of communication is generally understood to have begun as late as 1837 with the invention of the telegraph (Lucky, 2000:261). The major significance of the telegraph was that it severed the bond between transportation and communication. As seen by the same author, the telegraph was undone by the telephone. The functionality of the telephone remained almost unchanged until the latter part of the twentieth century. While the telephone companies were wiring the world, there was a parallel evolution of wireless media beginning with Guglielmo Marconi's experiments in 1894. James Clerk Maxwell made the experiments a practical reality with the first demonstration of radio transmission. Television was certainly the most influential communication medium of the last century. There came to be more television receivers in the world than telephones, and television broadcasts have purveyed culture to the farthest corners of the earth. The popularity and politics of science were affected by this new medium (Lucky, 2000:261).

However, until recently, access to knowledge was the privilege of an elite group and there was little transparency and public accountability. Magazines, radio, television, etc., have helped to democratise knowledge, to disseminate it so that everybody can participate in and get on top of the information flow. With this type of knowledge empowerment, it is possible to build a civil society in which citizens can gain access to major developments. Citizens can decide for themselves whether these developments suit them or not, make their voice heard and pursue an active role in public life. However, many people find today's communication environment intimidating, fast-paced and chaotic. Often they feel personally and professionally assaulted by today's electronic environment and many regard technology as a necessary irritation. Among these people, the mass media are perceived as manipulative, monolithic, and too obsessed with strategy and tactics than with issues and understanding. The role of communication specialists can add value to this perception by ensuring that

the media convey correct messages to the public. However, this can only be achieved if there is a relationship of trust and mutual understanding between communication specialists and journalists.

2.9 THE ARRIVAL OF THE MASS MEDIA AND THE APPLICATION OF MASS COMMUNICATION THEORY ON MASS AUDIENCES

Today's society has more radio stations, television channels, magazines, newsletters, telephones, computers and fax machines than ever. People have instant access to news, information, and entertainment. Despite all this growth, communication seems to have less meaning. Technology has altered everything – from people's personal perception of the world and their relationship to it, to how people buy groceries, how banking is done and how people entertain, educate and inform themselves. With instant news from around the world at one's fingertips, the sense that one is living in a global community grows every day. Yet, people lack the sense of common cause, community, and the public interest (Radtke, 1998:47). Mass communication aiming at mass audiences endeavours to create a sense of common cause amongst the general public.

According to Tan (1981:3), "... mass communication involves the scientific study of the mass media, the messages they generate, the audiences they attempt to reach, and their effects on these audiences". Mass communication involves basically the same process as one-to-one communication. Three interacting components (sender, facilitator and receiver) are involved; messages are encoded, filtered, sent through a channel, and decoded; responses in the receiver are observed; feedback allows interaction to continue between sender and receiver. However, there are some special characteristics of mass communication that distinguish it from interpersonal communication. The first characteristic is the receiver in mass communication. Early definitions of mass communication focused on 'mass society' as the audience of communication. Mass society was seen as the milieu within which mass communication functions. Blumer (in Tan, 1981:72), using concepts derived from theories of mass society, characterised mass audiences as follows:

- Heterogeneous in composition, its members coming from different groups in society;
- Composed of individuals who do not know each other, who are spatially separated from one another and who cannot interact with one another; and
- Having no leadership or formal organisation.

The audience was an aggregate of individuals, which could best be classified not on the basis of group memberships, but according to demographic characteristics such as age, sex, socio-economic status and education. The important questions were how members of the mass audience selected their

communication and how the media affected the mass. The prevailing idea was that the mass audience was passive, unstable and easily influenced (Tan, 1981:72). More recently researchers have discarded the view of 'mass audience' as a passive aggregate of disconnected individuals and have emphasised, instead, social structures or group affiliations among members of the audience, the social nature of most of the contact with the mass media and the reciprocal nature of media-audience relationships.

As in person-to-person communication, the interaction in mass communication is goal directed, transactional and influenced by the participant's ongoing culture. The main difference is that in mass communication the receiver is considered as "a vast number of people receiving simultaneously but independently the communication of a very few" (Tan, 1981:73). However, defining mass communication solely on the basis of a mass audience seems inadequate, since 'a vast number' can have several implications.

A more useful approach is to consider also the original communicator and the method by which the message is transmitted to the receiver. In mass communication the communicator is a social organisation capable of reproducing the message and sending it simultaneously to large numbers of people who are spatially separated. In this definition, the number of people reached is of secondary importance. The communicator in mass communication is often a mass medium – a newspaper, television station or network, magazine or book publisher. It is a social organisation because it is made up of many individual communicators with well-defined role responsibilities (Tan, 1981:73). In science communication, however, this is not the case, since the originator of the message is the scientist who conveys the message to stakeholders via the communication specialist (facilitator).

Another characteristic of mass communication that distinguishes it from interpersonal communication is that the messages are sent to the receivers indirectly, using some form of mechanical device. According to De Beer (1998:14) and Tan (1981:73), the sender and receiver are not physically in the same place, therefore, face-to-face or direct interaction is not possible, and since the message is sent through a mechanical device, the message can be reproduced and distributed to many receivers at the same time. In science communication, this interaction involves scientists (originators or senders) who use the channels (the media, such as Internet, science shows, newspapers, television and radio) to communicate the message of science to the various receivers (stakeholders, such as the general public). However, there is another link in this process, which refers to the facilitator (communication specialist) who has to ensure that the agenda setters (editors) and the gatekeepers (journalists) interpret the message correctly to reach the final destination (effect) of the message.

In the last decades, as a consequence of the growing interest in science communication activities, studies have been aimed at the use and possible impact of wider tools associated with mass communication. The discoveries and applications of science have appeared in literature and the mass media, therefore contributing to the creation of a collective image of science and scientists (Massarani, 2002:25). The next section addresses the Internet and World Wide Web as tools of mass communication to communicate science.

2.10 THE INTERNET AND WORLD WIDE WEB AS MEDIA CHANNELS TO COMMUNICATE SCIENCE

The electronic revolution fostered the development of computers, the rise of computer networks, and the digitisation of information and media. Together they created the present digital networked economy. Today's World Wide Web has been cited as a counterexample of the well-known thesis that all major technological developments require 25 years for widespread availability, as was the case with radio, television and the telephone. The Web, by contrast, has become overwhelmingly popular in only a few years (Lucky, 2000:262).

The Internet, a complex network of networks, removes the geographical and time limitations of operating in a global economy. According to Dhillon (2002:14), there is an underlying assumption in the popular belief that the Internet may be the saviour of the developing countries of the world. Such thinking is dependent on a single premise: the belief that access to the global marketplace leads to economic growth. Information is power; knowledge is wealth. In their effect on the way in which science is transacted, the Internet and World Wide Web have had the greatest impact of any communication medium since possibly the printing media (Lucky, 2000:263).

The beauty and power of these media are that they allow the formation of spontaneous communities of unacquainted users. Their topology is neither one to one nor one to many, but rather many to many. They allow the sharing of information in textual, graphic, and multimedia formats across these communities, and they empower users within these communities to build their own applications. This function is particularly beneficial to the distribution of science messages.

Internet and the World Wide Web are being increasingly used as a medium for producing and delivering news. Many magazines and newspapers nowadays have an online version and sell access to their content. The Web is regarded as a 'new space', where authors can 'guide' readers through diverse information sources and types. Either as a news-making or as a dissemination tool, the Web

is changing the practice of science writers and making new stories possible. There are, however, some concerns about source reliability and information quality (Trumbo, Sprecker, Dumlao, Yun & Duke, 2001:347), as the Web is unfortunately also loaded with jargon and questionable material. Science has also yet to evolve a satisfactory economic model that defines and protects the rights of intellectual property owners.

Another serious obstacle applicable to science communication has been the tenure committees at universities and their reluctance to give full credit to online publication. However, reasons exist to believe that the Web will be adopted as an important medium for publishing science news in the future. The Internet is also increasingly important for continuing education, the lifeblood of the scientific profession. Numerous courses are put up on the Web, and both universities and commercial enterprises are getting in the business of packaging educational material for distance learning.

Although communication technology will certainly contribute to easier access of information and faster communication, no such technology has yet preserved the important nuances of a face-to-face interaction.

2.11 SCIENCE POPULARISATION ON THE WORLD WIDE WEB

Even though some science popularisation websites are already visited frequently, not much data is available on how users actually read, understand and make use of their content. It is therefore not clear whether the Web allows the communication of science as effectively as, or perhaps better than, the traditional printed media (Macedo-Rouet, 2002:13).

On the one hand, authors can use electronic media to provide contextual material, increase the number of information sources, include multimedia contents and establish new forms of communication with the public. These potentialities are interesting and attractive. However, on the other hand, results from experimental research have shown that multimedia technology is not easy to handle. Issues of disorientation, high cognitive prerequisites and lack of experience with technology constitute barriers for users (Macedo-Rouet, 2002:13).

In the context of science popularisation, both print and electronic media deal essentially with written language. There are large differences in the way textual elements are displayed and interconnected. Technological developments in the 1990's have had a negative impact on the presentation of text on computer screens (Macedo-Rouet, 2002:13). As a consequence, reading on a computer screen takes

about 20% slower than reading on paper, according to Nielsen (2000:14). Computer presentation requires the use of a greater contrast, less information density and bigger characters to be able to provide a satisfactory level of legibility. Although screen legibility can be improved through the use of high definition screens, this technology is still not available to most users.

Attitudes toward a technology such as the Internet can predict the degree of its adoption in a given population. Although studies have indicated a positive attitude towards the Internet (Trumbo *et al.*, 2001:352), a positive attitude or even large-scale use does not mean absolute faith in the medium. In fact, many professionals tend to see the Web and e-mail as great tools for news making, but they are also sceptical, because the Web may easily lead to dispersion, waste of time and non-reliable information or illegitimate sources (Macedo-Rouet, 2002: 13).

Magazines, newspapers, radio and television were previously mentioned as mass media channels that are used to distribute science messages to the general public. The Internet and World Wide Web are also mass media channels that are used more frequently in today's society to distribute science. The advantage of these media, except radio, are the fact that visual images of scientific facts can be observed by users of any of these channels, which enhances the comprehension of the science messages to the general public. However, despite all the developments of technology and mass media to distribute messages to mass audiences, these developments do not always contribute to enhance the distribution of science to the general public. There are still too many people in South Africa who do not have access to all the new technologies and mass media channels to receive science messages effectively. Therefore, science communication activities were established at various institutions to contribute to the South African government's goal to create an informed public. Some of these activities are described in the next section.

2.12 SCIENCE COMMUNICATION ACTIVITIES IN SOUTH AFRICA

In South Africa there are a number of opportunities for promoting science and several science communication activities are taking place to communicate science to stakeholders. These activities that are used as vehicles for communicating science include the Government's annual National Science, Engineering and Technology week, the annual Sasol SciFest in Grahamstown and Sasol TechnoX in Sasolburg, various science centres, for example in Pretoria, Cape Town, Durban and elsewhere, planetariums in Cape Town and Johannesburg, and mobile science centres such as the Starbus of the South African Astronomical Observatory and the Tsebo Koloing truck of the University of Pretoria. At many HEI communication specialists are often tasked to organise or participate in and

manage a variety of these science activities. The science activities mentioned above are explained briefly below:

- **The Gateway Discovery Centre Trust, better known as the Discovery Centre**

According to Mvalo (2002), the aim of the Discovery Centre is to raise awareness and enthuse learners about the practical applications of science and technology. This is done in an informal but fun way through interactive exhibits where learners and educators are encouraged to discover for themselves by pulling, touching, pressing and observing science phenomena, thereby becoming discoverers in the scientific process. It is anticipated that these learners will continue to take mathematics and science subjects at high school and enrol for science, engineering and technology (SET) courses at HEI once they matriculated from school. In the final analysis a larger number of students in science, engineering and technology may lead to an increased human resource base in SET and improve national economic growth as well as the level of international competitiveness.

- **National SET weeks**

National SET weeks were introduced by the South African Government in 1998, and they have continued since then. Since its inception, the National SET Week took place annually in May. Several activities take place during that week, for example workshops, interactive displays, participative activities, etc., all of which are focused on simplifying scientific facts into comprehensible experiences for the target audience. All the science activities are targeted at children of all ages to enhance their awareness of the importance of science.

- **Sasol TechnoX and SciFest**

South Africa's weeklong National Festival of Science, Engineering and Technology (known as SciFest) is held annually in Grahamstown in the Eastern Cape during March/April. Since the first festival in 1997, it has attracted some forty thousand visitors a year, drawing prominent scientists from around the globe as key speakers, and securing participation and support from abroad, especially from Imperial College, London. Because HEI in the northern half of South Africa were not prepared to travel to Grahamstown every year, the Sasol TechnoX was initiated in Sasolburg in 2001. This festival has the same aims as SciFest, but more institutions and organisations based in the Gauteng area are involved in providing hands-on science activities for school children. The Sasol TechnoX takes place annually in August and the number of visitors reached 45 000 in 2004.

- **Science Centres and museums**

A handful of science centres and science museums in South Africa personalise science communication for their target market. Committed staff at the centres and museums accommodate and interest thousands of school children every year. The Discovery Centre and Camera Obscura at the University of Pretoria are among the few centres that accommodate children from preprimary school to adults in order to provide an opportunity of hands-on playing and experience of science applications. Other centres, which include the aquariums in these two cities, are situated in Cape Town and Durban. Science museums are situated in Cape Town, Johannesburg and Pretoria.

- **Planetariums**

Planetariums in South Africa (especially the Johannesburg Planetarium and the Planetarium at Cape Town's South African Museum) have particularly long track records for promoting science communication to the general public in South Africa.

- **Mobile science centres**

The Southern African Association of Science and Technology Centres (SAASTEC), which were established to promote communication and networking between science centres, encourage their members to join forces for travelling displays and sponsorships. Two of the established and successful mobile centres are the Starbus and Tsebo Koloing Truck.

The Starbus is the colourfully decorated minibus outreach vehicle of the South African Astronomical Observatory. It enables science communicators to take workshops and astronomy viewing sessions to rural communities and schools in remote areas. The Starbus carries high-tech equipment (e.g. telescopes) and low technical resource material (e.g. cardboard, plastic, glass and other everyday household items) for use in practical sessions. The University of Pretoria's Faculty of Engineering, Built Environment and Information Technology has equipped a large truck as a mobile technology laboratory. The Tsebo Koloing (meaning "technology in motion") truck has been visiting schools in and around rural areas in Gauteng and the Limpopo province since 1999.

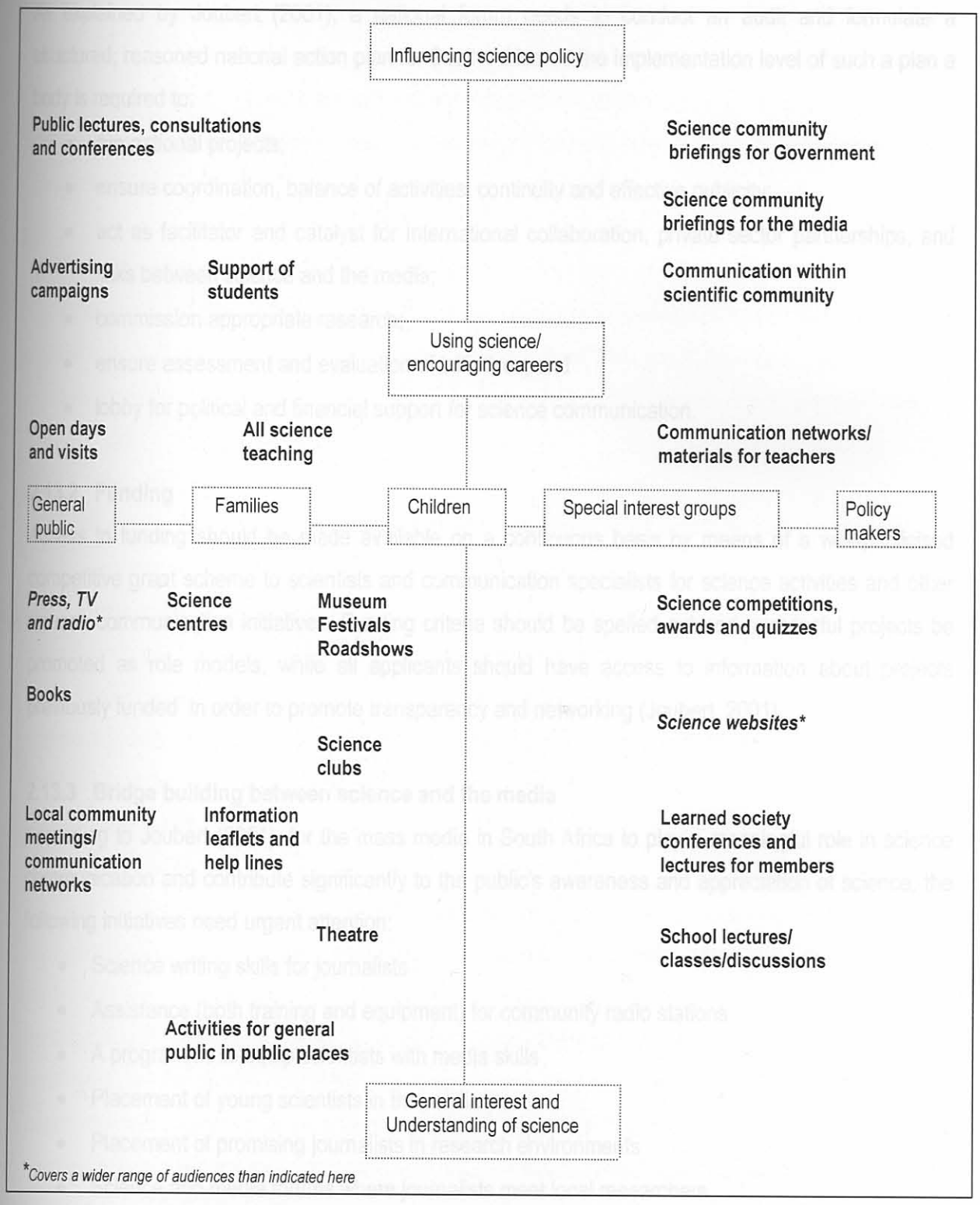
2.13 ASSESSMENT OF THE EFFECTIVENESS OF SCIENCE COMMUNICATION ACTIVITIES

Science communication activities are a fairly recent phenomenon in South Africa. These activities and the role they are playing in raising awareness about science still need to be evaluated, but some problems have already been identified. Funding is a pressing challenge that faces the future of science activities in South Africa. According to Joubert (2001), in an environment where formal science education struggles to achieve acceptable standards, teachers are often underqualified, demotivated and disillusioned; and many schools do not even have electricity. South Africa needs many more mobile outreach activities to promote science. New technology is certainly contributing to a better and easier way to communicate, but in rural areas this new technology will virtually be a waste of time and money. Therefore, despite all the new technologies available to distribute science to all segments of society, it seems as if not enough effort is applied to enhance science communication in South Africa.

Figure 2.3 displays a map, prepared by Research International (2000:9), to assist HEI in defining various types of activities according to different target audiences and the context or aims of the specific activity, which could be applied in South Africa to enhance science communication.

The horizontal axis represents the target audience (stakeholders), from 'general public' to 'policy makers', while the vertical axis portrays the context from 'influencing science policy' to 'general interest and understanding of science'. ('Influencing science policy' refers to activities undertaken in the context of aiding government policy development.)

Figure 2.3: Mapping of science activities



Source: Research International (2000:9)

The mapping of science activities points out certain priorities for future action, which can be divided into the following six categories as identified by Joubert (2001):

2.13.1 Leadership and coordination

As explained by Joubert (2001), a national forum needs to conduct an audit and formulate a structured, reasoned national action plan for South Africa. At the implementation level of such a plan a body is required to:

- run national projects;
- ensure coordination, balance of activities, continuity and effective publicity;
- act as facilitator and catalyst for international collaboration, private sector partnerships, and links between science and the media;
- commission appropriate research;
- ensure assessment and evaluation of initiatives; and
- lobby for political and financial support for science communication.

2.13.2 Funding

Access to funding should be made available on a continuous basis by means of a well-publicised competitive grant scheme to scientists and communication specialists for science activities and other science communication initiatives. Funding criteria should be spelled out and successful projects be promoted as role models, while all applicants should have access to information about projects previously funded in order to promote transparency and networking (Joubert, 2001).

2.13.3 Bridge building between science and the media

According to Joubert (2001), for the mass media in South Africa to play a meaningful role in science communication and contribute significantly to the public's awareness and appreciation of science, the following initiatives need urgent attention:

- Science writing skills for journalists
- Assistance (both training and equipment) for community radio stations
- A programme to equip scientists with media skills
- Placement of young scientists in the media
- Placement of promising journalists in research environments
- Science and media forums where journalists meet local researchers
- A programme to market science to editors and media leaders, and to secure their commitment
- Research into science in the South African media
- Effective networking among science communicators
- Promotion of South African science on the Internet

2.13.4 Science on local radio and television

South Africa needs strategies, high-level commitment and support to improve the quality and quantity of science in local broadcasts. Science needs to be integrated into popular, peak-time programmes, such as local dramas, historical and other documentaries, talk shows, and even soap operas. There is also a need for regular science inserts on news broadcasts and science fillers between programmes (Joubert, 2001).

2.13.5 International networking and exchange

Science communication in South Africa would be stimulated if science communicators could meet regularly and exchange ideas with science communicators from other countries. This could also provide a meeting ground for Western ways of understanding and indigenous or non-Western ones.

2.13.6 Main players

According to Joubert (2001), the government of South Africa must formulate policy and guide and promote interdepartmental collaboration in the field of science communication. In many cases, science councils are prepared and committed at the grassroots level, but they often function without resources or the backing of their leaders. The councils must take responsibility for science communication, which should perhaps be included in their Acts, as is the case in the United Kingdom. The same applies to universities and other statutory research institutions. Ultimately, scientists themselves must embrace their role in science communication, for without them science communicators and science journalists have nothing to say.

Although Joubert (2001) addressed relevant issues in the science communication environment, a very important aspect had not been addressed, i.e. the role of communication specialists in science communication. In addition to tasks generally devoted to communication specialists at HEI, participation in science activities is crucial. Communication specialists, as marketers of their institutions, are the people visiting schools, communities, etc., and in the role of marketers should also assist scientists to communicate science to all levels of society. The omission of these imperative role players is a concern for the researcher and result in questioning Joubert's interpretation of science communication in South Africa.

2.14 CONCLUSION

The phenomenon of science communication and the theories used as framework for the development of science communication were described in this chapter. The information theory, as discussed under

Section 2.7 and the mass communication theory are two of the theories that can be applied to science communication. These theories form an integral part with the rest of this study, referring to the importance of science communication (Objective 1), since science communication is information (information theory) that has to be distributed to all segments of society (mass communication theory).

It is true that the Internet and its associated developments, such as the World Wide Web, are a developed global phenomenon. It is also true that the gap between the economically advantaged and disadvantaged communities continues to increase in both developed and developing economies. Together with these phenomena, science and its communication become more and more crucial to sustain the development of society at large.

Despite the new technological developments too many people in South Africa still do not have access to these developments and although science communication activities contribute to distribute the messages of science, a variety of problems need to be addressed to enhance the effective application of science communication activities, as suggested in Section 2.13.

The development of science communication was clarified in this chapter, but unless the perception of the general public (as an important stakeholder group of HEI) towards the phenomenon of science and the communication thereof is known, all efforts to enhance the importance of science communication would be in vain. In Chapter 3 the theory of stakeholders of HEI (receivers of science messages) is discussed. Chapter 3 also not only provides answers to the question on how the public perceives science communication, but also contains a discussion on the results of studies aimed at determining the public's attitudes towards science.

Chapter 3

The general public's awareness and attitudes towards science

3.1 INTRODUCTION

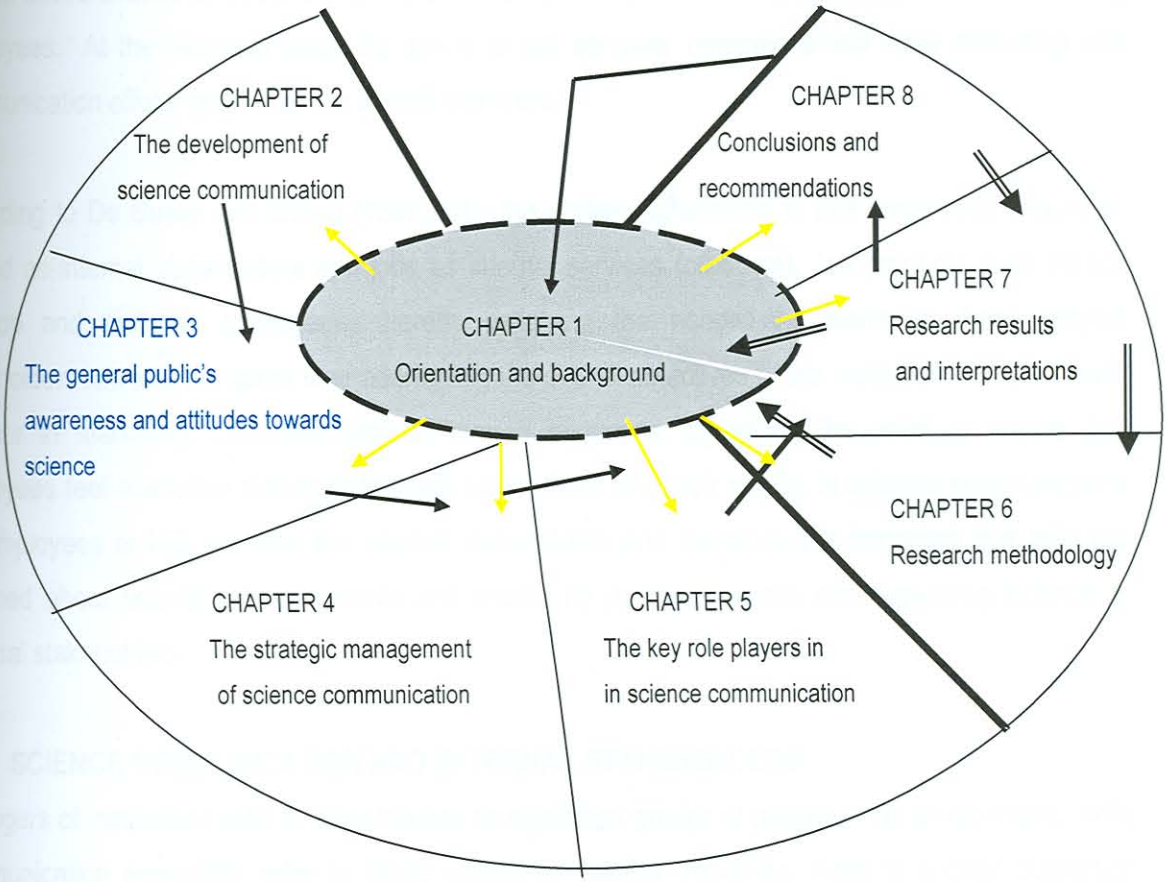
In Chapter 2 the information theory and mass communication theory were discussed and applied to the importance of science as information to be communicated to receivers by various communication mediums. Chapter 3 provides a broad overview of the general public's awareness and attitudes towards science. The stakeholder theory is discussed, since the stakeholders of HEI, including the general public, are the receivers of the message of science.

Science can be promoted and communicated by anyone in South Africa, but efforts at HEI, by the government and through media broadcasting and publishing will achieve very little if stakeholders' (especially the general public's) attitude towards science is not positive. Despite growing international awareness of the importance of public understanding of SET over the last two decades, there has been little agreement about the best methods to measure scientific literacy. Nationally representative surveys to gauge the public's understanding of science and their attitudes towards science have been undertaken in many developed countries. The value of using tried and tested instruments of this nature in developing countries can be contested. On the one hand, it is allowed to compare the profile of a developing country such as South Africa with other countries. On the other hand, there are invariably vast gaps in education levels between developing and developed countries, and many of the survey items used are pitched at a level that requires some familiarity with concepts normally learnt at secondary-school level in developed countries (Blankley & Arnold, 1999:2).

Given that science and technology policy falls within the realm of democratic policy formulation in most countries, including South Africa, citizens exercising their democratic rights and duties should be sufficiently knowledgeable about science matters to make informed judgements about major issues in science, engineering, health and technology. Moreover, the public should understand what it is buying with its multi-billion Rand investment of state funding in research and development. Civic scientific literacy has been defined as "... a level of understanding of scientific terms and constructs sufficient to read a daily newspaper or magazine and to understand the essence of competing arguments on a given dispute or controversy" (Blankley & Arnold, 1999:3).

This chapter investigates the research studies that have been performed on public attitudes towards this fenomena. The general public is a very important stakeholder of HEI and the stakeholder theory, on which the stakeholder relationship between the HEI and their stakeholders is based, is therefore discussed. But first, Figure 3.1 illustrates the location of Chapter 3 in relation to the other theoretical chapters. Chapter 2 provided theoretical perspectives on the development of science communication, but there is no sense in focusing on science communication if the attitude of stakeholders of HEI (the general public) is negative towards science. Chapter 3 therefore contains a discussion on the awareness of science, the results of previous studies to analyse attitudes towards science and the stakeholders who are the receivers of science communication.

Figure 3.1: Chapter 3 in relation to other theoretical chapters



3.2 SCIENCE COMMUNICATION AND INTERNAL STAKEHOLDERS

In terms of the stakeholder theory, there is no singular public; instead, there is layer upon layer of overlapping groups. These groups can be narrowed down, for example, into men and women, at home and at work, old and young, readers of particular magazines or newspapers, members of special

interest or hobby groups, religious groups, political groups, or families. Such distinctions and groupings can also provide a means of reaching people, for example through talks or workshops at group meetings, articles in club newsletters, or hands-on displays at exhibitions, fairs and open days. People are defined as stakeholders when they are affected by decisions of an organisation or if their decisions affect the organisation. Stakeholders who are or become more aware and active can be described as publics (Steyn & Puth, 2000:64).

Steyn and Puth (2000:5) identify stakeholders as individuals or groups of individuals who are influenced by or who influence the organisation. These groups can be found inside an organisation (employees, unions, sub-groups such as gender, ethnic or age groups) or in the external environment. There can be little argument that employees are a key stakeholder group for any institution (De Bussy & Ewing, 1997:224). Gronroos (1990:34) distinguishes between the implementation of internal communication (marketing) at the strategic and technical level. At the strategic level it should create an internal environment that bolsters external stakeholder consciousness and service-mindedness among employees. At the technical level, the aim is to sell services, campaigns and other marketing and communication efforts and initiatives to staff members.

According to De Bussy and Ewing (1997:224), the underlying thinking is that employees should be viewed as internal stakeholders and jobs as internal services (products). Job products must attract, develop and motivate employees, thereby satisfying the needs and wants of these internal stakeholders while at the same time addressing the overall objectives of the institution. All specialists, whether in marketing, communication or human resources, agree on the need to ensure that employees feel executive management care about them and their needs. In science communication the employees at HEI are also the internal stakeholders and therefore it is important that they are informed about scientific developments and should be positive towards communicating science to external stakeholders.

3.3 SCIENCE COMMUNICATION AND EXTERNAL STAKEHOLDERS

Managers of institutions refer to stakeholders as significant groups of people in the environment, while communication specialists refer to these groups as publics. However, there is a clear distinction between these two concepts. According to Steyn and Puth (2000:199), publics form when stakeholders recognise the consequences of an institution's behaviour as a problem and organise to do something about it. The moment that a stakeholder group becomes aware of a potential problem caused by the behaviour of the institution, the stakeholder evolves into a public. Even groups of people

never before recognised as stakeholders of the institution may form a public due to an issue in the macro environment. In this context, stakeholders and publics can be used synonymously. When Steyn and Puth (2000:196) outlined some of the stakeholder groups, the media were one of the groups that they identified. In this study, the media are the stakeholder group representing other external stakeholder groups of HEI.

The strategic-constituencies theories of organisational effectiveness explain why it is important for organisations to communicate messages, in this study specifically science, to their stakeholders. If the communication departments can identify the strategic publics (stakeholders) in the environment and manage the organisation's response to these interdependencies, these theories of effectiveness can assist to reduce uncertainty and conflict by stabilising relationships with key publics (Dozier, Grunig, Grunig, 1995:81).

Askew (1997:249) in his definition of the stakeholder theory, states that stakeholders have greater access to information and behaviour (and misbehaviour) of institutions. Institutions have become items of popular media content in a way they have never been in the past. As a result, stakeholders have become more knowing and even cynical about the strategies and tactics of HEI. At the same time, society at large has grown less deferential and less trusting of these institutions, which used to form its pillars. Whereas a stakeholder's assessment criteria of new products (new scientific developed products or technology) used to be limited to 'what can this product do for me?' and 'how much will it cost?' the questions that she/he is asking now include:

- Is this an institution whose values I share or respect?
- Do I want to be associated with them?
- Do they value my customs or are they taking me for granted?
- Can I trust them?

McDermott and Chan (1996) have a very simple message: stakeholder loyalty is obtained through trust, and institutions can only gain complete trust if they pay equal attention to all stakeholders. The flexible intelligent relationship management strategy (FIRMS) theory underwrites this message. The philosophical core of FIRMS is team work, based on principle-centred relationships of sincerity, integrity and trust. It therefore enables the enterprise (institution) to identify early on any deterioration in key relationships, and by acting quickly to avoid any adverse impact.

Communication professionals know that to be really effective they must know and understand the stakeholders, but many South African scientists and science communication specialists have yet to learn to meet their stakeholders halfway. Science communication is too often seen as a top-down flow from expert to ignoramus, with little regard for the requirements of those on the receiving end. The cultural and educational diversity of societies, however, requires one to replace this deficit model with a more participative approach in which mutual understanding is the ultimate goal. Scientists have to realise that they have to communicate with different audiences (stakeholders) for different reasons. Therefore, communication specialists in their capacity as facilitators should be acknowledged and included in situations where scientists are communicating with stakeholders. It is the role of communication specialists to ensure that scientists convey understandable and correct messages to stakeholders (Agunga, 1990:147). In Table 3.1 a selection of aims are lined up against four different types of audiences (stakeholders).

Table 3.1: Communicators' aims versus their audiences

AIMS OF COMMUNICATORS	AUDIENCE
Peer recognition Share concepts	Other scientists and the scientifically literate
Inform a policy issue Maintain funding levels Lobby	Decision makers Opinion formers
Create interest Demonstrate that funding is well-spent Whip up popular support for ideas Add to scientific literacy Convince audience scientists are normal people	The general public - adults
Create interest and educate Role of science in everyday life Encourage take-up of science Convince audience scientists are normal people	Children and young people

Source: National Environmental Research Council (2001)

The one mistake a scientist can make is to try and reach all these stakeholders with the same message in the same way. Different stakeholders need different approaches. In this regard, the role of communication specialists at HEI becomes very important. Communication specialists should be trusted and empowered with the correct training and expertise to assist scientists in compiling applicable material to present to the various stakeholders. However, if the public is not aware of

science or has a negative attitude towards science, all efforts to promote science will be in vain. The next sections discuss these two issues.

3.4 PUBLIC AWARENESS OF SCIENCE

Currently the public school system fails to get people interested and maybe a bit excited about an intellectual process called science. But once their minds are ignited, people use their own initiative to look for more information. They can assess and judge the pros and cons of a particular research project, as well as its technological applications. These knowledge seekers might even get involved as active and concerned citizens in order to enhance, divert or even stop certain scientific developments (Goede, 2001:4).

Wynne (in Goede, 2001:4), the inventor of the deficit and democratic model of communication, argues that "... the communication from science to the public has been a one-way process in which scientists assumed that they could find answers say to the question of consequences of nuclear power or genetically modified (GM) agriculture, and then merely educate the public about the scientific determination of the issue". This in fact has provoked the crisis of lack of public confidence in science. He complains that scientists either do not know how to communicate or refuse to communicate their work, although many of them are funded by the public and accountable to it. According to Wynne (in Goede, 2001:5) "... recent experiments in public participation have falsified the idea that the public cannot be trusted to respond wisely". He refers to a citizens' jury conducted with poor and illiterate Indian farmers on the issue of GM crops in the state of Bangalore. The jury actually demonstrated a sophisticated knowledge of the way new types of crops can impact on their lives. They saw interlinkages that scientists often miss and proposed practical conditions for improving food security for their people (Goede, 2001:5).

A growing network of institutions and individuals is involved in raising the public awareness and understanding of science and technology. The South African Government's *White Paper on Science and Technology* (Department of Arts, Culture, Science and Technology, 1998) recognised the importance of network activities and this recognition was demonstrated by the science awareness campaign in 1998. More and more scientists become convinced of the merits of explaining their work to stakeholders. But indeed, the public's (stakeholders') attitude involves more than just understanding, and understanding is not the only term used in relation to public association. Leschner (2002:3) clarifies the terms used in communicating science as follows:

- Public understanding: getting the full detail

- Public appreciation: more than 'liking' the science
- Public awareness: around you
- Public participation: take part in activities to communicate science
- Public engagement: involvement with organising activities to enhance communication
- Public understanding of research: what research is about and how scientists perform their science. The nature of the evidence must be known. People must understand what a scientist is and does. They must know who to listen to, since science cannot advance in a vacuum.

In any successful relationship, all participants in the communication process are required to understand one another. In the science communication scenario, communication specialists have a valuable contribution to make in acting as gatekeepers to ensure that messages not prejudicial to HEI are conveyed to stakeholders.

3.5 A SCIENTIST'S UNDERSTANDING OF 'THE PUBLIC'

Most people will have had no formal science education since they were 16 years old. Their general impressions of science may stem from experiences at school, maybe long ago, and from the images reflected in the media, which might not always be positive experiences. It is important to realise that not being familiar with or fond of science does not mean that non-scientists are uninformed. Indeed, some non-scientists might know more about a particular subject than some science writers do. These groups of non-scientists may reflect the same range of perceptions and knowledge about science as they do about everything else. But although knowledge of straight scientific facts may be limited, there is no shortage of interest.

What scientists choose to communicate should depend entirely on the specific stakeholder. Unfortunately scientists do not always realise how important stakeholders are. Therefore, the role of communication specialists is to assist scientists by mediation, to convey the correct message to the right stakeholder by transforming scientific facts into simplified facts, which can be understood by the laymen. Some stakeholders, for example, might be hobby enthusiasts, computer buffs, gardeners or wind-surfers, and have considerable knowledge of their areas of special interest. However, they may not have thought of it in terms of science or technology before. It is important to address the needs and concerns of the stakeholder and not assume that they are responding to whatever is communicating. The content is just as important as the communication. On the downside, some individual scientists still think that popularising science in some way cheapens it and that their colleagues who take part in popularisation activities of science are neither serious nor committed.

Popularisation is not always given the credit it deserves, and some scientists are wary that communicating publicly may have damaging consequences for their careers or reputations (Stempra, 2001). Due to this apprehension from scientists about communicating science to the layman, it is also important to be aware of the attitudes of the general public who are the stakeholders of HEI and who receive the message of science.

Public awareness surveys show that stakeholders (general public) want to know more about scientific research and how it affects their lives. They are curious about what scientists' work tells them about their origins, behaviour, employment options, health and many other aspects of their well-being. Conversely, the public is rarely interested in the technical aspects of research. For that reason, when they are communicating their research to stakeholders, scientists must focus on the application of their research data as it relates to the daily lives of the general public. Applied research may lend itself more easily to this approach than theoretical research, since applied research can be seen in products that can be seen and touched. Nonetheless, all researchers, whatever their field should be able to express simple ideas about how science works and put research in a context that stakeholders understand (Stempra, 2001). To assist scientists to overcome the difficulty of expressing their scientific facts in laymen's language, communication specialists should act as facilitators to ensure that stakeholders receive the correct messages a scientist want to convey to stakeholders.

The next section displays results from two studies performed in the UK and Australia respectively and summarise briefly three other studies conducted in France, Brussels and Japan. However, these were not the only studies that were performed. Many related studies were done in various countries, but the results were inaccessible and are therefore not included in this study.

3.6 RESEARCH CONDUCTED ON PUBLIC ATTITUDES TOWARDS SCIENCE

3.6.1 Research study by the Wellcome Trust and Office of Science and Technology

The Wellcome Trust and the Office of Science and Technology (OST) believe that some scientific developments are so fundamental that there needs to be a public debate before politicians and scientists can make decisions about them. The Trust and the OST consequently sponsored two research projects in 2000: the one looked at existing science communication activities in the United Kingdom, the aims of these activities and their intended audiences. The second project explored public attitudes to science, engineering and technology in Britain (Office of Science and Technology and the Wellcome Trust, 2000).

The task team, which was identified by the OST, conducted interviews with sixteen convened groups to explore the public's attitudes towards science, engineering and technology. The groups were based on age, sex, social grade and area (demographical area). Participants talked about science, engineering and technology, and the relationship between them. Results of the group discussions indicated that attitudes towards science are defined (to some extent at least) by general attitudes towards life. The attitude statements can therefore be put into three broad groups:

- Statements designed to explore personal confidence in coping with change and new developments (attitude to life).
- Statements focused on perceived benefits of science, which seem to be strongly related to interest in science (attitude to science).
- Statements looking at trust in politicians and regulation (attitude to authority).

A national representative survey was also conducted by interviewing more than 1 200 people using a quota sample method - with quotas set on age, sex and social grade. Booster samples of 200 members of minority ethnic groups and of 400 in Scotland were also interviewed. Respondents were asked about their attitudes towards science, life and authority, and their leisure interests. Statistical analysis of the responses to the questions explored a number of cluster solutions: the six-attitudinal cluster solution provided the best fit with the data. Table 3.2 provides an overview of the results.

Table 3.2: Public's interest in topical issues regarding science

Subject	Very interested (%)	Moderately interested (%)	Not interested (%)
Health issues	52	39	9
New medical discoveries	46	41	13
Education	40	39	21
Environmental issues	36	47	17
Welfare and social exclusion	32	46	22
Sport	32	29	39
New inventions and technologies	24	50	26
New scientific discoveries	23	49	28
Economics	17	42	41
International affairs/foreign policy	16	46	38
Politics	15	40	45
Energy/nuclear power issues	13	36	51

Source: Office of Science and Technology and the Wellcome Trust (2000)

It was found that three-quarters of respondents were 'amazed' by the achievements of science. This is largely because they could see the benefits for themselves – two-thirds agreed that science and technology are making people's lives healthier, easier and more comfortable. Most respondents were at least moderately interested in health issues and new medical discoveries.

Only a fifth said that they were neither interested in science nor could see why they should be, and a partially overlapping fifth agreed that the achievements of science were overrated. Eight out of ten respondents agreed that Britain needed to develop science and technology in order to enhance its international competitiveness. The need to invest in basic research was also appreciated: Seventy-two per cent agreed that, even if it brought no immediate benefits, scientific research that advanced knowledge was necessary and should be supported by the government.

Concerns were raised over the use of science and the ability of society to control science. When asked whether they thought the benefits of science were greater than any harmful effects, the response was ambivalent: 43% agreed, 17% disagreed, and a third preferred to give no opinion. There is a similar degree of ambivalence about politicians' motives for supporting science. Just under half of the sample (43%) agreed that politicians support science for the good of the country; nearly a quarter expressed no opinion and another quarter disagreed. Government's ability to control science also raised concerns. Only three out of ten did not agree with the statement that the speed of development in science and technology meant that it could not be controlled properly by government, while four out of ten agreed, revealing some degree of ambivalence. Moreover, half (53%) of the respondents thought that the media swayed politicians and that they should take more of a lead.

There is also concern about what might go on 'behind closed doors' in research institutions. Over two-thirds agreed that rules were not going to stop researchers doing what they want behind closed doors and over half thought that scientists seem to be trying new things without stopping to think about the risks. Despite this concern, only 36% agreed that science was getting out of control and that nothing could be done to stop it.

In general, scientists are respected: 84% of the respondents were of the opinion that scientists and engineers make a valuable contribution to society, and three-quarters were of the opinion that science and engineering are good careers and that science, engineering and technology are providing more opportunities for the next generation. Two-thirds of the respondents agreed that scientists want to

enhance the quality of life for the average person, while a similar proportion agreed that scientists should listen more to what non-scientists think.

3.6.2 Research conducted in Australia

In 1996 the Department of Industry, Science and Tourism in Australia published a document with background information on the public awareness of science and technology in Australia.

According to this publication, Australians have a high level of understanding of science concepts when compared with other nationalities. A comparative study conducted by the Bureau of Industry Economics in 1995 found that highly educated Australians are more aware of science concepts than highly educated Europeans.

Australians' understanding of science and technology is affected by their gender. Men have a slightly better understanding of most of the science areas tested, but women had a considerably better understanding of human biology. This reflects a more marked gender imbalance than is found in other nations. Middle-aged Australians have a greater understanding of science concepts than other age groups. For people less than 40 years of age, the older they are the better their understanding. For people over 40 years of age, the opposite is true: the younger the person, the better they understand science and technology. Education, however, has the greatest effect on an Australian's understanding of science. The higher the level of education, the better the person understands.

A 1991 study found that children in their final year of primary school (children around 10-12 years old) show varying levels of science understanding. A particular child could give advanced explanations for some common phenomena and at the same time show very basic, non-scientific understanding of other phenomena. A particular class could give excellent explanations for one phenomenon and poor explanations for others, showing the strong influence that teachings have on understanding. The children's skills at using scientific methods were as varied as their understanding of science. The students were good at measuring length, mass and temperature, as well as at classifying, but they did not do well in making inferences (Department of Industry, Science & Tourism, 1996).

Gender is a factor that affects a child's understanding of science phenomena. Boys outperformed girls in some areas, while girls outperformed boys in others. There was no difference in the level of science skill between the genders. The higher a child's socio-economic background, the better he or she performed. Children from homes where little English is spoken had lower levels of understanding and

skill. Children in suburban schools have lower levels of science skill than children in urban and rural schools.

Gaps in science skill and knowledge are apparent in other segments of society. Most middle managers know very little about the process of research and development. Science and technology is the one area where business, government and union leaders know as little as workers. For people who have completed their education, most of their information on science and technology comes from the mass media and their understanding of it will be affected by the way in which it is presented by the mass media. A study of changes in science reporting since 1986 found that there was an increase in the coverage of science and technology. Most stories were on life science or medicine, and domination by these areas has increased. Coverage of astronomy, space and environmental science has dropped. Most stories were light, entertaining, and 'whiz-bang' style presentations of the products of research and ignored the process of research completely. The authors of the report on the study doubted that the increased coverage would raise the level of public understanding of science (Department of Industry, Science & Tourism, 1996).

3.6.3 Research conducted in various other countries

In a study conducted in France by the Centre National de la Recherche Française (CNRS) in 2001, results indicated that medical and environmental issues are regarded more important than other scientific fields. Participants in the study requested concrete evidence of science and indicated that a social need must be there, for example cell phones (De Cheveigne, 2002:14).

According to Claessens (2002:22), the European Commission published the results of a major survey on "Europeans, science and technology" in 2001. The survey offers a unique insight into how European citizens view science and technology. The results included the following:

- Two-thirds of participants in the survey agreed that they are badly informed on science and technology, although 45,3% declare that they are interested in science topics;
- science remains a very positive value in European societies – citizens expect a great deal from scientific progress and want political decisions to rely more on expert advice;
- the majority of Europeans call for more control of research activities, particularly in terms of stakeholder protection, employment and social issues, energy and science;
- although crises can strengthen the image and importance of research, scientists have an ambiguous image, especially as regards their assumed responsibility for the misuse of scientific discoveries by non-scientists;

- the survey also showed that, compared to 1992 when the previous survey was carried out, the level of Europeans' scientific literacy remained stable.

In 2001 the National Institute of Science and Technology Policy of the Japanese government also conducted a survey about public attitudes towards and understanding of science and technology. The results indicated that Japan's public understanding of basic sciences is relatively low compared to a significant number of European countries and the United States (Ishii, 2002:24).

3.7 RESEARCH ON PUBLIC ATTITUDES TOWARDS SCIENCE IN SOUTH AFRICA

3.7.1 Comparative research: Interests, public attitudes and sources of scientific information in South Africa

In South Africa a few studies were also conducted on the attitudes of the general public. The results of two previous studies are described below. The objectives of a survey conducted by Pouris (2001:1) were the following:

- To identify the level of interest of the public in selected issues;
- to examine the public attitudes towards science and technology;
- to analyse the sources of information used by citizens to improve and maintain their understanding of technological issues.

Pouris's study focused on a survey conducted among 1 000 households in the main South African metropolitan areas in 2000, namely Pretoria, East Rand, West Rand, Vaal, Port Elizabeth, Cape Town, Bloemfontein and Durban/Pietermaritzburg. A representative cluster sampling approach had been followed with face-to-face interviews. Apart from the questions relating to science and technology, information on the following had also been collected from the respondents: gender, age, household income, race, life stage, highest educational level achieved, highest educational level achieved in mathematics and science, home language and marital status (Pouris, 2001:2). Table 3.3 provides an indication of the percentage of respondents agreeing that they are 'very interested' in science and technology issues.

Table 3.3: Respondents agreeing that they are 'very interested 'in science and technology issues

Issue	Male	Female	Black	16-24 year old	TOTAL
Foreign policy	22%	13%	15%	13%	18%
New science discovery	39%	27%	34%	37%	33%
New technologies	48%	36%	47%	47%	42%
Space exploration	23%	13%	16%	25%	13%
Energy/Nuclear power	25%	16%	23%	27%	21%
Medical discoveries	57%	56%	61%	56%	57%
Environmental issues	52%	47%	51%	49%	49%
Economic policy	49%	38%	50%	40%	43%

Source: Pouris (2001:4)

The table indicates that the issues of highest interest were medical discoveries, environmental issues and new technologies. Women were less interested than men in all issues and the interest of respondents increased as their educational level in general and/or their level of science/mathematics education increased. Young respondents (16-24 years old) showed below average interest in economic and foreign policy, and above average interest in issues of science and technology.

Table 3.4 demonstrates the issue interest index scores for the European Union (EU), the United States (USA), Japan and South Africa (SA). Although the interests of South Africans appear to be within the boundaries of interests of the citizens of the industrialised world, they show less interest in space exploration, energy and foreign/international policy (Pouris, 2001:5).

Table 3.4: Issue interest index scores per country

Issue	EU (1992)	USA (1995)	Japan (1991)	SA (2000)
Foreign policy	61	67	50	56
New science discovery	59	66	53	63
New technologies	68	83	65	73
Space exploration	75	74	71	69
Energy/Nuclear power	-	50	45	35
Medical discoveries	-	54	59	38
Environmental issues	-	68	65	62
Economic policy	-	48	55	37

Source: Pouris (2001:5)

Linked to the issue of interest is the issue of informedness. Informedness denotes an individual's self-assessment of his or her level of understanding of a particular issue area (Pouris, 2001:5).

Table 3.5 illustrates that only 9% of the respondents agreed that they were 'very well informed' about space exploration, while 12% felt like this about foreign policy. Environmental issues fell on the other side of the scale, and 28% of respondents indicated that they were well informed on issues of environmental matters.

Young respondents indicated that, in their opinion, they were better informed than the average respondent, while fewer women than men considered themselves informed about issues. The level of informedness increased with the level of education and greater participation in science and mathematics education. When the gap between interest and informedness was examined, it was found that the largest gaps were in medical discoveries and new technologies. Similarly, the levels of self-reported understanding were significantly lower than the levels of interest in the same issues across all topics.

Table 3.5: Respondents agreeing that they are 'very well informed ' about issues

Issue	Male	Female	Black	16-24 year old	TOTAL
Foreign policy	17	7	14	13	12
New science discovery	20	10	16	20	15
New technologies	23	16	25	24	20
Space exploration	11	6	8	11	9
Energy/Nuclear power	15	11	15	21	13
Medical discoveries	27	25	29	32	26
Environmental issues	28	29	27	35	28
Economic policy	36	21	30	28	26

Source: Pouris (2001:6)

Further results indicated that South Africans believe strongly in the beneficial effects of science and technology. More than three quarters of the respondents agreed that science and technology contribute to an easier and more comfortable life; that scientists focus on the interests of the average person; that scientific work becomes more interesting; and that science and technology should create more opportunities for future generations (Pouris, 2001:6).

Respondents, however, expressed concerns and reservations about the adverse effects of science and technology. Fifty-eight per cent of the respondents felt that non-scientists depend too much on science and not enough on faith, and 69% agreed that science changes people's way of life too fast. According to Pouris (2001:6), these statements are probably the result and a reflection of a society experiencing a faster pace of social and economic change than earlier generations.

3.7.2 Public understanding of science in South Africa

In March 1999, a national survey that used items from international surveys as well as from locally developed items was commissioned by the Foundation for Research Development (FRD) and undertaken by the Human Research Council (HSRC) in South Africa. The sample population comprised 2 207 randomly selected adults distributed throughout South Africa. The data was weighted appropriately to match the demographics of the national adult population (Blankley & Arnold, 1999:1).

The survey produced some notable results, such as that over 30% of adults had never studied mathematics at school, 50% had never studied biological science, and 55% had never studied physical or chemical science. The low level of understanding of science in South Africa was revealed through an international 8-item index of promise and reservation about science.

At almost all levels, men had passed more science and mathematics courses than women. The gender differential was least pronounced in the biological sciences, with about 18% of both genders having passed matriculation biology and 4 to 5% of both genders having passed courses at higher level. In the case of physical and chemical science, the gender differential was most noticeable: over 17% of male respondents had passed the matriculation examination, compared to fewer than 11% of females. It is also worth noting that only 2% of women respondents had studied mathematics at higher level, compared with close to 6% of men (Blankley & Arnold, 1999:3).

Regarding respondents' attitude towards science, the following results were noticeable according to Blankley and Arnold (1999:6): 68% of respondents expressed the belief that science was changing people's way of life in an unacceptably fast manner. Perhaps this reflects the uncertainties of a population that has experienced enormous transformations (including political, social and technological changes) over the last decade.

At face value, as suggested by Blankley and Arnold (1999:7), it would appear that South Africans in general are highly optimistic about science. The levels of interest are also encouraging and suggest that public understanding of science interventions, if tackled with imagination, might find a receptive audience.

3.8 CONCLUSION

In Chapter 2 the information theory and mass communication theory were discussed as they form part of the links in the science communication chain. Chapter 3 described the stakeholder theory, which refers to the stakeholders of HEI and who are the receivers of the science communication. The stakeholders of HEI as receivers of the science message various from the media to the general public and are therefore important components in the theoretical framework of this study. How they perceive science communication and science as such, is thus important for the purpose of this study.

As can be seen from the results of studies conducted all over the world, the majority of non-scientists are interested in science. However, both uncertainty and a full understanding of science provide a barrier to the acceptance of new developments. In South Africa, specifically, public understanding of science interventions needs to take into consideration the general lack of scientific vocabulary or scientific constructs that forms the basis for the assimilation of scientific knowledge. Whatever means communicators and policy makers choose to promote the understanding of science among the general public, care and forethought are needed where levels of conceptual development regarding science appear to be extremely low.

In Chapter 3 the results pertaining to public attitudes in South Africa were positive towards science, engineering and technology. Yet, without the correct means to convey the message of science to the various stakeholders in South Africa, this message is doomed to failure.

Up to now science communication as information (information theory) that has to be communicated to stakeholders (stakeholder theory) through channels, such as mass communication (mass communication theory) was discussed. Communication specialists at HEI should have the imperative role of facilitator to play in the communication process. They are the spokespeople of HEI and should ensure that no messages that could be prejudicial to HEI are conveyed to stakeholders. However, to achieve science communication successfully and to equip communication specialists for their responsibility as facilitator, strategic communication planning is required. The theory and concept of strategic communication, as well as the importance thereof in science communication at HEI are discussed in detail in Chapter 4.

Chapter 4

The strategic management of science communication

4.1 INTRODUCTION

In the previous chapters the importance of science communication (including its development and history) and awareness of science and science communication amongst stakeholders of HEI were discussed. The theories on which the aforementioned concepts are based were also described. Chapter 4 now contains a discussion of the strategic management of communication departments at HEIs in science communication. The theories of excellence in public relations and communication management and corporate communication strategy are also explained.

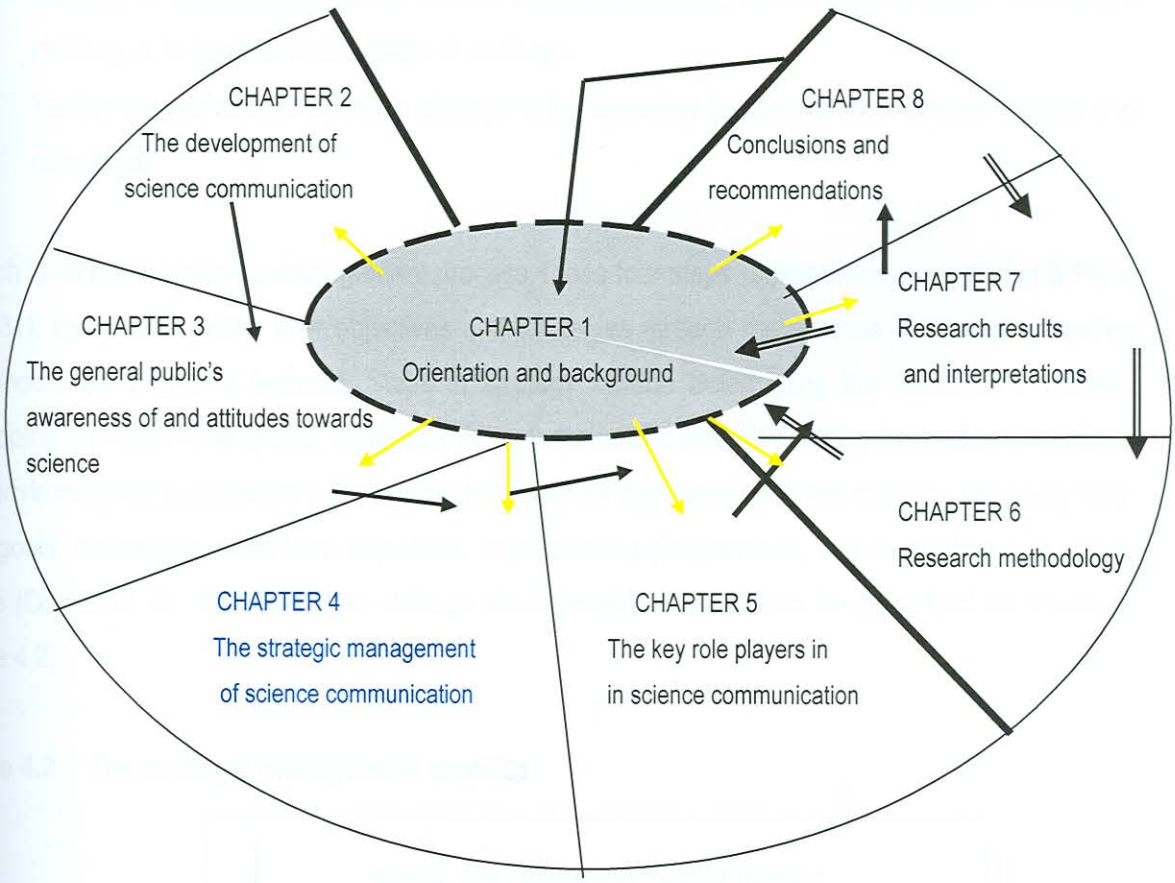
Strategic communication is about mission and message. It is also about the world and about changes occurring in the world people live in and the attentiveness they provide to the world. Since developments in science and technology during the recent past have resulted in changes in people's daily lives, it became a necessity to ensure that these developments in science are communicated properly to the general public. Strategic communication is furthermore the art of expressing values and solutions so that people who need to know would understand what is being said. But it is also about the science of transmitting information so that people who need to know would see what is meant and hear what is said (Radtke, 1998:xi). The clarification of strategic communication is also applicable to communicating science. In science communication it is equally important to have a proper strategy so that the right message can reach targeted stakeholders and in a way that can be understood by the particular stakeholder.

Strategic communication is a critical success factor in addressing the political, social and economic issues that business management would like to address. A management philosophy that excludes strategic communication is no longer appropriate for the present and likely future environment (De Beer, 2001:78). Axley (1996:24) states that "... many of today's most pressing organisational and management challenges – leadership, empowerment, shaping organisational culture, building effective teams, and managing change – hinge on communication activities and can best be understood and met in terms of communication and communicating".

Chapter 4 leads the study to the final discussion on theoretical conceptualisation in Chapter 5, in which the application of the theory is applied to science communication in more detail. In Chapter 4 the

theory of strategic management is discussed first and thereafter the application to science communication follows at the end of each section, since the strategic management of science communication at HEI should be regarded as highly important. Figure 4.1 demonstrates the position of Chapter 4 in relation to the other theoretical chapters.

Figure 4.1: Chapter 4 in relation to other theoretical chapters



4.2 STRATEGIC AND CORPORATE COMMUNICATION MANAGEMENT

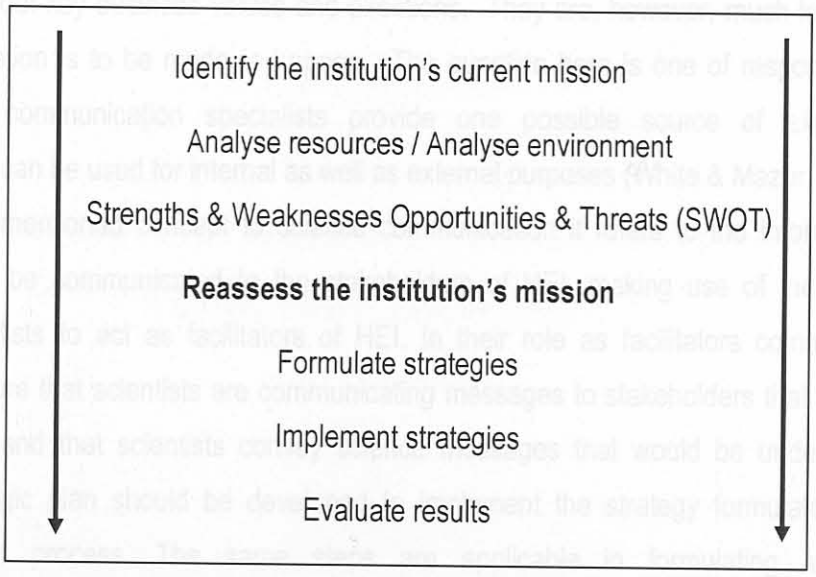
Strategy is the fundamental pattern of present and planned objectives, resource developments and interactions of an institution with its publics, stakeholders and other environmental factors (Walker, Boyd & Larréché, 1999:8). In a pure sense, a strategy is a plan to use selected means in predetermined ways to attain a desired result. Strategic thinking links the fact-finding phase to planning and programming (O'Hair, Friedrich & Shaver, 1998). Strategic management is a process that enables any organisation, company, association, non-profit or government agency, to manage the implementation of its strategy by identifying its long-term opportunities and threats, mobilising its assets to address them and carrying out a successful implementation strategy (De Beer, 2001:90).

Once the strategy has been decided upon, strategic planning in the strategic management process on how science should be communicated can begin. Makin (1999) identifies the following steps in formulating a strategic plan as part of the strategic management process:

- Aim or goal refers to what the institution wants to achieve.
- Objectives are the measurable steps by which one can judge whether the goal is being achieved.
- Strategy is a rationale for all the actions aimed at achieving the institution's goals, providing a framework to guide and to explain all activities.
- Tactics are the actions by which strategy is implemented to achieve the institution's goals and objectives.

At each level of the strategic management process, these four steps repeat themselves (Steyn & Puth, 2000:31). Institutions define their objectives and strategies through the process of strategic planning that should be long-term focused. Steps in strategy include determining the institution's mission, developing an institutional profile, assessing the external environment, matching the institutional profile with environmental opportunities, identifying best options consistent with the mission, choosing long-term goals, developing short-term objectives, implementing programmes, and evaluating success or failure (Dozier *et al.*, 1995:85). The strategic management process can be described as shown in Figure 4.2.

Figure 4.2: The strategic management process



Adapted from: Makin (1999: [3])

Beerel (1998:162) states that strategic planning is a formal process designed to interpret the institution's environment for the purpose of identifying its adaptive challenges and guiding its responses so as to optimise longer-term competitive advantage. Although planning undoubtedly produces a series of integrated decisions, this serves a secondary purpose. The very process of monitoring and evaluating the environment is the sharp end of the strategic planning process. It is the critical link between the institution as a living network and the infinite number of networks that defines its environment (Beerel, 1998:162).

Steyn and Puth (2000:17) describe strategic communication management, as part of strategic management, as: " ... a process of thinking through the current mission of the organisation, and the current environmental conditions, and combining these elements by setting forth a guide for tomorrow's decisions and results". Strategic management and planning are high-level institutional functions tightly linked to excellence in communication management. The purpose and direction of an institution (its mission) is affected by relationships with key constituents (stakeholders) in the institution's environment. These relationships affect an institution's autonomy to pursue its mission and accomplish its goals (Dozier *et al.,* 1995:85).

Strategy is, therefore, essentially concerned with the long-term direction and scope of an institution. It is arrived at through a process of analysis and decision making, to which many in the institution should contribute. Once developed, it would need to be communicated so that it can be implemented (White & Mazur, 1995:25). Writers on strategy stress the importance of communication in transmitting and sharing information about key business values and directions. They are, however, much less explicit about how communication is to be made to happen. The question here is one of responsibility for communication, and communication specialists provide one possible source of expertise in communication, which can be used for internal as well as external purposes (White & Mazur, 1995:27). In applying the abovementioned concept to science communication it refers to the information on science which should be communicated to the stakeholders of HEI, making use of the ability of communication specialists to act as facilitators of HEI. In their role as facilitators communication specialists should ensure that scientists are communicating messages to stakeholders that would not be prejudicial to HEI and that scientists convey science messages that would be understood by stakeholders. A strategic plan should be developed to implement the strategy formulated by the strategic management process. The same steps are applicable in formulating a science communication strategic plan.

Kotler (1997:68) states that the strategic plan for an institution contains several components:

- the mission;
- strategic objectives;
- strategic audit;
- strengths, weaknesses, opportunities and threats (SWOT) analysis.

Mission

The mission states the purpose of an institution and what it wants to accomplish in the larger environment. According to Kotler (1997:68) a mission statement should be developed formally. It should be neither too narrow nor too broad, but should be realistic, specific and based on distinctive competencies. It should also act as a motivation tool in the institution. Within the context of science communication, the mission of HEI should be to promote science communication to stakeholders.

Strategic objectives

The institution's mission needs to be turned into corporate goals and objectives to guide management. Each unit on corporate level should have objectives and be responsible for reaching these objectives within a specific time frame. HEI should strive towards reaching science communication objectives by participating in science events, marketing the hands-on science activities, training scientists to communicate with the media, government and other stakeholders, and allow communication specialists to formulate their own objectives to enhance science awareness, for example to act as facilitators between scientists and stakeholders.

Strategic audit

The strategic audit covers the gathering of vital information. According to Kotler, Armstrong, Saunders and Wong (1996:78,79) it is the intelligence used to build the detailed objectives and strategy of an institution. Executive management at HEI should empower their communication specialists to gather relevant and important information required for the formulation of objectives and to use this information at their own discretion.

SWOT analysis

The guidelines that a unit, for example the marketing and communication function, can use to develop strategy in coherence with the institutional strategy and objectives are constituted in the unit's **s**trengths, **w**eaknesses, **o**pportunities and **t**hreats (the SWOT analysis). Normally, strengths and weaknesses are focused on the internal environment, while opportunities and threats focus on the

external environment. Ghemawat (1999:6) combines these elements in a way that emphasises the fact that competencies or resources have to match environmental needs in order to have value. In science communication it would be in the interest of a particular HEI to determine the strengths and weaknesses of the science communication process, which would refer to issues such as the relationship between scientists and communication specialists, as well as the trust and empowerment executive management provide to communication specialists. On the other hand the opportunities and threats science and the communication thereof have on stakeholders should be determined.

It is important for HEIs to ensure that the mission of science communication is clear to all key role players at that particular HEI and that they all understand the objectives of science communication. Executive management should empower and trust communication specialists to obtain the necessary information to formulate the objectives of science communication and lastly the SWOT analysis should be done to enable key role players in science communication at HEIs to focus on strengths and opportunities, while at the same time reduce the weaknesses and threats.

Although the components of strategic management mentioned above are applicable to all departments within an institution, the communication department has additional characteristics that distinguish it from the corporate strategic management of institutions. The strategic management of communication is discussed in the following section.

4.3 STRATEGIC MANAGEMENT OF COMMUNICATION

Strategic communication and management of communication differ from tactical or functionary communication. Strategic management communication involves top communication specialists in the highest management roles in an institution, and help executive management assess the external environment and respond appropriately (Dozier *et al.*, 1995:85). Steyn and Puth (2000:5-6) differentiate between corporate communication and communication management and state that corporate management are managing communication to increase organisational effectiveness by creating and maintaining relationships with stakeholders. Management communication, on the other hand, is the only field that integrates communication and management. Management communication follows a functional approach and regards communication as the means to an end, the achievement of organisational goals. According to Kinkead and Winokur (1992:23), the communication manager should work closely with executive management to help formulate policy, as opposed to merely plan the communication aspect of given events. In science communication it is not the communication specialists that are responsible for the strategic issues, but the executive management at HEIs, while

communication specialists are implementing the formulated strategies in managing communication with stakeholders.

Change in the external environment impacts directly on the way communication is being practised. The communication specialist or manager has to interpret change in the immediate external environment as well as globally, and has to initiate adjustments where necessary. The recognition the communication management function enjoys in the institution has a significant influence on the extent to which it is allowed to consult directly with management and to initiate changes (Claassen & Verwey, 1997:49). This recognition is also important in science communication, since executive management formulates the strategy to be implemented in communicating science to HEI stakeholders and the communication specialists have to be aware of any changes in the strategy to be able to inform stakeholders of these changes.

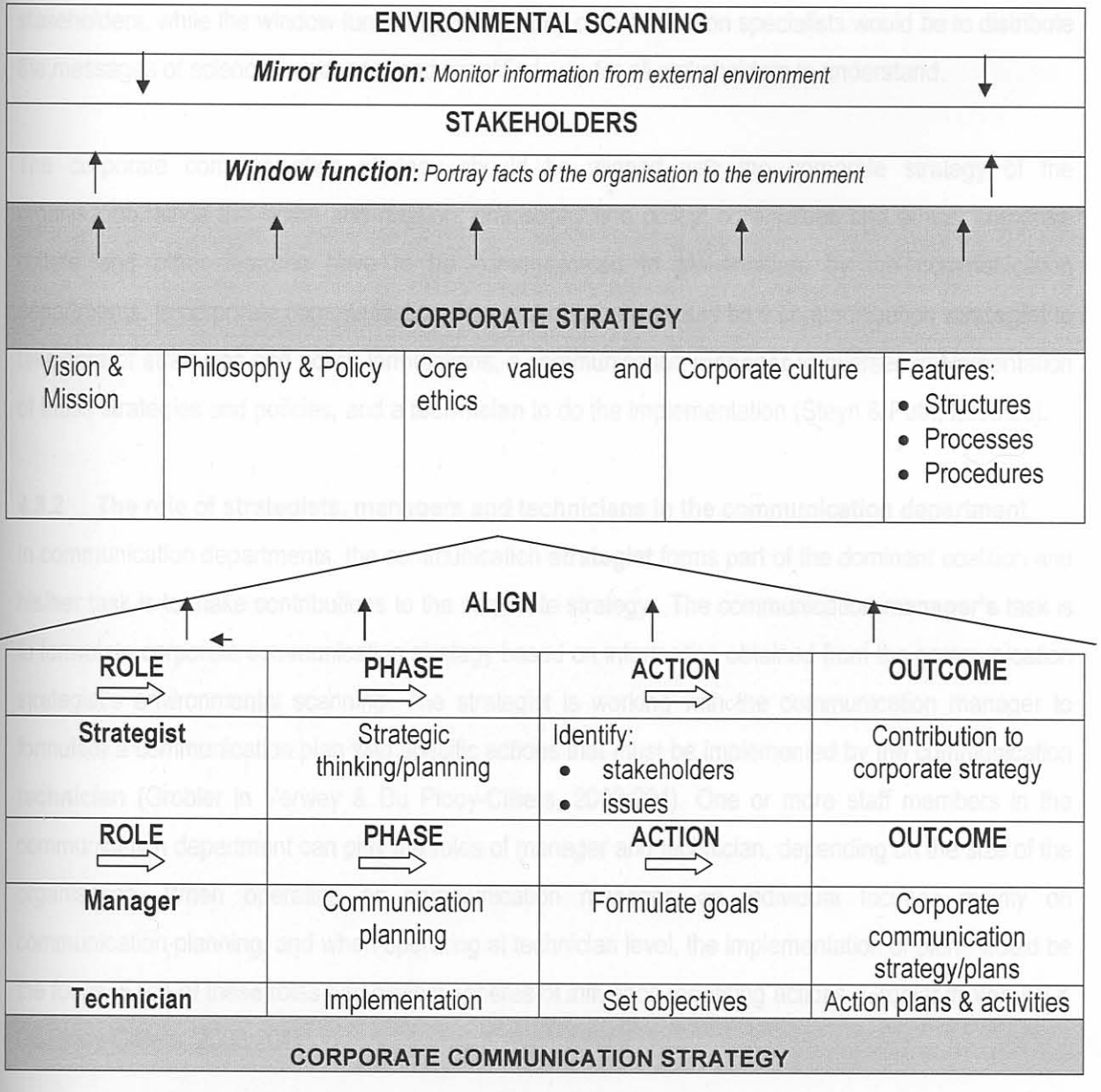
4.3.1 Strategic communication departments

The strategic communication department develops programmes to communicate with stakeholders that provide the greatest threats and opportunities to the institution. Participation in strategic management also elevates communication from its traditional reactive style of responding to communication crises to a proactive, responsive style of anticipating and then helping to reduce emergent conflicts (Grunig, 1997:5). Large-scale, complex organisations have a higher tendency to include communication in the policy-making process. They usually operate in a highly competitive environment and are more sensitive to policy issues, public attitudes and establishing a solid corporate identity. Consequently there is more emphasis on press conferences, formal contact with the media, writing executive speeches, and counselling management. In contrast, a small-scale organisation feels few public pressures and little governmental regulatory interest. It has little communication activity, and staff members are relegated to such technician roles as producing the company newsletter and issuing routine news releases. Communication has little or no input into management decisions and policy formulation (Wilcox, Ault & Agee, 1989:66,67).

Unfortunately many HEIs seem to operate like the small-scale organisations where science communication is concerned. Due to a lack of a proper relationship between executive management and communication specialists, science communication is not regarded as a priority. Since a proper strategic plan has not been developed, it results in too many voices responding on behalf of the HEI and different messages being sent to stakeholders.

Grobler (in Verwey & Du Plooy-Cilliers, 2003:200) incorporates all the theoretical assumptions, dimensions and elements of Steyn and Puth's (2000:53-76) model for a corporate communication strategy into a model for the alignment of strategic intent within the context of continuous change as demonstrated by Figure 4.3. Steyn and Puth's model focuses on the elevation of the contribution of the corporate communication division from purely tactical (functionary) practice to a key element of corporate strategy decision making.

Figure 4.3: Aligning the corporate communication strategy with the corporate strategy



Source: Grobler (in Verwey & Du Plooy-Cilliers, 2003:204)

The first block of Figure 4.3 represents the dimensions of corporate strategy and the second block the corporate communication strategy. The members of executive management, also known as the dominant coalition, formulate the corporate strategy. Environmental scanning provides information to formulate the corporate strategy. According to Van Riel (in Steyn and Puth, 2000:19), environmental scanning refers to the mirror function of the corporate communication's role to achieve the organisation's mission. The window function refers to the preparation and execution of a corporate communication strategy and policy, resulting in messages that portray all facets of the organisation to its stakeholders (Steyn & Puth, 2000: 19). In science communication the mirror function would imply that communication specialists need to scan the environment to obtain information on the HEI's stakeholders, while the window function performed by communication specialists would be to distribute the messages of science in a correct and simplified way for all stakeholders to understand.

The corporate communication strategy should be aligned with the corporate strategy of the organisation, since the vision and mission; philosophy and policy; core values and ethics; corporate culture and other features have to be communicated to stakeholders by the communication departments. In corporate communication departments, there should be a communication **strategist** to take care of strategies and policy formulations, a communication **manager** to oversee implementation of these strategies and policies, and a **technician** to do the implementation (Steyn & Puth, 2000:20).

4.3.2 The role of strategists, managers and technicians in the communication department

In communication departments, the communication **strategist** forms part of the dominant coalition and his/her task is to make contributions to the corporate strategy. The communication **manager's** task is to formulate corporate communication strategy based on information obtained from the communication strategist's environmental scanning. The strategist is working with the communication manager to formulate a communication plan with specific actions that must be implemented by the communication **technician** (Grobler in Verwey & Du Plooy-Cilliers, 2003:204). One or more staff members in the communication department can play the roles of manager and technician, depending on the size of the organisation. When operating as communication manager, an individual focuses mainly on communication planning, and when operating at technician level, the implementation of plans would be the focus. Each of these roles has distinct spheres of influence regarding actions (Grobler in Verwey & Du Plooy-Cilliers, 2003:204).

In science communication the roles of communication specialists are embedded in the managerial roles, since communication specialists have to formulate the strategy and action plan of science

activities. With regards to science communication, the corporate communication strategy should also be aligned with the HEI's corporate strategy, but the communication strategist is represented by executive management of HEIs who formulates the strategy to be followed in communicating science, while the communication specialist would represent the manager in implementing these strategies formulated by executive management. It is therefore imperative for executive management and communication specialists to have a relationship of trust and empowerment to ensure that the correct messages received from scientists are communicated to all stakeholders of the HEI.

However, to be successful in communicating science, excellence in the management function of science communication is required. The following section contains a discussion on the General theory of excellence in public relations and communication management on which part of this study is based.

4.4 APPLICATION OF EXCELLENCE IN PUBLIC RELATIONS ON SCIENCE COMMUNICATION

Communication departments strive towards excellence in their management of functions of their departments. Based on this goal of achieving excellence in public relations (PR) and communication management, the General theory of excellence was developed in the 1990s. The first phase of the *Excellence Study* was performed in 1990 and 1991 and included a survey of 321 organisations in Canada, the United Kingdom and the United States. The second phase included a follow-up of case studies in 1994 of 24 organisations that participated in the original survey. The findings of this study of public relations and communication management are reported in the book *Manager's Guide to Excellence in Public Relations and Communication Management* by Dozier, Grunig, L. and Grunig, J. (1995).

According to White and Mazur (1995:22), the *Excellence Study* has assisted to identify the following key elements of excellence communication:

- It can make an organisation more successful by developing and managing the organisation strategically, and by supporting the strategic objectives of the organisation.
- It nurtures relationships with key internal and external publics and stakeholders who provide the greatest threats and opportunities for the organisation.
- It makes a direct contribution to the bottom line by preventing the costs of conflict with key stakeholders in terms of strikes, litigation and boycotts.
- It can also assist the organisation make money by enhancing relationships with stakeholders, i.e. customers, shareholders and regulators.

White and Mazur (1995:23) identified certain key characteristics of excellence in communication and communication management, which include the following:

- These practices are strategic, not historical, and excellent communication programmes are created for strategic purposes. They are not just an evolution of what has been done in the past; they are aimed at groups that are important to the institution in strategic terms.
- They are concerned with impact, not process, and aim to influence stakeholder attitudes, opinions or behaviours rather than simply putting processes into motion such as news release production.
- Excellent communication use both formal and informal research to understand its stakeholdrs and monitor effectiveness.

The *Excellence Study* focused on three spheres of communication excellence: the 'knowledge level of the communication specialist'; the 'shared expectations between executive management and the communication specialist', and the 'culture of the organisation'. All three spheres are important to establish a successful relationship between an organisation's executive management and communication departments. These spheres are also applicable to science communication, since communication specialists need to have a basic knowledge of science; the expectations of executive management and communication specialists at HEIs should be understood by both groups; and the culture of the HEI should be of such a nature that there is trust and empowerment between executive management and communication specialists to ensure the correct science messages are conveyed to the stakeholders of the HEI.

4.4.1 The knowledge level of science communication specialists

Most communication departments have creative communication specialists, called technicians, who can write and edit, handle technical aspects of production and know about photography and graphics. However, enhancing these technical skills in themselves does not lead to excellence (Dozier *et al.*, 1995:11). Communication specialists need to become business managers who specialise in communication and should assist other business managers to be more effective and successful with their science communication experience (Potter, 1998:15). In the case of science communication it would mean that communication specialists as managers must have a basic knowledge of science to be able to act as facilitators between HEI and stakeholders. Communication specialists should be in a position to decide what should be communicated to stakeholders and what should not be communicated.

The *Excellence Study* found that executive management believed that communication specialists' most valuable contribution to their institutions could be in identifying trends that might affect business and operations. However, most of the executive management agreed that communication specialists were not effective in determining and managing those trends. It is not easy to be knowledgeable and courageous enough to confront strategic issues – even if that is what the executive management want and expect of communication specialists (McGoon, 1998:19). Although this statement might be true in the corporate function of the communication department, it is not applicable to science communication, since communication specialists are the managers and not strategists with regards to science communication.

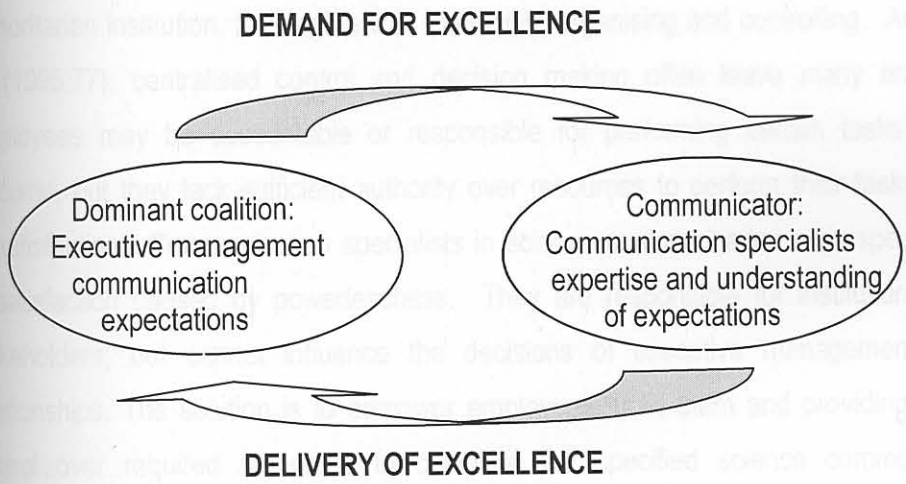
4.4.2 The shared expectations between executive management and science communication specialists

Surrounding the core of the knowledge base there is a sphere that represents a set of shared expectations about communication between executive management and top communication specialists. Shared expectations create linkages between the executive management and communication specialists. These linkages are the demand from executive management for communication excellence and the delivery of such excellence by the communication specialists (Dozier *et al.*, 1995:10).

Communication specialists and executive management at HEI have certain expectations from each other, such as empowerment and trust, especially in science communication. Mutual understanding is therefore required to ensure that communication specialists implement science communication strategies determined by executive management correctly. Regular consultation between communication specialists and executive management should take place to achieve excellent communication and relationships with stakeholders. Communication specialists require freedom to make recommendations to executive management and subsequently to implement these recommendations. According to Potter (1998:15), it is therefore imperative that communication specialists establish what the executive management value and what behaviours communication specialists have to adopt to be valued. Communication specialists should also develop mutual understanding between executive management and the stakeholders of the institution. Communication specialists should research the external environment and inform management of what stakeholders think about the institution. Executive management want two-way communication and win-win outcomes (Lindeborg, 1994:5).

When executive management demand excellence from the institution's communication specialists and communication specialists understand that demand and are able to deliver, a demand-delivery linkage is established. This demand-delivery linkage, displayed in Figure 4.4, describes an ongoing relationship between communication specialists and executive management (Dozier *et al.*, 1995:16).

Figure 4.4: The demand-delivery linkage for communication excellence



Adapted from: Dozier *et al.* (1995:16)

Over time, expectations and performance reinforce one another. Executive management value and support the communication specialists when they play an integral part in developing shared expectations, which lead to communication excellence (Dozier *et al.*, 1995:16-17). In science communication executive management expects communication specialists to mediate the process of communication between scientists and journalists to ensure the message of science reach the stakeholders of HEI successfully.

4.4.3 The culture of the institution

The institutional culture surrounds the knowledge core and shared expectations sphere. According to Dozier *et al.* (1995:17), the *Excellence Study* highlighted two basic forms of institutional culture: participative and authoritarian.

In science communication a participative corporate culture fosters excellent science communication. Such a culture is decentralised with shared power and decision making. It values cooperation and equality, including opportunities for women. It welcomes ideas from outside and innovation (Lindeborg, 1994:5). A participative culture would enhance a relationship of trust and empowerment between

executive management and communication specialists and would encourage all key role players in science communication at HEIs to participate in achieving the ultimate goal of science communication, which is to convey the message of science successfully to all stakeholders.

Authoritarian cultures emphasise centralised control and decision making by a few powerful managers. Participative cultures, on the other hand, emphasise teamwork, with wide participation in decision making (Dozier *et al.*, 1995:77; Lauzen, 1995:191). According to Senge (1990:181), in the traditional authoritarian institution, the dogma was managing, organising and controlling. According to Dozier *et al.* (1995:77), centralised control and decision making often leave many employees powerless. Employees may be accountable or responsible for performing certain tasks or achieving some outcome, but they lack sufficient authority over resources to perform their tasks. This leads to job dissatisfaction. Communication specialists in science communication are especially subject to such dissatisfaction caused by powerlessness. They are responsible for institutional relationships with stakeholders, but cannot influence the decisions of executive management that shape those relationships. The solution is to empower employees, trust them and providing them with sufficient control over required resources to complete the specified science communication tasks. The empowerment value runs deep in participative culture.

Science communication excellence can grow in a participative culture that provides a nurturing soil. Communication specialists are more likely to be excluded when executive management makes centralised decisions by virtue of formal authority. As decision making expands to include other contributors without formal authority, communication specialists are more likely to be influential and trusted. Communication specialists in science communication need such informal power, a form of empowerment for communication specialists, in order to achieve communication excellence (Dozier *et al.*, 1995:78).

In a HEI where communication is excellent, assuming that there is a healthy relationship between executive management and communication specialists, scientists of the institution would also feel comfortable to trust communication specialists liaising with stakeholders on their behalf. In science communication the excellent communication would furthermore result in a positive relationship between the institution and its stakeholders, especially the media.

4.4.4 A single, integrated communication department

Communication departments in the less-than-excellent institution are often splintered into discrete functions that support other departments (primarily marketing, finance or personnel) or that respond to different publics. These departments typically develop from a historicist, rather than strategic, direction. As a result of their fragmented structure, they cannot respond and change as the strategic nature of their public fluctuates (Grunig, 1997:6).

The excellent communication department is an integrated one. It encompasses all communication functions and thus has the flexibility to shift its resources to respond to the inherent dynamism of today's environment (Grunig, 1997:6). If the communication department is to be the interpreter of management, then it must know what management is thinking at any moment on virtually every public issue. If communication is made subordinate to any other discipline, such as marketing, advertising, legal, administration, etc. then its independence, credibility, and ultimately its value as an objective management counsellor, would be sacrificed (Seitel, 1989:47).

At some HEIs a dilemma exist, since HEIs have various faculties with their own communication specialists. Besides these communication specialists there is also a corporate communication and/or marketing department with communication specialists. This structure causes problems for HEIs, since there are spokespeople within the faculties as well as in the corporate communication department. It is therefore imperative for executive management to ensure that all faculties and communication departments are informed of who is the spokesperson of the HEI in different situations. In science communication it should be clear to all HEI employees who the communication specialists are that are responsible for liaising with all stakeholders of the HEI. These communication specialists should be the facilitators between scientists and HEIs to ensure that the communication of science is done correctly and understandable.

4.4.5 Symmetric versus asymmetric approaches in science communication

In 1976 Grunig took the idea of one-way and two-way models of communication and elaborated on the idea to include the purpose of the communication as well as the direction. He used the terms synchronic and diachronic. However, research revealed that the two models were too gross and oversimplified to capture the reality of PR practice. He then replaced these terms with the terms asymmetrical and symmetrical to describe the purpose of PR as striving for balanced rather than unbalanced communication and effects (Grunig, 1992:287).

Rensburg and Angelopulo (1996:11) described the symmetrical model as a non-commercial communication process with the purpose of disseminating information in order to inform, to create awareness and to educate within a development context focusing on capacity building, empowerment and information sharing between all parties involved. Although the process of diffusing information is inherently one-way, the processes around it should be participatory (not only interactive) and dialogic employing two-way communication in a face-to-face context. The asymmetrical model on the other hand is described as one-way, top down flow of information from a central authority, which is inflexible.

The *White Paper on Science and Technology* (Department of Arts, Culture, Science and Technology, 1998) leaves little doubt about the importance of information and communication: "The ability to maximise the use of information is now considered to be the single most important factor in deciding the competitiveness of countries as well as their ability of empower their citizens through enhanced access to information". This forms part of the goal to promote science in order for people in South Africa to be informed about science and technological developments, since knowledge allows people to make informed and better decisions in their daily lives.

As stated by Dickson (2003), achieving a proper public understanding of science is a two-way process. To quote the words of Leschner (2002): "There is a need to engage the public in a more open and honest, bi-directional dialogue about science and its products, including not only their benefits but also their limits, perils and pitfalls". Dickson (2003) continued that there is even a need to go beyond inquiring how the process of developing a partnership with the general public, including rural communities works in practice. It is necessary to acknowledge the role of communication specialists, whose role it is not only of conveying the 'truth' to the public, but to communicate significant facts and the nature of this significance. In other words, the task of communication specialists is essentially one of extracting significance from a mass of scientific evidence, policy documents, and headline-grabbing statements from individuals and institutions that may or may not have a vested interest in the outcome. Those engaged in the communication of science – particularly when it is conceived of as a two-way process – becomes proxies for the public when it comes to interpreting and articulating the relationship between science and society (Dickson, 2003).

The symmetric model can be linked to the general systems theory with principles such as openness and adaptability. In order to achieve successful science communication, HEIs should allow proper two-way communication, which will allow communication specialists to distribute science to stakeholders

and will allow stakeholders to provide feedback. This process will provide an effect on the distributed science message.

4.5 STRATEGIC COMMUNICATION PLANNING

The concepts of strategic communication planning and design go beyond isolated, anecdotal message production and consumption activities. Strategic communication planning implies an *a priori*, long-range co-ordination of purposes for institutional communication activities. Analysis of strategic communication planning begins with an understanding of communication management philosophy. Management philosophy influences design selections; while design selections influence communication content, division of communication labour, and communication flow (Cummings, Long & Lewis, 1987:89).

In communication departments the strategists will be responsible for formulating the communication plan, while the managers will implement the plan and the technicians will be responsible for the material used to communicate the message to stakeholders. The manager has the responsibility to implement the corporate communication strategy in harmony with the institution's corporate strategic plan. The communication plan should integrate employee communication with the messages to all constituencies and stakeholders. Because these groups interact with and influence one another, it is vital to have consistent, candid messages tailored to the specific stakeholders with the overall goal of contributing to the success of the business (Foster, 1990:9-12; White & Mazur, 1995:27; Winokur & Kinkead, 1993:18). In applying the aforementioned concept to science communication it would mean that scientists would convey scientific facts to communication specialists, who communicate the messages of science to various stakeholders. By facilitating the process of communication flow between scientists and stakeholders, communication specialists, as managers, should ensure consistent science messages are being conveyed to stakeholders. Executive management at HEIs are responsible for formulating the strategic communication plan.

In today's strategising, there is a tendency that those who do not take 'ownership' of the plan are least likely to implement the plan effectively. Since modern corporate strategic plans go well beyond financial forecasts and incorporate strategies that deal with the way in which an institution ought to interact with its stakeholders, communication must inevitably be part of the strategising process. The communication department must help to define the target stakeholders to be reached by the institution and to devise and implement the communication plans to reach those stakeholders (De la Rey in Lubbe & Puth,1994:23). It would also be the case in science communication, where it is important for

HEIs to know who their stakeholders are and communication specialists are responsible for defining these stakeholders.

Communication strategies, formulated by the strategists, must be coupled with objectives and the results must be measurable. Management commitment to communication is a prerequisite for the success of any such strategy. If the members of management display a negative attitude towards company strategies, objectives, goals and decisions, those reporting to them would probably feel the same. In science communication, executive management who take responsibility of the objectives, should realise that science communication should be regarded as a high priority at the HEI. Executive management cannot expect to obtain credibility and acceptance for a communication strategy if they do not provide support to the idea of communication. Communication decisions would therefore be taken within the parameters of the constraints placed on effective communication (Oberholster, 1993:25). It is therefore of the highest importance to be assured of executive management's full support for communicating important issues, such as science.

Institutional and communication goals are reciprocally related. Communication is the consequence of institutional goals, not the reverse. As such, communication programmes focus upon complementing institutional productivity, efficiency, member and stakeholder satisfaction, adaptation, development and survival through communication management activities (Long & Hazelton, 1987:8). Even in the absence of a strategic plan for the department of communication, an institution can emerge with an effective, well-coordinated programme because of its results-orientated approach. From the beginning, once a communication initiative is taken in a particular area, for example a science communication activity, it should be strategically supported by research, planning and involvement by many players within the institution who would be critical to the programme's success. Communication departments should also be managed by objective, and the function should be held accountable for measurable and meaningful results (Webster, 1990:19).

4.6 ENVIRONMENTAL SCANNING IN ANALYSING THE INSTITUTION'S ENVIRONMENT

The model of Grobler (in Verwey & Du Plooy-Cilliers, 2003:204) that was displayed in Figure 4.3 demonstrates the alignment of the corporate communication strategy with the corporate strategy, incorporating the mirror and window function. The mirror function refers to monitoring relevant environmental developments and anticipates the consequences for the institution's strategies and policies. The corporate communication department is in an excellent position to provide and interpret strategic information, because of its wide contact with the external and internal environment (Steyn &

Puth, 2000:19). The window function refers to the preparation and execution of a corporate communication strategy and policy, resulting in messages that portray all facets of the institution. Communication specialists interpret the philosophies, policies, programmes and practices of executive management to the institution's stakeholders. In this facilitating role, they assist to accomplish an active outward orientation for the institution, establishing a firm base for mutual understanding and cooperation with strategic stakeholders (Steyn & Puth, 2000:19). However, to be able to fulfil the mirror and window functions successfully, communication specialists need to conduct environmental scanning. Environmental scanning could be seen as part of the interpretation process in an institution, which represents the data collection.

Applying the open systems approach to PR calls for the purposeful scanning of the environment to anticipate and detect changes that may affect the institution's relationships with its stakeholders (Mersham *et al.*, 1995:51). In science communication, the non-scientific stakeholders and the media are important communities and the environment in which they function is of critical importance for the best-structured messages to reach them.

Environmental scanning is the study and interpretation of the political, economic, social and technological (PEST) events and trends, which influence a business, an industry or even an entire market. Scanning is also the communication activity through which institutions learn about trends and events in their environment. Institutions with formal environmental scanning systems tend to monitor a larger number of issues in their environments for shorter periods of time, when compared to institutions or organisations with informal environmental scanning systems (Lauzen, 1995:187). Since science communication is a relatively new concept, environmental scanning is imperative to determine the trends and requirements of the social environment, including literate and illiterate, urban and rural societies as well as old and young people, who are all stakeholders of HEI. It is furthermore important to determine the political environment, in other words know what the Department of Science and Technology's goals for science communication are and how the economy would impact on the promotion of science. The media should also be scanned, since they are the channels by which the science message should reach the general public. New technological developments should be scanned, since technology is used in communicating science to the general public.

Communication specialists' role of gathering and processing information contribute to executive management decision making. They must bring executive management to an understanding of broader issues that can affect the HEI's image and reputation (Osborne, 1994:64). Inadequate

scanning of environmental changes might be an important reason for the failure of strategic planning in some institutions (Steyn & Puth, 2000:169). Where environments generate a variety of problems or uncertainties, boundary-spanning staff that are able to interpret and make sense of surroundings, become influential in decision making. Boundary spanners or environmental scanners are individuals within the institution who frequently interact with the institution's environment and who gather, select and relay information from the environment to decision makers in executive management. Communication specialists are among an institution's designated boundary spanners (White & Dozier, in Grunig, 1992:103). Regarding high-level strategic decisions, boundary-spanning practitioners perhaps play their most important role when they serve as consultants who advise on methods of problem representation (De Beer, 2001:85).

In science communication for example, communication specialists should take previous studies on attitudes towards science into account and should perform similar research on stakeholders of HEI to determine how science would be received (positive or negative) by stakeholders. Boundary spanning is discussed in more detail in Chapter 5.

4.7 EVALUATION RESEARCH IN THE COMMUNICATION PLANNING PROCESS

Current institutions realise that institutional functions and departments must satisfy demanding stakeholders in a globally competitive environment, since the quality of their work would ultimately make a difference in how stakeholders behave with respect to the institution. Although communication departments have opportunities to contribute measurably to institutional performance, these departments first have to improve their managerial capabilities in performance assessment (Fleisher & Mahaffy, 1997:118). Steyn and Puth (2000:158) describe evaluation research as research conducted primarily to ensure or determine the effectiveness of a corporate strategic plan.

Evaluation research is well known to most communication specialists. They realise that a well-designed performance assessment system is an essential part of any strategic communication initiative. Strategic performance assessment systems should be balanced, integrated and designed to highlight the communication function's critical input, process, output and outcome (results) variables (Fleisher & Mahaffy, 1997:118). Science communication activities and programmes should also be evaluated to determine if the science messages successfully reached all stakeholders of the HEI.

Various models evaluation has been established, but the model most applicable to science communication is the guidelines provided by Lindenmann. According to Lindenmann (1997:394), the

following seven guiding principles were selected as key factors to measure PR effectiveness. These principles have been applied to science communication:

- Establish clear science communication programme objectives and desired outcomes before beginning, to provide a basis for measurement of results. The goals of communication specialists should tie in directly with the overall goals of the science communication strategy.
- Differentiate between measuring science communication *outputs*, which are usually short-term and measuring science communication *outcomes*, which are usually long-term and can have more impact.
- Measuring media content needs to be viewed as only a first step in the science communication evaluation process.
- There is not one, simple, all-encompassing tool or technique that can be relied on to evaluate science communication effectiveness. Usually, a combination of different measurement techniques is required, since the stakeholders of HEIs varies from literate to illiterate; urban to rural societies and young to old people.
- Be wary of attempts to draw a precise comparison between science communication effectiveness and science promotion effectiveness.
- Science communication effectiveness can best be measured if an institution's principal messages, key target audience groups and desired channels of communication are clearly identified and understood in advance.
- The science communication evaluation process should never be carried out in isolation.

The principles for evaluation research mentioned above are guidelines that could contribute positively to evaluate the science communication activities or campaigns of HEIs. However, without the cooperation of all key role players in science communication, no strategic plan can be implemented successfully.

4.8 CONCLUSION

Chapter 4 described the importance of strategic management and planning in communication, specifically science communication as a division of the corporate communication department at HEI. The General theory of excellence in PR and communication, which forms the theoretical base for the strategic management of science communication in the context of this study, was discussed in detail. The theories described in Chapter 4 are important to this study, since they provide guidelines by which communication specialists should act to successfully distribute science messages.

Communication specialists can build excellence by becoming more expert in the emerging, increasingly sophisticated aspects of communication practices, specifically as far as science communication is concerned. Executive management must also broaden their conception of science communication and representation to recognise that communication can make a contribution to effectively distribute science messages. A management philosophy that excludes strategic communication is no longer appropriate for the present and likely future environment – science communication will become a meaningless function unless it complements management strategically at the executive level. In order to be excellent and a valuable contributor to decision making, communication specialists need to scan the environment, acknowledge the needs of stakeholders and implement a strategic science communication plan to execute the identified strategies and objectives of the HEI. After the implementation of the science communication plan, evaluation research has to be conducted to measure the outcomes and success of the plan or science communication campaign.

Although science communication is an important phenomenon all over the world, the contribution of key role players in science communication in distributing the message of science to stakeholders is even more important. The roles of executive management, scientists, communication specialists and journalists are explored in more detail in Chapter 5. The specific role of the media as well as the agenda setting theory and gatekeeper theory as functions thereof which forms part of the theoretical base of this study is also discussed.

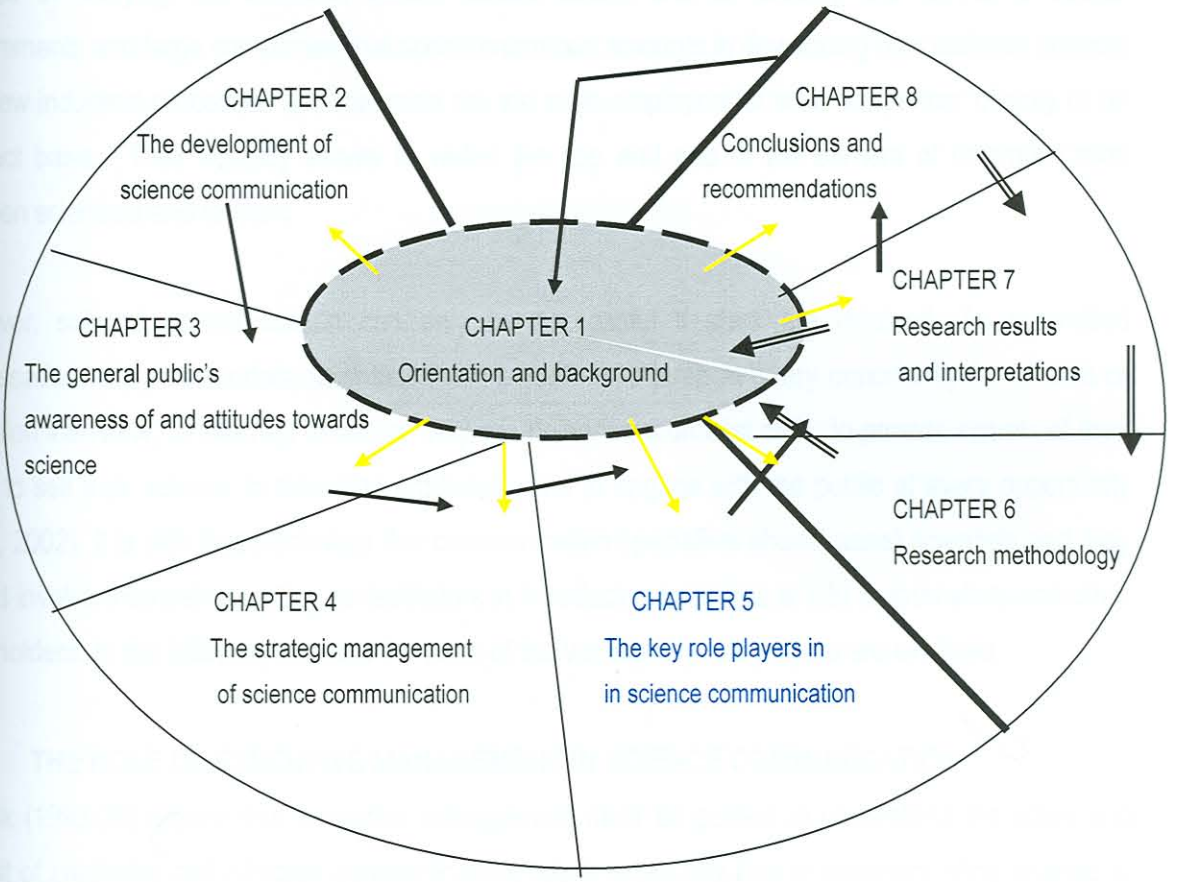
Chapter 5

The key role players in science communication

5.1 INTRODUCTION

In the previous chapters the concept of science communication, the awareness of SET, as well as the strategic management of science communication were described. The theories on which the theoretical framework is based in the previous chapters can be summarised as: science communication as information (information theory described in Chapter 2) that has to be communicated to stakeholders (stakeholder theory discussed in Chapter 3) through mediums, such as mass communication (mass communication theory described in Chapter 2). However, to achieve science communication successfully, strategic science communication planning is required. Therefore, the General theory of excellence in PR / corporate communication management and strategy were discussed in Chapter 4. To conclude the theoretical framework, the roles of the key role players in science communication are discussed, as well as the agenda setting theory and the gatekeeper theory. Figure 5.1 illustrates visually the position of Chapter 5 in relation to the other chapters in the theoretical component of the study, as well as to the empirical component.

Figure 5.1: Chapter 5 in relation to other theoretical chapters



As mentioned before, for the purpose of this study, the key role players in science communication include executive management, scientists and communication specialists at HEI, as well as journalists (an important stakeholder of HEI) in South Africa. Each role player has specific tasks and responsibilities to ensure that science is communicated effectively to the other stakeholders of HEI. These roles are important to acknowledge and understand one another, since a successful relationship between the role players can only be developed and maintained once the role players realise the valuable contribution they can make to successful science communication. To assist the role players, the mass media are imperative, since the mass media constitute an effective tool to reach all stakeholders timeously and effectively, as was pointed out in Chapter 2.

From the discussions in Chapter 3 it has become clear that the lay audience expresses a clear demand for scientific information, particularly when health and welfare are involved. For most people science is what they learn from the media. The need for good scientific journalism is pressing to

bridge the gap between the slow pace of science and the fast-moving and concise nature of successful mass communication. A complication that increases the barrier between science and the public is the practice of carrying out research behind closed doors, and of keeping the results a secret. Governments and large companies that spend enormous amounts in developing new defence projects and new industrial processes and materials are the main employers of scientists, either directly or on contract basis. Their secrecy serves to widen the gap and add to the barriers of communication between scientists and laymen.

However, science communication can only be successful if stars are involved. As committed ambassadors and role models, scientists must be willing to jump at every opportunity for a radio or television interview, to interrupt whatever they are doing if a journalist calls, to provide visuals of their work, to sell their science to television producers, and to engage with the public at every opportunity (Jaffe, 2002). It is with these activities that communication specialists should assist scientists and they should involve themselves acting as facilitators in introducing scientists at HEI to journalists and other stakeholders. In the following sections the roles of the various key role players are explored.

5.2 THE ROLE OF EXECUTIVE MANAGEMENT IN SCIENCE COMMUNICATION

Berzok (1993:25) argues that executive management must be guided to understand the value and benefit of credibility and effective communication; this is especially true in communicating science to stakeholders. The above statement implies the development of separate executive management communication strategies that are fused with the overall communication and business strategies. Many executive management teams remain unenlightened and unconvinced; therefore they hold the communication function at arm's length. However, as was described in Chapter 4, executive management at HEIs are responsible for the science communication strategies and strategic communication plan and should provide direction to communication specialists who should implement these strategies in communicating science to HEI's stakeholders. A key to sensitising executive management to the complexities and potential of their transformed communication role is to change the way they think about communication (Pincus & De Bonis, 1994:28). They should therefore be trained and educated about the importance of science communication.

The direct link and trust relationship between executive management and communication specialists is the umbilical cord that should ensure an open flow of information, intelligence and ideas. According to Ngcobo (2003:4), executive management sometimes need to leapfrog the line communication system and communicate directly to stakeholders. Not only do communication specialists manage the

channels their superiors would use for this purpose, but it is also their responsibility to alert executive members to potential pitfalls and advise them on the media so as to use a suitable style of presentation, a typical mediation function to be performed by communication specialists, especially in science communication. It is therefore required that executive management empower and trust communication specialists in fulfilling the facilitator's role between HEIs and their stakeholders.

However, to gain credibility with executive management, it is essential that communication specialists display a high level of skill, knowledge and experience. They need access to executive level information and be allowed to contribute to the enterprise's management planning process. For this crucial need to become a reality, executive management need to understand the important role of communication specialists in communicating science to all stakeholders.

5.3 THE ROLE OF SCIENTISTS IN SCIENCE COMMUNICATION

Traditionally working in a context where success is measured by the judgement of peers, scientists have long assumed that a record of accomplishment is sufficient to maintain research support. Therefore, information – the scientist's 'stock-in-trade' – has been directed primarily toward professional colleagues. Most scientists have not been interested in public visibility; on the contrary, they have feared it could result in external controls on their work (Nelkin, 1995:125). Scientists increasingly emphasise the pragmatic goals of science communication as the scientific and technical enterprise grow in complexity and importance. Science communication activities have become important and the role that communication specialists can play to enhance institutional prestige, encourage public support for research and influence public policy with respect to science and technology has increased tremendously since the 1990s.

Many of our day-to-day decisions are based on what we hear or see in the mass media, which for the majority of the population has become our only source of scientific information. The scientific community therefore can no longer afford to dismiss the importance of the mass media. Despite this, however, many young scientists complete their studies and embark on a career in research without any training in public speaking, interviewing or popular writing. It is not surprising then, that scientists often shy away from media interviews and public platforms. Scott (in Nelkin, 1995:136) remarks that "South African scientists are very creative and innovative in their work. They are often highly respected by their peers abroad. But, they have absolutely no idea how to communicate to a non-scientific audience". Therefore, communication specialists and scientists should have a relationship of trust and mutual understanding. Communication specialists should be allowed to act as facilitators between

scientists and stakeholders, not only to protect scientists, but also to ensure that stakeholders receive the correct science message.

It is obvious that scientists have built a barrier to understanding between themselves and laymen, simply because scientists use a special language. Because science is a specialised way of observing facts and of showing how they relate to one another, the scientist must train himself/herself to think clearly, to measure exactly and to devise experiments with a definite purpose. Then, she/he must describe his/her observations as precisely as possible. There must be no doubt in the mind of someone who reads his/her report about what a scientist means when she/he describes a particular event. The scientist must say exactly what he found, no more and no less. For this reason, scientists should attempt to write sentences that have one meaning and one meaning only (Barry *et al.*, 1965:176).

According to Dean (2002:26), for most scientists talking to the media is still a no-win proposition. Reputable scientists do not normally communicate their findings in the lay press; they report them in scientific journals or at scientific meetings. Newspaper articles do not necessarily help them with tenure decisions or grant applications; and, if the media describe their work inaccurately, it reflects badly on them, or their peers might dismiss them as public hounds. The result is that scientists have little incentive to speak to the media. Often they are also shocked that the journalists are not better informed about their research. However, when they are asked to explain their work in simple terms, they themselves are at a loss. It is here where communication specialists can be of great value to translate the message correctly to the media and other stakeholders.

Also, scientists have an ethical obligation to the public to account for their stewardship of the public funds used to support their work. In large part, they can meet this obligation by helping produce explanatory material such as news releases and by making themselves available to the public's representative, the media. Coverage of science and technology attracts not only more public and private support for research, but also interested, talented students to careers in science and engineering (National Environmental Research Council, 2001).

Scientists who use the media effectively see significant advantages in having a media presence for themselves, their projects, and their research institutions. It is regarded as an imperfect, but powerful means of reaching end users, research funders, bureaucrats and other scientists (Foundation for Education, Science and Technology, 2001). Scientists should realise that they are not communicating

to the media; they are using them to communicate with a variety of stakeholders. As educators in science, scientists have a responsibility to explain their research to communities, since these people are the taxpayers who contribute financially to the research efforts. Furthermore, communities are the receivers of new scientific and technological developments. Scientists should therefore avail themselves of every opportunity to participate in science activities aimed at enhancing an awareness of science in schools, among the public and even in government.

In order to achieve successful awareness among the public it is important for scientists to feel that their need to convey science to external stakeholders is taken care of by executive management and communication specialists, and that it is regarded as a priority of the institution.

5.4 THE ROLE OF COMMUNICATION SPECIALISTS IN SCIENCE COMMUNICATION

Some people are 'born communicators', while others can be made. Scientific staff and research managers often have little communication training or experience, yet need to serve as spokespeople because of their knowledge and expertise. Communication specialists can help formulate policy, coach from the wings, act as liaisons and train other staff, but they cannot replace the important interchange between the 'experts' and their stakeholders (Metcalfe, 2002). In situations where the expert needs to communicate directly with stakeholders, it should take place in conjunction with the communication specialist and preferably in his/her presence.

As described in Chapter 4, every university and technikon in South Africa has its own structured marketing and communication division whose major responsibility it is to market the institution and communicate important news to stakeholders of HEI. Regardless of how the division is structured, part of the role of communication specialists is to share research performed at the institution with the media who have to convey the message to other stakeholders. Symmetrical practices among communication specialists require that communication specialists act as advocates of their institutions' viewpoint when communicating with stakeholders, including the media, and as advocates of public interests when communicating with executive management. Communication specialists assist institutions, stakeholders and the media to negotiate mutually acceptable resolutions to disputes and to build long-term relationships.

The communication specialist is often called upon to guide and counsel management in determining its objectives, responsibilities, and the route it should take in designing its policies and procedures that affect public interest (Skinner & Von Essen, 1982:7). Communication specialists are supposed to

assist institutions in setting up newsrooms, arranging news conferences, setting release times and providing essential aids such as summaries or abstracts, photographs and videotapes to journalists. They should fill the translation gap between scientists and stakeholders asking questions. However, in most cases stakeholders and institution executives are not convinced that communication specialists have the expertise and sophistication to deliver their promises (National Association of Science Writers, 2000). Nelkin (1995:141) postulates that in the era of science, communication specialists do contribute in important ways to inform stakeholders about science. They are a useful source of information for journalists. By presenting complex material in a manageable form, they serve as liaisons between scientists and journalists, easing the reporting of science. It is therefore very important for communication specialists to have sufficient knowledge on science to formulate the correct messages targeted at HEI stakeholders. In this regard it is imperative that a good relationship should exist between communication specialists and scientists. Scientists should have trust and faith in communication specialists to ensure the correct scientific facts are communicated to stakeholders.

The role of communication specialists in the strategic management of science communication and the theory of environmental scanning were discussed in Chapter 4. However, in addition to the roles communication specialists play as managers, communication specialists in science communication also have an important task to fulfil as boundary spanners. The application of the concept of boundary spanners in science communication is discussed next.

What an institution needs most for its decisions is data on what occurs outside its borders. It is only outside business where there are opportunities and threats. And it is here where communication specialists as boundary spanners can play an important role in the management of science communication (Howard, 1995:15). It is his or her task to cross borders to survey the environment. Changes in the environment might cause the re-formulation of the vision, mission and corporate goals in the corporate strategy, which contains guidelines to how the goals and implementation plans for science communication activities might change.

Information is acquired from external sources and decisions are taken as to whom information should be provided in the institution, as well as when and what portions of such information, i.e. the facilitation/mediation function of communication specialists. In science communication this would involve the specific information to be provided to executive management and scientists in order to enable them to make decisions that will benefit the institution and its stakeholders. Information is

provided to others to create a favourable image of the institution and a willingness to accept the messages of science distributed by this institution.

Acquiring and integrating a large amount of information about the external environment offers a challenge to assess changes in relationships over time. A second procedural conclusion involves the presumption that relationships should be reflected in business landscapes. Although this requirement adds to the difficulty of the analysis, it also enhances the chances of finding win-win strategies (Ghemawat, 1999:39). Communication specialists are necessary contributors to the 'interface' between institution and environment. It is important that communication specialists should determine in conjunction with scientists where the message of science has not yet been received and to work out a plan on how to address these stakeholders, in other words communication specialists should act as facilitators between scientists and stakeholders of HEI.

Besides the important task of scanning the environment, communication specialists are also responsible for building relationships with internal and external stakeholders. HEI require a corporate communication manager who can undertake continuous research on stakeholders or publics. Without a thorough understanding of adversarial groups, the institution is at their mercy, especially in science communication where the risk of new scientific or technological developments has to be considered. Communication specialists can play a significant role in preventing or resolving fundamental conflicts with stakeholder groups. They can exacerbate or reduce the problem facing institutions pressured by outside constituencies (Steyn & Puth, 2000:204). As described in the stakeholder theory in Chapter 3, stakeholders have access to more information than in the past and since the value of information increases when it is shared, collaboration with stakeholders can result in increasing the HEI's store of valuable information on scientific developments.

In order to be successful in their role as facilitators, communication specialists need at least a basic training in science. Just as journalists, they need to be able to translate the messages received from scientists effectively to be understood by stakeholders of HEI.

5.5 THE ROLE OF JOURNALISTS IN SCIENCE COMMUNICATION

Journalists (a very important stakeholder of HEI), who use everyday language to report scientific discoveries, play an important role in any society. Although good journalists attempt 'intelligent fact-based journalism, honest in intent and effect, serving no cause but the discernible truth, and written clearly for readers whoever they may be', the reality is that journalists, willingly or not, occasionally do

print untruths or half-truths. Journalists realise that they have to gather the truth and present it to a public that supports the ideals of individual liberty and democratic government, but unfortunately the reality is usually driven by money and profit (Frost, 2002:4).

The mass media make profit only by attracting large audiences, and audiences are attracted by sensation, crime and 'too-good-to-be-true' articles. Journalists, therefore, are under pressure to make their reporting sensational – which nearly always means an oversimplification of scientific facts. Ever-increasing media output that tempts audiences to spend less and less time with any individual provider and persuades readers to spend a little longer with a specific newspaper has become one of the critical measures of performance for the media. Consequently, journalists rarely get the time or the encouragement to conduct proper investigations in order to educate and inform their publics. They are required to find entertaining and exciting articles quickly and with a minimum of research (Frost, 2002:5). Such reporting, in turn, portrays to the man in the street a distorted view of science. The result is the very opposite of what a scientist would wish for. The layman marvels at scientific progress, but at the same time she/he is bewildered by it. Often she/he ends up by mistrusting and even hating scientists.

Whereas scientists specialise in increasingly narrow fields, journalists have the responsibility to cover quite a broad field. On many occasions the same journalist has to report on science, sport as well as politics. This is an almost impossible task and certainly does not add to scientists's trust of journalists. Among the many kinds of specialised writers, the science journalist has a unique responsibility to the reader. Unlike the sports journalist, for example, whose reader already knows – often in extraordinary detail – the rules of the game and who the players are, science journalists must often introduce readers to a new 'game' in every article they write (National Association of Science Writers, 2001).

Journalists reporting on science must first and foremost understand the science, which is often the toughest part of being a science journalist. Then she/he must write the article and translate it accurately into a form that is both interesting and intelligible to the layman. However, these journalists are writers first and not scientists. Good science journalists do their best to report accurately, but they always keep in mind what they think would interest the public, which may not be what the scientist thinks should interest the public. This results in journalists retailing science and technology rather than investigating them, and identifying with their sources rather than challenging them (Hotz, 2002:6).

In South Africa many journalists are freelancers, making them dependent on corporate and university assignments. To survive, journalists rely on the daily cascade of embargoed research papers, e-mailed press releases, university tip sheets and conference abstracts. In many instances the sources despise the media for their many excesses and oversimplifications, resulting in many journalists being more ignorant of science and hostile toward it than the readers of their articles (Franklin, 2002:8). According to Rensberger (2002:11), every journalist should know the following about science and science journalism:

- Science demands evidence, and some forms of evidence are worth more than others. A scientist's authority should command attention.
- There is not a single scientific method, but all good science includes elaborate procedures to discover and avoid biases that might mislead.
- Uncertainty is a sign of honest science and reveals a need for further research before reaching a conclusion. Cutting-edge science is highly uncertain and often flat-out wrong.
- The pace of science, despite the hype, is usually slow, not fast. Breakthroughs are never the result of one experiment.
- Balanced coverage of science does not mean giving equal weight to both sides of an argument. It means apportioning weight according to the balance of evidence.
- Virtually all new technologies pose risks along with benefits. Thus 'safe' and effective, whether applied to drugs or new devices or processes, are always relative terms. It is irrational to ask whether something is safe or not. Nothing is 100% safe. Policy decisions involving science must therefore balance risks and benefits.
- Journalists and scientists espouse similar goals. Both seek truth and want to make it known. Both devote considerable energy to guard against being misled. Both observe a discipline of verifying information. Both insist that society allows them freedom to pursue investigations wherever they lead. Neither requires licensure or approval of an outside authority to practise their craft.
- News organisations usually attach too much importance to a scientific development and not nearly enough to the broader trends.

Science journalism is difficult and journalists have to cover everything from anthropology to astrophysics to atherosclerosis. At the same time, science is becoming increasingly specialised. So it is even more difficult for journalists, even those with advanced training, to know what is important and what not. Another complication of relatively recent origin is the intense widespread commercialisation of research, particularly medical research. These difficulties can be addressed only by scientists

committed to explaining their work to the lay public in clear and dispassionate terms (Dean, 2002:25,26). However, despite the difficulties and concerns, journalists remain a very important and powerful role player in science communication. Without journalists and the media, the message of science would not reach stakeholders effectively. Journalists and communication specialists, who are spokespeople of HEI and facilitators between scientists and journalists, need to engage in a relationship of trust and mutual understanding to ensure that stakeholders of HEI receive the correct science messages as was intended by scientists.

5.6 THE THEORIES APPLICABLE TO THE ROLE OF THE MASS MEDIA IN SCIENCE COMMUNICATION

Mass media can be defined as a means of communicating a message through a medium or channel to a mass or large number of people who are considered to be one large group, indistinguishable from one another. Modern mass media include television, radio, newspapers and magazines, books, films and recordings (Mersham & Skinner, 2001:3). Although the mass media is regarded as a major distribution channel for communicating science, it must be realised that not all stakeholders, i.e. literate and illiterate, urban and rural and young and old people, have access to these media. Most people in rural areas do not have access to computers, radio, television and newspapers and are therefore excluded from receiving news via the mass media. This problem can be addressed if the community centres in these areas are able to install equipment such as television and radio where local people can have access to these communication mediums. Unfortunately this creates problems of their own which fall outside the scope of this study and therefore, for the purposes of this study, it is recognised that the mass media cannot be used successfully in communicating to all identified stakeholders. However, although the mass media as such is not a key role player in science communication, the mass media as a channel by which messages are distributed, unavoidably fulfil an agenda setting function, as well as a gatekeeper function. These two functions as theories are therefore described, since they form part of the theoretical base of distribution of the message of science.

5.6.1 The agenda setting theory

In the same way that people set up their own agendas on matters that require attention, the mass media 'select and call to the public's attention both ideas and events' (De Vito, 1991:477). According to McQuail and Windahl (1981:62), the media inform their audience what is important and what is not. People also tend to think that news covered in the mass media may be more important than news not attended to by the media (Merrill, Lee & Freelander, 1990:89). Studies in America have found that there is considerable correlation between the amount of news coverage of a particular issue and the

importance that the general public attached to it (Tan, 1981:277). Agenda setting can thus be seen as the hypothesis that the mass media, through coverage of ideas and events, may have an influence on what the public regards as important (De Beer, 1998:21). McCombs and Shaw's agenda setting theory (in Griffin, 2003:391) boasted two attractive features, that is, it reaffirmed the power of the media while still maintaining that individuals were free to choose.

According to McCombs and Shaw (in Griffin, 2003:393) the hypothesised agenda-setting function of the media is responsible for the almost perfect correlation they found between the media and public ordering of priorities. However, results of another study by Funkhouser (in Severin & Tankard, 1992:210) were in line with the agenda setting hypothesis, although these results pointed out the question of causal direction. McCombs and Shaw conducted a further study, the Charlotte survey, in order to obtain evidence concerning the causal direction of agenda setting. Although the results were not as clear-cut as expected, the Charlotte study did provide evidence of causal direction, in other words, it is likely that the media do have a causal effect in shaping the public's agenda, rather than vice versa (Severin & Tankard, 1992:211).

According to Littlejohn and Foss (2005:280), agenda setting occurs because the media must be selective in reporting news. The agenda setting function is a three part linear process. Firstly the priority of issues that should be discussed in the media or media agenda; secondly, the public agenda is created by the effect or interaction of the media agenda on what the public's views are; and lastly, the public agenda affects or interacts in some way with what policy makers consider important, called the policy agenda. To some extent, the media agenda is set by the media passing on issues and events that are occurring in society. However, Westley (in Severin & Tankard, 1992:223), suggested that in some cases pressure groups or special interest groups are able to transfer an issue onto the media agenda. In other words, the media agenda is established by some combination of internal programming, editorial and managerial decisions and external influences from nonmedia sources, such as government officials and commercial sponsors, etcetera (Littlejohn & Foss, 2005:280). The degree, to which the media reflect the public agenda, is called representation, that is the public influences the media. If the same agenda is maintained by the public the entire time, it is called persistence and in such a case, the media may have little effect. When the media agenda influences the public agenda, it is called persuasion and this influence of the media on the public, is what the agenda setting theory predicts.

De Beer (1998:111) describes how the media team performs in setting the agenda. The editor is the executive responsible for the smooth running of the newspaper. The editorial team, assisting him, could be divided into three sections, i.e. those deciding on news, those gathering the news, and those processing it for publication or broadcasting. The combined team gathers the news, judges its importance, evaluates its meaning, and writes and displays it in ways that will attract and hold the attention of readers. These functions all form part of the agenda settting function, of which the editor is the team leader. The editorial team normaly consists of the editor, assistant editors and editors of the various news sections, such as the news editor, chief sub-editor, sports editor, financial editor, arts editor, chief photographer, etc. They have conferences at certain times during the day at which they decide on the news and its display, in other words the agenda setting (De Beer, 1998:111).

Since the South African government has made science communication a priority, science should be high on the priority list of editors when the agenda is set for a particular issue of the newspaper. Therefore, a relationship of trust and mutual understanding between scientists, communication specialists at HEI and the media is critical to ensure that scientific discoveries are regarded newsworthy by editors.

5.6.2 The gatekeeper theory

The concept of gatekeeper has been used frequently in studies of the mass communication process, especially with reference to any action within a media organisation that involves choosing or rejecting some potential item for publication (McQuail & Windahl, 1981:100).

The term 'gatekeeper' was coined by Lewin (in Windahl *et al.*, 1993:125) who used it to describe how food found its way into a household. It became a key concept in mass communication studies about news selection. A gatekeeper in a social system decides which of a certain commodity (materials, goods, information, etc.) may enter the system. Media gatekeeping studies have shown how a journalist's decision making may be based on a rich mixture of general principles of news values, organisational routines, input structure and plain idiosyncrasy (Windahl *et al.*, 1993:125). Kosicki (in Griffin, 2003:400) stated that the media as gatekeepers do not merely keep watch over information, shuffling it here and there, but they engage in active construction of the messages, emphasising certain aspects of an issue and not others.

Gatekeeping is vital in communication planning. Almost all communication-planning roles include some aspect of gatekeeping, for example:

- The agricultural consultant, who has to transform and reduce scientific news into practical advice intended for farmers.
- The leader of an environmental discussion group, who selects teaching materials to be used in the group.
- The planner of an anti-drug campaign, who must select among hundreds of arguments for quitting cocaine.
- The journalist of a daily newspaper, who chooses material coming from sources all over the world.

As a gatekeeper, the journalist undoubtedly can exercise some power over the communication process by deciding what information to discard and what to let pass. Nevertheless, as stated by Windahl *et al.* (1993:125), gatekeeping is often a routine, guided by some set of standard questions, such as:

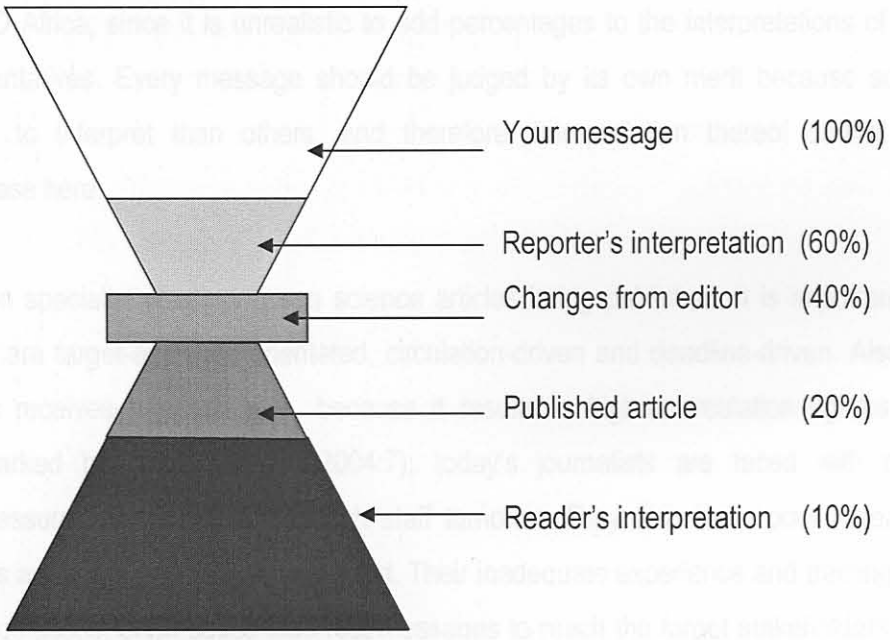
- What, from this material, do stakeholders need to know?
- What do they want to know?
- What do they know already?
- What will they understand?
- What will they refuse to accept?

Gatekeeping can become a means of reducing openness in a social system and may result in distrust. Gatekeeping might also be one of the reasons why science seldom receives attention in the media, since there seems to be always more important news to cover than scientific discoveries or results.

Every day journalists are being pressed 'to put it right'. Sometimes they are actually asked to correct a mistake of fact or an omission of importance. At other times, they are asked to excise or downplay a significant and uncomfortable truth. Journalists receive demands openly and surreptitiously from many powerful centres: government departments; political leaders; company bosses; service authorities; and any more who advertise in all the commercially funded media and who threaten sometimes to stop their funding. Because of these reasons, weak journalists change an article because somebody in power demands it, whereas strong journalists only change an article because they are convinced it deserves to be changed, irrespective of who demands it. The only acceptable way is for journalists to decide. This means isolating the point made and considering it fairly, regardless of whether the source is important or ordinary, accepting the point if it is reasonable, rejecting it if it is not – and tolerating the

scepticism or wrath, if applicable (Wilson, 1996:38). Figure 5.2 represents the interpretation of the gatekeeper theory as seen by APCO Africa.

Figure 5.2: The gatekeeper theory



Source: APCO Africa. (2004:7)

According to APCO (2004:8), the media see themselves as

- guardians of public safety;
- keepers of public morals;
- 'watch dogs';
- defenders of the 'little person';
- seekers of the truth;
- enemies of villains;
- sources of correct information, and
- a link between readers and news sources.

As can be seen from the model, only 10% of the original message in effect reaches the receiver of the message. In a relationship of trust and mutual understanding between scientists, communication specialists and journalists, the filtering process would be reduced, since the journalist (reporter) would have a better understanding and his/her interpretation of the message should be much higher. Even if

the relationship results in an interpretation of 80% of the original message and the editor only has to make changes of 10%, the published article should reflect a percentage of 50% and the end receiver or reader would receive at least 40% of the original message. The contribution of communication specialists would result in an increase of at least 30%, but the ideal would obviously be that the receiver should receive 100% of the message. However, the researcher does not agree with the model as presented by APCO Africa, since it is unrealistic to add percentages to the interpretations of the various media representatives. Every message should be judged by its own merit because some messages are easier to interpret than others, and therefore, interpretation thereof cannot be generalised as is the case here.

For any communication specialist wanting to see science articles being published, it is important to realise that the media are target-audience orientated, circulation-driven and deadline-driven. Also, a crisis situation always receives high attention, because it results in higher circulation figures for newspapers. As remarked by APCO Africa (2004:7), today's journalists are faced with poor remuneration, time pressures, limited staff and high staff turnover. They also have poor research facilities, outdated tools and often non-existent transport. Their inadequate experience and training, as well as government regulations, often cause incorrect messages to reach the target stakeholders. To counter these problems, it is therefore crucial for scientists and communication specialists to provide the journalist with relevant, accurate information and, most importantly, an interesting story.

5.7 THE ROLE OF THE MASS MEDIA IN SCIENCE COMMUNICATION

Reasons why science should be communicated to HEI stakeholders generally fall into five categories – economic, utilitarian, democratic, cultural and social. As far as the community is concerned, science is often invisible until such time as people perceive a need to use it (Bryant, 2002). Besides communication specialists, schoolteachers, scientists, government and organisations involved in promoting science, the media as a channel of distribution also plays an important role in distributing the science message.

The public learns about science news via many different routes, including newspapers, magazines, books, radio, television, the Internet, electronic news services and films. Communication specialists at HEI are the important link between scientists and the media, as well as between scientists and stakeholders of HEI. It should be the communication specialist's task to ensure that correct science messages are communicated to every non-scientist.

As mentioned in Chapter 1, science and technology affect the lives of everyone, not just those who are professionally involved, and no one can doubt the immense impact of SET on society today. People face the challenges of not only understanding the current multiple revolutions in SET, but also how they affect the future of humanity and of the Earth (Stempra, 2001). In the coverage of science, the media have encouraged the widely held belief that science is distinct from politics and beyond the clash of conflicting social values. Media articles seldom foster a discussion of deep-seated structural dilemmas, for instance, fundamental problems in the institution, the regulation of industry or distortions in the allocation of resources, that can lead to neglect of public safety (Nelkin, 1995:63). Seldom do science writers analyse the distribution of scientific resources, the social and political interests that control the use of science, or the limits of science as a basis for public decisions.

The images presented by the media are often inflated, but they vary in different types of media. According to Nelkin (1995:66), "... the ubiquitous 'advisory arts' are a source of inflated expectations about what science can do. The extraordinarily popular 'how to' books and syndicated health columns provide endless information (sometimes misinformation) about health and science. Readers are presented with promises of future technological marvels and images of science as the ultimate source of authority. Similar promises are to be found in television documentaries, idealising and explaining science with elegant visual images and starring authoritative scientists who assume the role of the 'host'".

Many readers come into contact with science through articles in the tabloids visible at the supermarket checkout counter. Scientists in the tabloids can "cure splitting headaches", "create human beings", "guarantee boy babies", "save brain-damaged victims", "cure impotence", "prevent cancer" and "find the key to long life". Tabloid images of science also appear in reports that border on pseudo science and superstition. Many newspapers not only run a daily horoscope feature, but give prominent attention to astrological and pseudoscientific claims that purport to predict elections, natural disasters, economic trends, or personal affairs. Although such claims may be played down or dismissed, their frequent appearance in the media lends them an aura of credibility (Nelkin, 1995:67). According to Patairiya (2001:5), misleading scientific information, a continuous decay of creativity in presentation, distortion in translation, inconsistency in organising the contents, lapses in the use of language, and many more deviations can be seen frequently not only in print, but in broadcast media also.

There are several different publics for science in the media. A minority of people have some professional training in science or engineering and are genuinely interested in many forms of

popularisation, sometimes because of family traditions or political convictions (Caro, 1997:123). These people read the prominent popularisation monthly magazines and attend conferences organised by museums or learned societies. But sometimes the lecturer is surprised to discover that even among this small sympathetic crowd there are from time to time demonstrations of strange beliefs, for instance in the paranormal. Science is reasonably understood as a language and a method by roughly 5% of the population of Europe. But in South Africa, at least, belief in the parascientific, the paranormal, astrology and the like is a mass phenomenon involving roughly 50% of the population. Parascientific or science fiction printed articles or television shows use literary tricks as the legitimate ('scientifically correct') media's science articles. Many people cannot tell the difference, especially because many parascientific articles mimic the scientific language.

5.8 COMMUNICATING SCIENCE THROUGH THE MEDIA

Public beliefs about SET tend to correspond with the messages conveyed in the media, though the direction of cause and effect is not clear. In part, the difficulty of assessing the influence of the media reflects the persistent contradictions in the public view of science. Major stumbling blocks involve the lack of expertise in science writing and the lack of commitment to science by editors who do not believe that science sells newspapers. South Africa is driven by politics, obsessed with sport, and plagued by crime; and such material dominates newspapers, radio and television (Joubert, 2001).

Few media outlets in South Africa have dedicated science desks. Junior or inexperienced general staff reporters without the skills, interest or experience to do justice to the content often handle science news. There is little room or time for sophisticated, investigative science journalism and no incentives to build a career in science writing. When a major breakthrough in science is made, locally or internationally, South African journalists are ill equipped to handle it (Joubert, 2001). As suggested by her, the South African media report on bread-and-butter science issues, mostly related to agriculture and the environment, and life-and-death issues such as malaria, HIV, tuberculosis, heart disease and cancer. A journalist writing about drinking water would focus for example on whether the water is safe to drink, rather than explore the advantages and disadvantages of adding fluoride for healthy teeth.

According to Joubert (2001), the South African media furthermore tend to view foreign science as always better than South African science; so, what little space goes to science news in the local media is often filled with straight downloads from international newswires. This is easier and cheaper than finding local science news. South African scientists and communication specialists have to realise that they are competing for media attention and space with the rest of the world. Ironically, much cutting-

edge scientific research from South Africa, published in journals like Nature, attracts media attention in London and New York, but is all but ignored in South Africa's media (Joubert, 2001).

Media coverage can also affect the financial support given to research, a fact well understood by scientists and their institutions. The extensive media coverage of biotechnology suggested its growth potential, increasing the availability of venture capital for new biotechnology firms during the 1980s. Later, in the 1990s, media reports of public concerns about biotechnology encouraged caution. By amplifying possibilities and calling attention to potential problems, the media can influence the dissemination of new products and shape the direction of scientific and technological priorities (Nelkin, 1995:76).

Furthermore, the mass media can impede cultural growth, since people tend more and more to speak the same way, dress the same way, think the same way and act and react the same way, due to the hours of media exposure – people tend to accept role models presented by the media (Severin & Tankard, 1982:214). The media content is probably most intended as entertainment, taking into consideration the many columns, features and fillers. The media also expose millions to a mass culture of art and music. According to Dilosothlhe (2002:4), the Department of Science and Technology in South Africa and the American Association for the Advancement of Science (AAAS) have formed a partnership to introduce a science radio journalism fellowship programme. In South Africa the general absence of scientific literacy and awareness, as well as the large sections of the population with little or no access to information about SET is a serious problem that needs to be addressed. The aim of the project is to build a critical mass of science radio journalists who can communicate science to the public in South Africa's indigenous languages. Radio was chosen as medium because

- it is a crucial means of communication;
- there is a radio in almost every home in South Africa;
- a radio is battery operated and available at low cost;
- listenership is across all age groups, social and economic classes;
- radio can engage the public (e.g. phone in).

According to Caro (1997:125), it is possible that the future position of science and scientists in society *will* depend in part on their ability to win the mediatic battle, that is, to engage themselves in an efficient 'literary' presentation of science. This is because the future depends on the decisions of the politicians, and the politicians usually follow public opinion. However, in a society where knowledge is a fragmented offer, spread over a large number of different media, scientists have to plan a strategy to

present their achievements to literate and illiterate, urban and rural and young and old people. They may try themselves to build the articles necessary to be listened to, but obviously one needs to see more and more journalists with a science background. Certainly this seductive trend would have to be extended to education at the primary and secondary levels. Many things need to be invented to bring contemporary research to a larger audience. It is a challenge for the current century.

Science forms an integral part of everyone's life and due to the impact of the mass media on society, it has become imperative for society to acknowledge the importance of science, to know the real facts and understand exactly what scientists have to communicate. In the understanding of what scientists wish to convey, the media play an important role, as was described, but without a relationship between scientists, communication specialists as facilitators and journalists, wrong messages would reach stakeholders. In the following section, the results of a study conducted on the relationship between scientists and the media are described.

5.9 RESULTS OF A SCIENTIST'S AND MEDIA RELATIONSHIP SURVEY CONDUCTED IN SOUTH AFRICA

In 2001, Gething (2001:6) conducted a study among researchers at the Medical Research Council (MRC) in South Africa to determine their attitudes and experiences with regard to communication to the public and the media. Results aimed to inform the development and implementation of strategies to fast track a turnaround at the MRC towards the promotion of science communication.

According to Gething (2001:40), the study found that although 48.9% of the scientists had each published over 30 articles in peer-reviewed journals, 38.9% had never had these articles mentioned in the lay media. Yet, the scientists regarded the public and policy makers as the most important groups they should communicate with. The scientists might not trust the media to provide accurate scientific information, but they felt that the general public did. The vast majority (92.8%) strongly agreed or tended to agree that they had a duty to communicate their research and its implications to the public, and 70.8% would have liked to spend more time on this.

However, the scientists also agreed that the requirements of their daily tasks left them with too little time to communicate the implications of their research to others (47.5%) or even to get on with research (36.4%). Most of the scientists had never had contact with the media, or only every few years. Many of their comments reflected unrealistic expectations, which can only be addressed by training in what the media are all about. Although most (86.9%) had never had any training in dealing

with the media, 80.8% would be interested in such training. Science communication and the development of links with the community and media should be seen as part and parcel of scientific research, and should be given due recognition and support. Policies about recognising, encouraging and rewarding such efforts should also be agreed and communicated with the scientists (Gething, 2001:84). The results of the study indicate that scientists generally want to communicate and see the potential benefits of their communication with the media and other stakeholders. Unfortunately, although the media cover a complete spectrum of topics, science is rarely to be seen or heard. But what are the trends? The science journalism trends are discussed next.

5.10 TRENDS IN SCIENCE JOURNALISM

The content and style of science reporting have adapted to the different agendas of science journalists and have changed to correlate with the shift in the audience's needs over the last couple of decades. The tone of science reporting also reflects the cycles of scientific development. Contrary to popular belief, a steady decline in the coverage of science and technology did not occur. According to a British study, however, the trend has been different in the quality media and in the popular media in Britain (Bauer, Durant, Ragnarsdottir & Rudolfsdottir, 1995:7,8).

From 1946 to the early 1960s the quality media demonstrated a 400% increase in the coverage of science and technology, whereas the popular media indicated a 300% increase. From the early 1960s to the mid-to-late 1970s the quality media demonstrated a 50% decrease in science coverage, while such coverage in the popular media stabilised. Towards the 1990s, the quality media made a 50% recovery, whereas the popular media presented a 60% decline in the coverage of science and technology. The general increase in science coverage during the 1970s and 1980s was reflected by similar results obtained from Australia and Germany over the same period (Bauer *et al.*, 1995:7). According to Nelkin (1995:7), in the 1970s the wonder of science was replaced by a concern for the environment, while the 1980s was once again characterised by a discourse on the benefits of science in the media. "The idea of progress was resurrected as innovation, and the celebration of technology turned to high-tech hype" (Nelkin, 1995:7). This 'hype' continued through to the 1990s, although the emphasis shifted from the biological to the physical sciences.

The growing competition in the media influenced the coverage of science in the 1990s. Yet, the degree of homogeneity between different publications increased. In that era of unprecedented scientific discovery, journalists seemed to be pulled in several directions by scientists, the industry advertisers and politicians (Van Rooyen, 2002a:15). However, science increasingly appeared in the coverage of

such global issues as climate change, environmental disasters and international economic affairs (Nelkin, 1995:2).

According to Weingart (2002:703), it is clear that the field of SET has taken on a whole new dimension over the last few decades, namely that of 'post-normal science' or science closely related to politics and social legitimisation. Weingart (2002:705) identifies another important trend: that of science that is increasingly commercialised and linked to the media as scientists use the media to gain funds. As a result, perhaps, science coverage is still more explanatory and adulatory than challenging or analytical. In too many newsrooms there might be time to report the quick hits of scientific discovery, but not to probe the more complex debates over theory or regulatory policy or the role of business in research (Hotz, 2002:6). Almost no literature could be found on trends in the South African media. However, it is obvious from the coverage in general magazines and newspapers that science always takes second place. The next section contains some results of the studies conducted in South Africa to explore the role of the media in distributing science news to stakeholders.

5.11 STUDY RESULTS ON HOW THE MEDIA WAS USED TO COMMUNICATE SCIENCE

According to Joubert (2001), hardly any science news is heard on the radio, except for very few interview broadcasts. She furthermore states that television coverage of science discoveries or explanation of new technology is also limited to one or two television programmes. The Internet has evolved as a tremendous breakthrough to reach mass publics almost as soon as an important event has occurred. Since the aim of the Internet as medium differs from that of printed media and television, the use of the Internet was discussed in Chapter 2.

South Africa needs high-level commitment and support to improve the quality and quantity of local science in local broadcasts. Science needs to be integrated into popular, peak-time programmes, such as local dramas, historical and other documentaries, talk shows and even soap operas. Regular science inserts on news broadcasts and science fillers between programmes could also enhance the communication of science (Joubert, 2001).

In a study conducted by Blankley and Arnold (1999:4), it was found that in the USA television is the leading source of information about new developments in SET, followed by books and newspapers. Patterns of media usage differ in South Africa, and the reach of some of the mass media in South Africa is as follows (figures should be considered in the context of an adult population of 25.7 million):

- African language radio services reach 19.3 million listeners

- 13.2 million South Africans watch television
- 1.82 million South Africans have access to the Internet
- 1.43 million South Africans receive a daily newspaper (although readership is indeterminable and known to be higher than newspaper distribution).

Radio, particularly African language radio, is altogether the most far-reaching of the mass media, and thus recommends itself for use in public understanding of science interventions. It is affordable and within reach of almost every member of the target audience (Blankley & Arnold, 1999:11).

In his study, Pouris (2001:3) also identified sources of information used by the public. Table 5.1 indicates the different sources of information used by the total number of respondents, female respondents, those between 16 and 24 years old and African respondents. The most frequently mentioned media involved reading a magazine and watching television shows that focus on science and nature. The most frequently read category of magazines, namely family/actuality (e.g. *You, Bona, De Kat*), was mentioned by 58% of respondents, followed by women's magazines (*Fair Lady, Femina*, etc.), read by 29% of the respondents. The televion programme that was mentioned most frequently is 50/50 (61% of respondents), followed by Mnet Explore (59%).

SET museums, a relatively new activity in South Africa was mentioned by only 5% of the respondents. In contrast, 41% and 23% of the respondents mentioned visiting a library and a zoo or aquarium respectively (Pouris, 2001:11).

Table 5.1: Public sources of science information

Source	Total	Female	African	16-24 year old
Read newspaper regularly	57%	49%	54%	56%
Read 1 magazine regularly	77%	81%	73%	94%
Visited a natural history museum	15%	15%	13%	25%
Visited a zoo or aquarium	23%	22%	19%	31%
Visited a science or technology museum	5%	4%	4%	8%
Visited a public library	41%	42%	31%	69%
Watch TV shows focusing on science and nature	66%	62%	47%	68%
Use computer at home	19%	19%	8%	22%

Source: Pouris, (2001:11)

Considering the mediums that South African citizens use for news on science activities, it is clear that the little coverage of scientific issues by these mediums is far too insufficient to serve its purpose.

Van Rooyen (2002:15) conducted a survey on the media coverage of SET and found that only 1.8% of the 15 local publications that were included in the study devoted editorial space to science and technology. Of the published articles on SET, 38% were obtained from international broadcasters and 74% of the published material involved mere snippets and short articles. A very small percentage of the articles (only 0.2%) covered mathematics and physics. The reason for the shortage of science news articles for the period of the study (18 March to 17 June 2002) seemed to be a lack of devoted science writers. The study conducted by Van Rooyen is compared with the content analysis conducted in this study and the results are described in full detail in Chapters 7 and 8.

5.12 SCIENCE COVERAGE IN THE SOUTH AFRICAN MEDIA

The advent of electronic media has had an impact on newspaper readership. In the past a newspaper was a daily necessity for up-to-the-minute news, but nowadays Cable News Network (CNN), Sky and BBC World have eroded that stronghold. According to Mersham and Skinner (2001:37), the readership figures for newspapers are increasing despite the fact that the circulation figures for newspapers are decreasing. According to a study by All Media Product Survey (AMPS), adult readers increased from 8,3 million in 1997 to 9,5 million in 1999. Although the increase in younger readers in the age group 16 to 24 years old, where readership grew by 15%, is quite encouraging, figures over the last ten years since 1994 show a general downward circulation trend for newspapers. Nevertheless, despite circulation losses, newspapers remain viable and immediate.

Most of the larger publications have websites on the Internet, of which the on-line *Mail & Guardian* is considered to be one of the best on-line newspapers or magazines in South Africa. There are more than 600 magazines and newspapers listed as on-line publications in South Africa, with at least 16 of them specialising in daily news (Mersham & Skinner, 2001:42). The consequences that new media technologies such as the Internet have for communication specialists are described in the following section.

5.13 CONCLUSION

The agenda setting theory and the gatekeeper theory, which are two of the theories that are used as the framework for this study, were discussed in this chapter. Chapter 5 also described the specific roles of the key role players in science communication, as well as the role of the media.

It became evident from each theory described in Chapters 2 to 5 that science communication should be practised as excellent communication, taking into consideration the various stakeholders, i.e. literate and illiterate, urban and rural and young and old people. The mass media, as an important channel to convey the message of science, have to be convinced of the crucial nature of their role in conveying true and trustworthy messages to all stakeholders.

In light of the media's effect on public policy, the media today represent a battleground for political and economic interests seeking to convey their views to the public. As issues involving SET are increasingly at stake, scientists must also enter this arena. Their contacts with journalists are often strained, since the communities of science and journalism approach the problem of public communication from different professional perspectives, cultural frames, and political perspectives. In this regard, the role of communication specialists is very valuable and it should be their responsibility to act as facilitators between scientists and journalists. Without communication specialists the relationship between the other key role players in science communication cannot reach a stage of trust and mutual understanding. However, a lack of training is a limiting factor in communicating science effectively to stakeholders.

As can be seen from the results of studies conducted on the South African media, training for all role players in science communication is lacking. One of the reasons for the apparent lack of dedicated science writers within the South African context is probably economic restraint. Time can, however, also be a restraint, as well as a lack of experience and knowledge of science.

Chapters 2 to 5 focused on the theory on which this study is based. The next step will be to apply the theory to the empirical part of the study. Exploratory and descriptive research was conducted to investigate the role of role players in science communication. The objectives of exploratory research include the establishment of research priorities, the clarification of concepts and the development of questions or hypotheses for further research (Cooper & Schindler, 2001:134). Descriptive research aims to answer questions pertaining to who, what, where, when or how (Cooper & Schindler, 2001:136). Content analysis was conducted to investigate the coverage of science in the print media. Therefore, the empirical component of this study helps to describe the reality of the problem situation. It also supplements the broad theoretical framework within which future research can be conducted. The research methodology that was used is discussed in Chapter 6, while the results are presented and interpreted in Chapters 7 and 8.

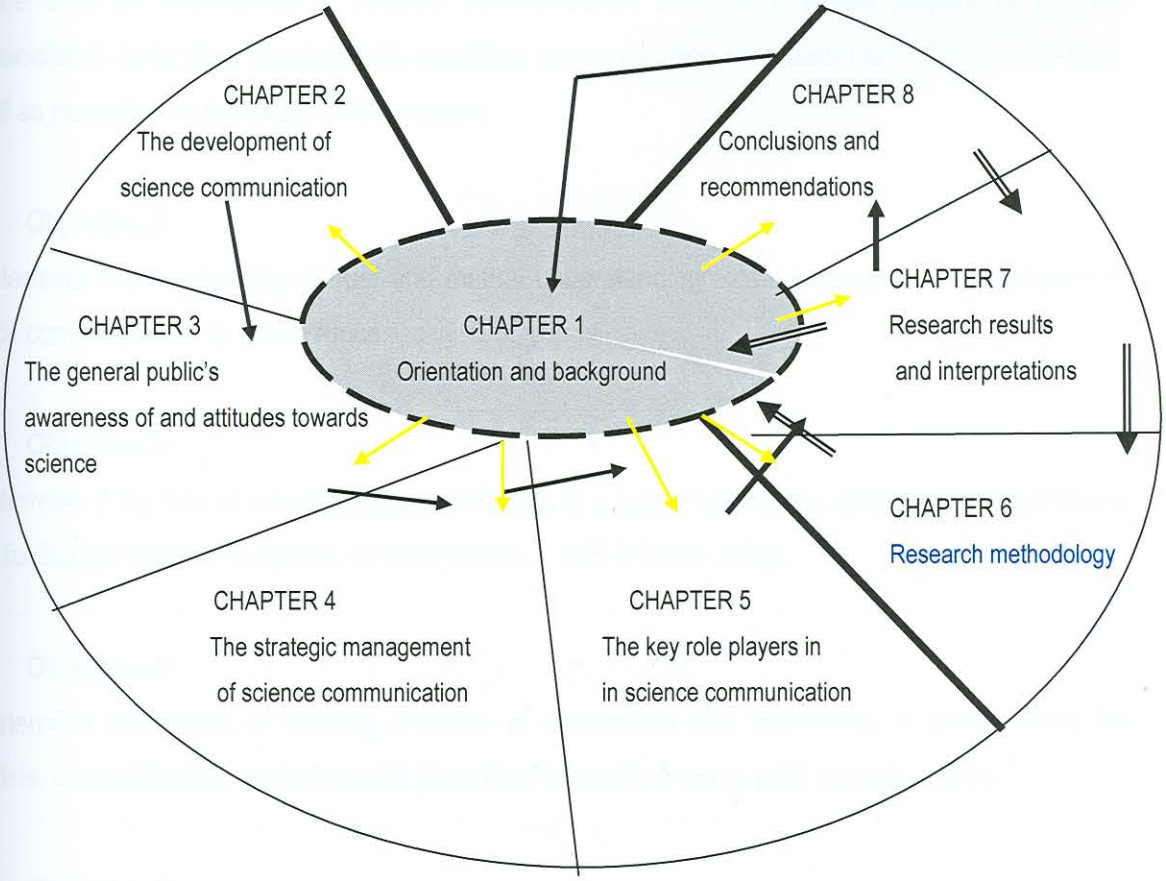
Chapter 6

Research methodology

6.1 INTRODUCTION

This chapter focuses on the research methodology used in this study. Figure 6.1 illustrates the positioning of this chapter in relation to the theoretical and empirical phases. Chapter 6 is the first of the three components of the empirical phase and is central to enhancing the internal validity of the findings. Furthermore, there is a constant interplay between Chapters 1 and 6, as well as between Chapters 6, 7 and 8.

Figure 6.1: Chapter 6 in relation to the theorey and empirical phases



Mouton (1996:39) makes it clear that the choice of methodology depends on the research problem and research objectives. It is therefore appropriate to restate the general research aim and research objectives that guide this study, as stated earlier in Chapter 1.

General research aim:

The general research aim of this study is to investigate the relationship between key role players in science communication and to determine the role of the key role players in science communication. The key role players refer to executive management, scientists and communication specialists at HEI as well as South African journalists.

Research objectives:

- **Objective 1:**

To determine the importance of science communication amongst key role players of science communication, (executive management, scientists, communication specialists) at HEI in South Africa, as well as journalists in the South African media.

- **Objective 2:**

To determine if a relationship of trust and mutual understanding exists between key role players in science communication in South Africa.

- **Objective 3:**

To determine if the role of communication specialists is a role of strategists, managers or technicians in the facilitation process in science communication at HEI in South Africa.

- **Objective 4:**

To determine the extent of training provided at universities and technikons in South Africa for scientists, communication specialists and journalists to enable them to write science articles.

- **Objective 5:**

To investigate the coverage of scientific topics in articles in the South African mass media.

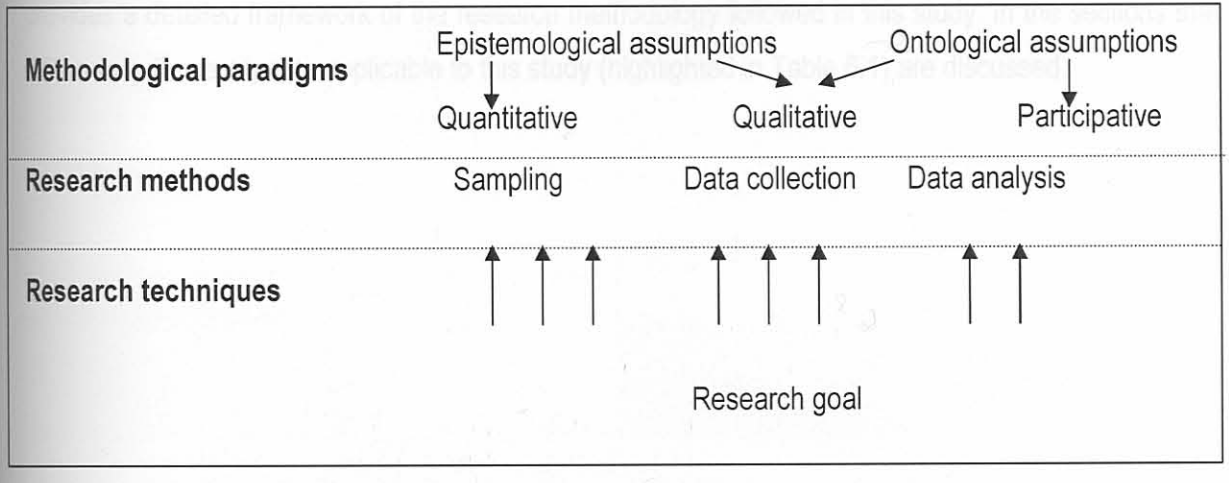
- **Objective 6:**

To analyse the content of articles on science in selected South African media from 1 March to 31 May 2004 and to compare the results of this study with Van Rooyen's study conducted in 2002.

6.2 PERSPECTIVES ON RESEARCH METHODOLOGY

The methodological dimension of research is distinguished on three levels, namely methodological paradigms, research methods and research techniques (Mouton, 1996:37). Methodological paradigms, the most abstract level, include the distinction between qualitative, quantitative and participatory research. Research methods are those that are used in certain stages of the research process, for example sampling, data collection and data analysis. Research techniques represent the most concrete level of the methodological dimension to execute specific tasks and include specific techniques related to sampling, data collection and data analysis. This distinction between paradigms, methods and techniques is helpful in forming a better understanding of the concept 'research methodology' (Schoonraad, 2003:129). The three levels as described by Mouton (1996:37) are demonstrated in Figure 6.2.

Figure 6.2: Levels in the methodological dimension



Source: Mouton (1996:37)

Du Plooy (2001:20,21) suggests that the ontological, epistemological and theoretical assumptions about communication should be considered in deciding which methodological assumptions would govern a study. In this study the assumptions of Du Plooy (2001:27), namely that the epistemological assumption guides the way in which researchers acquire knowledge (epistemology), are accepted.

Research strategy and research design are two other terms related to research methodology. Research strategy guides the research effort by defining the context within which it is conducted and provides the link between research objectives and research activities. Research strategy is partly

derived from the methodological paradigm – qualitative or quantitative – that fits a particular research problem. Du Plooy (2001:81), on the other hand, describes research design as a plan of how a research project is conducted, specifying who or what is involved, and where and when it is taking place. In other words, research strategy indicates which 'direction' is taken, while research design indicates what needs to be done while heading in that specific direction (Schoonraad, 2003:130).

Du Plooy (2001:49) further states that research strategy refers to qualitative versus quantitative, exploratory versus formal, descriptive versus causal research. Cooper and Schindler (2001:135) describe the research design as control over variables, time dimension, research environment and perceptions of participants. The methods and techniques used to collect, analyse and interpret data are discussed under one heading, because according to Mouton (1996:36) the distinction between methods and techniques is one of degree and scope.

This study is following two methods and techniques to collect, analyse and interpret data. The first data collection technique is a *survey method* and the second technique is *content analysis*. Table 6.1 provides a detailed framework of the research methodology followed in this study. In the sections that follow, only those aspects applicable to this study (highlighted in Table 6.1) are discussed.

Table 6.1: A framework of the levels and aspects of the research methodology

RESEARCH STRATEGY	RESEARCH DESIGN	RESEARCH METHODS AND TECHNIQUES	
Qualitative or **quantitative (both Phase 1: survey and Phase 2: content analysis)**	Control over variables • Experimental • **Ex post facto**	Sampling design • Unit of analysis • Population • Target population • Sampling frame	Sampling techniques • Probability (simple random; systematic; stratified; cluster; sequential or multiphase) • **Nonprobability** (convenience; **purposive**, snowball)
Exploratory or formal research	Time dimension • **Cross-sectional** • Longitudinal	Data collection	Data collection techniques • **Quantitative** data collection (e.g. experimental; **survey**; **content analysis**) • Qualitative data collection (e.g. field observation; historical research; content analysis)
Descriptive or causal research	Research environment • **Field** • Laboratory • Simulation	Data analysis	Data analysis techniques • **Quantitative** data analysis (**descriptive statistics**; inferential statistics) • Qualitative data analysis (e.g. grounded theory; discourse analysis; conversation analysis)
	Perceptions of participants • Actual routine • **Modified routine**		

Compiled from: Cooper and Schindler (2001:135), Mouton (2001:166), Du Plooy (2001:191) and Schoonraad (2003:131).

6.3 RESEARCH STRATEGY

According to Mouton (1996:37), the research strategy that is partly derived from the methodological paradigm (qualitative or quantitative) fits the research question. The research strategy is further described as exploratory or formal; descriptive or causal. In this study a quantitative, exploratory and descriptive research strategy was followed.

6.3.1 Quantitative research

Cooper and Schindler (2001:139) note that the objectives of exploration may be accomplished with different techniques. Both qualitative and quantitative techniques are applicable, although exploration relies more on qualitative techniques. The objectives of the empirical component of this study are not to obtain in-depth information, but rather to gain a wide range of perspectives from the key role players (executive management, scientists, communication specialists and journalists) in science communication. Thus, a quantitative strategy, rather than a qualitative one, is used.

6.3.2 Exploratory research

Exploratory studies tend toward loose structures with the objective of discovering future research tasks. The immediate purpose of exploration is usually to develop hypotheses or questions for further research (Cooper & Schindler, 2001:134). According to Mouton (1996:102) exploratory studies are typically used when very little previous research has been conducted on a specific topic.

Science communication is a new phenomenon in South Africa and very few research studies have been conducted, especially on the role of key role players in science communication (Joubert, 2001). Two of the objectives of this study are to describe the role of role players in science communication and to establish the level of training required for role players to be effective in science communication. A natural result of these is the identification of shortcomings in the current situation in order to identify priorities for future research.

6.3.3 Descriptive research

Cooper and Schindler (2001:136) distinguish between descriptive or causal research in the objectives of the research study. Descriptive research attempts to answer questions such as who, what, where, when or how much. Causal research on the other hand focuses on why – in other words, how one variable produces change in another.

The objectives, as noted in the introduction of this chapter, attempt to describe the current role of communication specialists, the relationship between key role players in science communication, the training provided to role players in science communication and the media coverage that science receives in the media. Therefore, the objectives of this study attempt to answer questions of 'what' and 'how much'. The study is thus descriptive.

6.4 RESEARCH DESIGN

As mentioned earlier and illustrated in Table 6.1, the research design encompasses factors such as researcher control of variables, time dimensions, research environment and participant's perceptions (Cooper & Schindler, 2001:135). The factors as applicable to this study are discussed in the following sections.

6.4.1 Control of variables

An *ex post facto* research design aims to study a specific situation or phenomenon *as it is* (Leedy, 1997:189). It does not attempt to manipulate any of the variables in the situation. According to Cooper and Schindler (2001:136), researchers should avoid manipulating variables by adhering strictly to sampling procedures, otherwise bias might be introduced. This is in contrast to experimental design, where variables are deliberately manipulated in order to observe cause and effect relationships. The main objective of this study is to describe the current role of role players in science communication. It is therefore based on an *ex post facto* research design.

6.4.2 Time dimensions

Within the time dimensions of the design, two possibilities exist: Cross-sectional studies and longitudinal studies. Cross-sectional studies are carried out once and represent a snapshot of one point in time, while longitudinal studies are repeated over an extended period (Cooper & Schindler, 2001:136). As the objectives of this study are to describe a current situation, not to observe trends or changes, a cross-sectional time dimension is appropriate.

6.4.3 Research environment

Research can be conducted either under actual environmental, laboratory or simulated conditions. According to Mouton (2001:157), field experiments distinguish themselves from 'true' or 'classical' experiments by the fact that they occur in natural settings. This study is conducted under actual environmental conditions (in the field/natural environment) and can therefore be classified as field research.

6.4.4 Perceptions of participants

Cooper and Schindler (2001:139) warn that when people involved in a research study perceive that research is being conducted, they may behave less naturally. The following three levels of perception are identified:

- No deviation from everyday routines
- Deviations, but unrelated to the researcher
- Deviations as induced by the researcher

The last level illustrated in Table 6.1 is referred to as 'modified routine'. Du Plooy (2001:85) suggests that when performing a cross-sectional study, the unobstrusiveness of the measuring instrument and/or the researcher's behaviour can contribute to internal validity. However, in the case of questionnaire surveys, this is not possible. Respondents or subjects are aware that research is being conducted. When analysing the data and discussing the results, it is therefore important to make provision for the possibility that respondents' responses might have been influenced by this awareness. A self-administered questionnaire was used in this study and the level of respondents' awareness can therefore be described as 'modified routine'.

6.5 RESEARCH METHODS AND TECHNIQUES

This section devotes time to the more concrete levels of the research methodology, which include sampling, data collection and data analysis methods and techniques (Mouton, 1996:37). Two methods were used in this study to conduct the empirical research. **Phase 1** makes use of the survey method, while in **Phase 2** a content analysis is conducted. First, in Phase 1 of the study, the sampling, data collection and data analysis methods are described, followed by a discussion of the questionnaire design and pilot test. Thereafter, in Phase 2, a description of the content analysis is provided.

6.5.1 Phase 1: Sampling design

The basic idea of sampling is to identify the unit of analysis, the target population and sampling frame, as well as the appropriate sampling technique(s).

- **Unit of analysis**

The unit of analysis is the person or object from whom the researcher collects data (Mouton, 1996:91). Such data can only describe the specific unit from which data is collected, but when combined with similar data collected from a group of similar units, provides an accurate picture of the group to which that unit belongs (Du Plooy, 1996:39; Cooper & Emory, 1994:114). Units of analysis fall into broad categories such as individuals, groups, organisations, time periods and social artefacts (Mouton, 1996:48). He further observes that in some cases the unit of analysis and data source are identical, while they differ in other cases (Mouton, 1996:92). One way to distinguish between the two is to remember that the unit of analysis is that to which a researcher's conclusions ought to apply, while the

data source is that which has to be explored or investigated in order to gather information about the unit of analysis. In Phase 1 of this study the unit of analysis and data source are identical, that is, the key role players in science communication in South Africa. The key role players include executive management, scientists, communication specialists at HEI and journalists in South Africa.

- **Target population**

Defining the population involves two steps: identification of the target population and construction of the sampling frame (Mouton, 1996:135). According to Dane (1990:336) and Du Plooy (2001:100), there is a distinction between the population and the target population: the population is all possible units of analysis, while the target population is the population to which the findings can be generalised. In this study the population includes all South African universities, technikons and media. The target population only includes executive management, scientists and communication specialists at universities and technikons (also referred to as HEI in this study) and daily newspapers, weekly newspapers and family magazines (targeted at the whole family and not only at women or men).

The numbers of the selected target populations for the HEI and journalists were obtained from various sources. The membership of executive managements was obtained telephonically and via the Internet. These numbers may however not be absolutely correct, since the information on the Internet might be outdated. The target population of scientists was obtained from the 2003 (2004 was not available yet) National Research Foundation database, which includes only rated scientists and cover all sciences, including human sciences, which are outside the scope of this study. The communication specialists were obtained from the Practitioners in Marketing and Communication, trading as UNITECH database, which is also very outdated. UNITECH is a membership-based organisation that promotes the interests of practitioners in the intergraded marketing, communication and development fields at the various HEI in Southern Africa. The media that was selected for this study focused on the South African media, since it has often been criticised for its lack of SET coverage. The media that was included in this study focused on weekly and daily newspapers and family magazines. These newspapers and magazines were contacted and their number of journalists was obtained telephonically. The South African newspapers and magazines do not have journalists who report specifically on science (Van Rooyen, 2001:15). Journalists are reporting on four main categories and science would have to fall into one of these categories, depending on the field of the science news. The four categories are environment, health/medical, technology and education. Table 6.2 illustrates the number of respondents from the four target populations as defined above.

Table 6.2: Target populations

TARGET POPULATION	TOTAL NUMBER
Executive management	62
Scientists	1 110
Communication specialists	234
Journalists	68
TOTAL	1 474

The objective of this study is not to generalise the findings to the target population. Although the empirical component of the study is quantitative in nature, the study as a whole is exploratory in nature. This is not necessarily problematic in terms of the definition of the concept 'target population'. For the purposes of this study, 'target population' is understood as those units of analysis that are applicable in terms of the research problem and objectives.

- **Sampling frame**

The sampling frame is closely related to the population. The sampling frame is the list of elements from which the sample is actually drawn (Cooper & Schindler, 2001:170). Although the sampling frame should ideally include all members of the target population, it is not always practically possible. For example, existing or available lists of members of the target population might be outdated.

It has been noted that the target population for Phase 1 of this study consists of executive management members, scientists and communication specialists at universities and technikons, as well as journalists at daily newspapers, weekly newspapers and family magazines. During the course of this study some universities and technikons merged or are in the process of merging, and some of the executive management and communication specialists are no longer in their previous employment positions. Technikons *per se* are no longer in existence, but for the purposes of this study, they remain as they were previously known. Restructuring of the institutions influenced the designations of previous executive management members and communication specialists. Therefore, some of the institutions included in this study will no longer be in existence at the conclusion of the study. However, it was possible to include almost all institutions as had originally been anticipated.

Journalists at the daily newspapers included a representation of all the provinces, while journalists at the weekly newspapers included those papers with the highest number of readers. The journalists at magazines that were selected are journalists reporting for family magazines with the highest likelihood of publishing science articles. Magazines such as *Sarie* and *Fair Lady* were not included because they focus mainly on women, while *Farmers Weekly* and *Landbouweekblad*, etc., were also not included since they focus on a specific reader group that may tend to be biased in terms of agriculture. Gender-focused and specific reader groups fall outside the scope of this study. Therefore, the sampling framework is constructed from the following sources:

- Executive management, scientists and communication specialists from the following universities: – Cape Town, Witwatersrand, Stellenbosch, Port Elizabeth, Rhodes, Western Cape, Free State, Potchefstroom, North West (Potchefstroom and North West were in the process of merging when the research was conducted), Rand Afrikaans, Witwatersrand, Pretoria, South Africa, KwaZulu-Natal (Durban, Pietermaritzburg and Durban-Westville already merged), Venda, Transkei and the North.
- Executive management, scientists and communication specialists from the following technikons: – the Cape, Free State, Eastern Cape, ML Sultan, Mangosuthu, Northern Gauteng, Natal, Peninsula, North West, Pretoria, Port Elizabeth, Vaal Triangle, South Africa and Witwatersrand. Since the research was conducted, some of these technikons have merged with universities or undergone a name change.
- South African journalists at the following daily newspapers, weekly newspapers and magazines: Daily newspapers – The *Pretoria News*, *Beeld*, *Die Burger*, *Die Volksblad*, *Sowetan*, *The Mercury*, *The Argus*, *This Day* and *Star*. Weekly newspapers – *Mail & Guardian*, *Sunday Times* and *Rapport*. Family magazines – *Financial Mail*, *Finansies & Tegniek*, *De Kat*, *Huisgenoot* and *You*.

The information on the selected target populations was carefully scrutinised and outdated information was removed. After cleaning the data on the target populations, the sampling frame consisted of the numbers as displayed in Table 6.3.

Table 6.3: **Sampling frame**

SAMPLING	NUMBER OF POPULATION
Executive management	46
Scientists	234
Communication specialists	58
Journalists	51
TOTAL	389

- **Sampling technique**

Sampling, according to Du Plooy (2001:100) is described as a rigorous procedure of selecting units of analysis from a larger population. There are several reasons why samples are drawn, rather than to investigate the whole population (Cooper & Schindler, 2001:163). These reasons include lower cost of the research, greater accuracy of results, greater speed of data collection and availability of population elements.

Sampling techniques can be divided into two broad categories, namely probability and non-probability samples. Probability samples are distinguished by the fact that each population element has a known, non-zero chance of being included in the sample. Non-probability samples rely on personal judgement somewhere in the element-selection process and therefore prohibit estimating the probability that any given population element is included in the sample (Cooper & Schindler, 2001:166). If the objective of a research study is to generalise the findings to the population, probability sampling is the logical choice. However, if the study is exploratory in nature, with less concern about the sample's representativeness of the population, non-probability sampling is appropriate.

This study is exploratory in nature, therefore the emphasis is not so much on generalisation, but rather on gathering preliminary information about how the key role players (executive management, scientists and communication specialists at South African HEI, as well as journalists) in science communication interact and what roles they are playing. Non-probability sampling was therefore the choice and purposive sampling (more specifically judgement sampling) was chosen as the sampling technique. In purposive sampling the researcher selects elements of the population with a specific purpose in mind. The elements, or characteristics, are usually especially informative (Zikmund, 2003:382). Furthermore, using judgement sampling, the researcher selects sample members in order to conform to a certain criterion (Cooper & Schindler, 2001:192).

The sample size constitutes roughly 26% of the target population. It was hoped that a larger sample could be drawn, seeing that the data collection method used in Phase 1 of this study (electronic questionnaire survey) is characterised by low response rates. However, many e-mail addresses of the target population were no longer valid.

6.5.2 Phase 1: Data collection

There are various methods of collecting primary research data, for example by means of mail-based self-administered questionnaires, telephonic interviews, personal interviews (face-to-face) and focus groups (Malhotra, 1996:198). When undertaking a survey in communication research, the researcher collects information from a group of people to describe their abilities, opinions, attitudes, beliefs and/or knowledge with regard to a particular topic or issue. Generally, the purpose of using survey research in communication is to explore and describe what is, rather than to evaluate why an observed distribution (or attitude) exists (Cooper & Schindler, 2001:295).

The communication approach involves questioning or surveying people and recording their responses for analysis. The great strength of questioning (or conducting a survey) is its versatility. It does not require any visual or other objective perception of the information sought by the researcher. Abstract information of all types, opinions, attitudes, intentions and expectations can be gathered by questioning others (Cooper & Schindler, 2001:295). Questioning is more efficient and economical than observation. However, questioning has its shortcomings. The major weakness is that the quality and quantity of the information secured depend heavily on the ability and willingness of respondents to cooperate. Even if respondents do participate, they may not have the knowledge sought or even an opinion on the topic of concern. Too often, respondents feel obliged to express some opinion, even if they do not have one. Respondents may also interpret a question or concept differently from what was intended by the researcher (Cooper & Schindler, 2001:295).

The largest constraint when using a self-administered questionnaire is a low rate of return. The data collection time is also long. Dillon *et al.* (1993:157) sees survey research as a process of social exchange: "... an interpersonal relationship in which an individual's willingness to enter or remain in the relationship depends on expectations of rewards and costs". The researcher can therefore increase the rate of return by making the completion of the questionnaire worthwhile for the respondent, thus ensuring an acceptable rate of return for the e-mailed and/or faxed questionnaire.

According to Dillon *et al.* (1993:158-172), versatility, quantity of data, sample control, quality of data, response rate, speed, cost and uses, influence the choice of a survey method. After considering all the advantages and disadvantages of the various methods (shopping mall intercept, personal interview, mail, telephone and e-mail), a decision was taken to make use of a self-administered questionnaire sent via e-mail to potential respondents as the measurement instrument. E-mail is fast and cost-effective, and the questionnaires would be completed in the respondents' own homes or at work, requiring only a few minutes of their time.

- **Compiling a database**

Successful data collection depends on a reliable database. Already during construction of the sampling frame the available databases for the four target populations were compiled and existing databases were revised. Possible respondents who were no longer at the various institutions and printed media were removed from the databases. As a second step, the websites of institutions and printed media in the sampling frame were visited to obtain the e-mail addresses of respondents. However, not all the institutions had websites and not all of the printed media listed their journalists. All the available information on executive management members, scientists, communication specialists and journalists was recorded.

As an alternative method, the institutions and printed media applicable to this study were contacted telephonically to obtain information. Unfortunately, this strategy yielded less successful results. A large number of institutions, newspaper and magazine offices were not prepared to provide e-mail addresses of executive management members, scientists, communication specialists or journalists. However, some were cooperative and provided the e-mail addresses as requested.

- **Distribution of questionnaires**

Due to the four target populations identified for the purpose of this study, four separate questionnaires were distributed. They were targeted specifically at each member of the executive managements, scientists, communication specialists and journalists. This phase was implemented in January 2004. E-mails were sent directly to the respondents. The e-mail message included an explanation of the process behind submission of responses and an offer was made to send the respondent the results of the study. The e-mails were not personalised, but a different e-mail was sent to each of the four target populations, since the number of questions in each questionnaire differed.

The respondents all had extremely busy schedules and would not have time to read lengthy e-mails. The most essential information was therefore placed right at the beginning of the e-mail message. The subject line and introductory sections were formulated to immediately grab respondents' attention. The research study was introduced in the introductory section. (See Appendix 1 for an example of the e-mail message that was sent to respondents.) The questionnaires were attached to the e-mail and were accompanied by a cover letter addressed to each of the four target populations. The covering letter explained the purpose of the study, indicated how the information would be used and motivated why the individual's participation was important. The letter identified the person undertaking the survey and was aimed at persuading the respondent to complete and return the questionnaire by the closing date. The address to which the questionnaire had to be returned was clearly indicated so as to facilitate its return. (See Appendix 2 for the cover letter.)

Step-by-step instructions were provided in the questionnaire to facilitate its completion. On the last page a space was provided to fill in an address, should the respondent require a copy of the results, or should the researcher require further information from the respondent. (See Appendices 3, 4, 5 and 6 for the questionnaires developed for executive management, scientists, communication specialists and journalists respectively.)

The response (in terms of submitted questionnaires) was extremely poor. However, quite a number of replies on the e-mail messages were received. Surprisingly, most principals returned the questionnaire, or indicated that a vice-principal would reply on behalf of the institution. However, hardly any vice-principal returned the questionnaire, except for the ones who were requested to reply on behalf of the institution. In many cases, the scientists apologised for being too busy to be able to complete the questionnaire, and some declined to participate in the survey. At some institutions communication specialists also declined to participate, since the institution does not participate in any science communication activities. Most journalists did not reply to the e-mail at all. Two weeks before the initial closing date of 31 March 2004 reminders were sent to those respondents from whom no response had been received. The response was slightly better.

In a final attempt to increase the response rate, e-mail messages were again sent to members of executive managements, scientists and communication specialists. In the case of journalists, an e-mail was sent to the newsdesk editor with the request to hand the questionnaire to the journalists. Some newspapers required a fax copy of the questionnaire, which was sent immediately after the request.

This strategy was more successful in terms of the number of responses received. However, it was necessary to postpone the deadline of submission to the end of April 2004.

- **Recording of data**

All responses received from respondents were immediately printed. To prevent any loss of data, the contents of all e-mails were saved in a folder on Outlook Express. Thereafter data was captured in a Microsoft Excel spreadsheet.

6.5.3 Phase 1: Data analysis

There are two types of questions, open-ended and close-ended questions, which require different types of data analysis. Since the questionnaire contained only structured or close-ended questions, the researcher coded all responses.

- **Coding**

Coding means assigning a code, usually a number, to each possible response to each question. The code includes an indication of the column position and the data record it would occupy. For example, the gender of respondents can be coded as 1 for males, and 2 for females (Malhotra, 1996:475). Assigning numerical symbols permits the transfer of data from the survey to the computer (Zikmund, 2003:458). The respondent code and record number also appeared on each record in the data.

- **Statistical procedures used**

Date was captured and stored in a Microsoft Excel spreadsheet. The data was also subjected to a verification process in order to eliminate non-response and data-capturing mistakes. The Excel file was prepared for data processing using the SAS computer statistical software package.

- **Descriptive statistics**

Descriptive analysis refers to the transformation of the raw data into a form that is easy to understand and interpret (Zikmund, 2003:473). Describing responses or observations is typically the first form of analysis. The calculation of averages, frequency distributions and percentage distributions constitute the most common form of summarising data. The following are the main statistical procedures that were considered for use in the data analysis of Phase 1 of this study.

Frequency distributions

In a frequency distribution, one variable is considered at a time. The objective is to obtain a count of the number of responses associated with different values of the variable. A frequency distribution for a variable produces a table of frequency counts, percentages and cumulative percentages for all the values associated with that variable (Malhotra, 1996:504). The most commonly used statistics associated with frequencies are the mean, mode, median and standard deviation.

Mean

According to Cooper and Schindler (2001:442), the mean is a measure of *location* or central tendency. The measurement scales used in the questionnaire consisted of five points. The mean values for each variable therefore indicate whether most responses are located to the left or to the right of the centre of the scale. However, it must be remembered that the mean is an *average*, and does not indicate how individual responses are spread across the five-point scale.

Standard deviation

This limitation is addressed by the most commonly used measure of the standard deviation. The standard deviation is the positive square root of the variance (Malhotra, 1996:508). When compared with the mean calculated for each variable, the researcher could establish how far away from the average the data values are (Cooper & Schindler, 2001:444). Standard deviations can be used to determine whether mean differences between groups can be regarded as significantly different or not.

The mean values for the variables in each question are presented in table format and in the cases of high standard deviation separate bar charts were drawn for each variable in order to compare values between the population groups.

6.5.4 Phase 1: Questionnaire design

In Chapter 1, the conceptual framework that forms the basis of this study is set out. The framework includes two concepts and their related constructs. In the following parahraphs an explanation is provided as to how this conceptual framework guided the formulation of questions in developing the questionnaire that was used as measuring instrument for Phase 1 of the study. It is important to note that the discussion that follows applies to the final version of the questionnaire. For the purpose of this study four questionnaires had to be developed to appropriately address the four target populations selected. The four populations that were included are executive management, scientists, communication specialists and journalists. The questions are not different for each of the populations,

but certain questions were not applicable to all four populations and therefore were not included in all four populations' questionnaires (see Appendices 3,4,5 and 6 for the four questionnaires). However, since the role of communication specialists in science communication is one of the main concepts, the questionnaire developed for communication specialists included all the questions, because all questions are applicable to them. The pilot test and subsequent changes to the original questionnaire are discussed in section 6.5.5.

- **Formulation of questions**

The questionnaires have been formally divided into different sections according to the concepts. The relationship between the general research aim, the six research objectives and the questions in the questionnaires is best illustrated by means of a table (Table 6.4). Since the questionnaire for communication specialists contained all questions asked to the other three populations as well, the table below refers to the questions in the communication specialists' questionnaire. Objective 6 relates to Phase 2 of the study, in other words the content analysis, and was therefore not included in the questionnaire.

Table 6.4: Research objectives in relation to the general research aim and questions

Research objectives	Questions
General research aim: To investigate the relationship between key role players in science communication and to determine the role of the key role players in science communication.	1-58
Objective 1: To determine the importance of science communication amongst key role players of science communication, (executive management, scientists, communication specialists) at HEI in South Africa, as well as journalists in the South African media.	1-16
Ojective 2: To determine if a relationship of trust and mutual understanding exists between key role players in science communication in South Africa.	17-27
Objective 3: To determine if the role of communication specialists is a role of strategists, managers or technicians in the facilitation process in science communication at HEI in South Africa.	28-44
Objective 4: To determine the extent of training provided at universities and technikons in South Africa for scientists, communication specialists and journalists to enable them to write science articles.	45-50
Objective 5: To investigate the coverage of scienctific topics in articles in the South African mass media.	51-58
Objective 6: To analyse the content of articles on science in selected South African media from 1 March to 31 May 2004 and to compare the results of this study with Van Rooyen's study conducted in 2002.	Content analysis

The questionnaires included questions based on the theoretical framework as well as on general demographic information. They were divided into six sections:

- Section A: The importance of science communication

- Section B: The relationship between key role players in science communication
- Section C: The role of communication specialists in science communication
- Section D: Training in science communication
- Section E: Coverage of scientific topics in the mass media
- Section F: Demographic information

In the next section there is a discussion of the abovementioned sections in the questionnaires. Since the communication specialists' questionnaire includes all the questions, it was decided to discuss only this questionnaire.

Section A: The importance of science communication

The first section of the questionnaire (Questions 1-7 in the version for executive management, Questions 1-16 for scientists and communication specialists, and Questions 1-6 for journalists) contains the main constructs or dimensions designed to measure the importance of science communication to the four target populations. In Chapters 2 and 3 the theory of mass communication, information theory and the stakeholder theory were applied respectively to describe the development and importance of science communication and awareness, understanding of and attitudes towards science communication. Questions 1-11 referred to the importance of science communication for HEI and asked in which science communication activities the institution was participating. The purpose of Questions 12-16 was to determine the relationship with internal and external stakeholders.

Section B: The relationship between key role players in science communication

Relationship (Questions 8-14 in the version for executive management, Questions 17-21 for scientists, Questions 17-24 for communication specialists and Questions 7-9 for journalists) involves the constructs of Concept 1 regarding relationships between key role players in science communication. In Chapters 1 and 5 the theory of relationships amongst key role players were described. The questions in Section B were asked to determine whether there was a relationship of trust (Question 17 to 24) and whether there was a measure of mutual understanding (Questions 23, 24 and 32-25) among key role players.

Section C: The role of communication specialists in science communication

Section C (Questions 15-31 in the version for executive management, Questions 24-27 for scientists and Questions 28-44 for communication specialists) tested the role of communication specialists in science communication at HEI, specifically whether they are regarded as strategists, managers or

technicians. The theory of excellence as described in Chapter 4 was applied to this section's questions. These questions were derived from Concept 2 – management of the role of communication specialists. The purpose of Questions 28-30, 37, 40-44 was to determine to what extent communication specialists assumed the roles of strategist, manager or technician, as described by Steyn and Puth (2000:20-21). It also included questions about trust and empowerment. To summarise the discussion in Chapter 4 very briefly, the role of *strategist* is to determine the consequences of an institution's strategies and policies on its relationships with various stakeholders. The information gathered serves as input into an institution's strategic decision-making process. The role of the *manager* involves the development of a corporate communication strategy (deciding what should be communicated to stakeholders), while the *technician* role involves the implementation of communication plans and campaigns. The reasoning behind the inclusion of these questions is that, if communication specialists do have an important position and role in a HEI, chances are that they would be actively involved in the institution's planning and implementation of science communication activities.

Section D: Training in science communication

Training in science communication writing is important for scientists, communication specialists and journalists to ensure understanding amongst them and to ensure that the correct science messages are conveyed to stakeholders. Questions 28-30 in the version for scientists, Questions 45-50 for communication specialists and Questions 13-14 in the journalists' version of the questionnaire are derived from Concept 1.

Section E: Coverage of scientific topics in the mass media

Objective 5 refers to the contact of HEI with the various media, as well as the amount of coverage the media allocate to scientific articles or news. Questions 31-33 in the version for scientists, Questions 56-58 for communication specialists and Questions 17-21 in the journalists' version of the questionnaire address the media contact, while Questions 51-57 for communication specialists and Questions 15, 16, 22 and 23 for the journalists address the amount of coverage.

Section F: Demographic information

The purpose of the demographic information is to record the employer's name and whether the respondent has received any training in science writing or science journalism. Furthermore, it was important to include the employer's name in order to enable the researcher to keep track of who has responded and who has not. The question regarding science writing training was included to determine

how many of the respondents had in fact received any training in science writing or science journalism, since training in science communication is extremely important for the improvement of scientific articles in the media.

- **Levels of measurement**

Measurement in research consists of assigning numbers to empirical events in compliance with a set of rules (Malhotra, 1996:271, Cooper & Schindler, 2001:203, Du Plooy, 2001:117). In other words, by assigning numbers to variables, people can observe what is otherwise invisible. The levels of measurement reflect the correspondence numbers assigned to the observations in question and the meaningfulness of performing mathematical operations on the numbers assigned. There are four levels of measurement, namely nominal, ordinal, interval and ratio (Malhotra, 1996:271-275). One can distinguish between these levels according to four characteristics, namely classification, order, distance and origin (Cooper & Schindler, 2001:204-205).

- A nominal scale is a figurative labeling scheme in which the numbers serve only as labels or tags for identifying or classifying objects, such as classifying the respondent as a male or female.
- An ordinal scale is a ranking scale in which numbers are assigned to objects to indicate the relative extent to which the objects possess certain characteristics.
- On an interval scale, numerically equal distances on the scale represent equal values in the characteristic being measured.
- A ratio scale possesses all the properties of the nominal, ordinal and interval scales, and in addition, an absolute zero point.

This study used nominal and interval scales. The nominal scales served to identify and classify respondents, whereas the interval scales represented the values of the attitudes being measured. Scaling is considered an extension of measurement and is discussed below.

- **Scaling techniques**

According to Cooper and Schindler (2001:229) there are three types of measurement scales, namely rating, ranking and categorisation scales. In itemised rating scales, respondents are provided with a scale that has a number of brief descriptions associated with each category. The Likert scale, which is an example of itemised rating scales, was employed in this study. As a general rule, researchers should use the scaling technique that would yield the highest level of information feasible in a given situation and permit using the greatest variety of statistical analysis. Likert scales are mainly used to

measure attitudes, and since this study aimed to measure the attitudes (or opinions) of the key role players in science communication, the main part of the questionnaire consisted of Likert scales. The Likert scale is a widely used rating scale that requires the respondents to indicate a degree of agreement or disagreement with each of a series of statements about the objects (Cooper & Schindler, 2001:234). Each scale item has five response categories, ranging from 'strongly disagree' to 'strongly agree'. Each response is given a numerical score to reflect its degree of attitude favourableness, and the scores may be totaled to measure the respondent's opinion or attitude (Jordaan, 2003:177). The Likert scale was used here because it has several advantages. Likert scales assist researchers to compare one respondent's scores with the distribution of scores from a well-defined group; it is easy to construct and administer, and respondents readily understand how to use the scale (Cooper & Schindler, 2001:234). The main disadvantage of the Likert scale is that it takes long to complete because respondents have to read each statement.

6.5.5 Pilot test

A pilot test of the questionnaire is conducted to detect weaknesses in research design and instrumentation (Cooper & Schindler, 2001:81). An important purpose of the pilot test is to discover the respondents' reactions to questions and it also helps to discover repetitiveness or redundancy.

A pilot test was conducted in December 2003. As a first phase, the communication specialists' questionnaire was submitted to two senior communication specialists, one at the University of Pretoria and one at Pretoria Technikon, to evaluate the content and format of the questionnaire. Minor changes were made to the wording of the questions. In one of the questions 'social and ethical' implications of science were grouped together. Based on the opinion of the two communication specialists, it was decided to rather divide the question into two separate units (see Questions 15 and 16 in the communication specialists' questionnaire – Appendix 5). As a result, various questions were renumbered.

As a second phase, all four questionnaires were submitted to a sample of three respondents per population, drawn from the identified sampling frame. The respondents were from the University of Pretoria, PretoriaTechnikon, *Sunday Times* and *Beeld*. At least two respondents from each population responded and the following responses were received:

- The Likert scale-type questions were initially worded in the "we" statement format. An example is: "Our institution regards science communication as a high priority". The subject was

changed to "I". For example: "In my opinion science communication is regarded as a high priority".

- Some respondents indicated that there seemed to be repetition in the questions. When measuring opinions, researchers often ask several similar (but not the same) questions for the purpose of reliability. As a result of these comments, a decision was made to group similar questions together. Grouping questions that dealt with similar topics together eliminated the sense of repetition and seemed to create a more logical sequence for the respondents (Jordaan, 2003:192).
- Overall, the survey questions proved to be understandable and meaningful to the target population.

6.5.6 Phase 2: Content analysis

Content analysis looks at the characteristics of communication messages. The purpose is to learn something about the content and those who produced the messages. The eventual interest of the researcher might lie with the effects the content might have on receivers. Therefore, it is preferable to link content analysis with another method such as survey or experimental research to address such effects (Rubin *et al.,* 2000:200). According to Cooper and Schindler (2001:428), content analysis has been described as "... a research technique for the objective, systematic, and quantitative description of the manifest content of a communication". Because this definition is sometimes confused with simply counting obvious message aspects such as words or attributes, more recent interpretations have broadened the definition to include latent as well as manifest content, the symbolic meaning of messages and qualitative analysis (Cooper & Schindler, 2001:429). However, since Phase 2 of this study attempts to identify large-scale patterns and trends in the South African media, and as it is useful to monitor the content of mass media communication, the content analysis is quantitative in nature (Reinard, 2001:169).

Content analysis is a multistage process. First, titles that need to be sampled are selected, for example television comedy programmes, or headings in the media. Secondly, a sample of dates is selected. Thirdly, the units of analysis are selected and these units are subsequently assigned to predetermined categories. The categories must be mutually exclusive (i.e. all categories must differ from one another) and exhaustive (i.e. all possible categories are included in the analysis). Lastly, comparisons are made of the different findings (Rubin *et al.,* 2000:200). As can be seen from the above, content analysis is a very systematic process (Cooper & Schindler, 2001:429; Rubin *et al.*, 2000:200).

Content analysis was conducted in this study to determine the amount of coverage of scientific topics in articles in the media over a period of three months. The reasoning behind the decision to conduct content analysis was twofold: First, the researcher wanted to determine whether scientific articles are considered a priority by the media and secondly, to make a comparison with Van Rooyen's study conducted in 2002. Van Rooyen (2002:21) invited researchers to repeat the study she conducted in 2002 at regular intervals. Therefore, based on the invitation by Van Rooyen, Phase 2 of this study was conducted, using the same criteria, method and time frame as Van Rooyen. Comparisons of results of the two studies are provided in Chapter 8.

As mentioned earlier, content analysis is a multistage process. Following below is a description of each of the steps of this process:

- **Select the titles**

In this study 16 South African publications were monitored over a period of three months. South African regional and national print media titles, which reflect a geographical and cultural diversity in its target markets and which are produced by South African-based companies, were selected.

- **Dates to sample**

The dates sampled in this study covered a period of three months, from 1 March to 31 May 2004.

- **Units of analysis and sampling frame**

A description of unit of analysis was provided in Phase 1 of this study. For the purposes of Phase 2 the unit of analysis is scientific articles in the South African media.

- **Categories**

The various categories identified are mutually exclusive and exhaustive, and they are discussed under the data analysis. The sampling frame and sampling technique for Phase 2 of this study are discussed next.

- **Sampling frame**

According to Cooper and Schindler (2001:170) the sampling frame is closely related to the population. It is the list of elements from which the sample is actually drawn. The South African media were divided into three groups, namely daily newspapers such as *The Pretoria News, Die Beeld, Die Burger, Die Volksblad, Sowetan, This Day, The Mercury* and *Cape Argus;* weekly national newspapers

such as the *Mail & Guardian, Sunday Times* and *Rapport,* and five family magazines, including *Financial Mail, Finansies & Tegniek, De Kat, Huisgenoot* and *You.*

The daily newspapers were selected to cover all regions in South Africa, while the weekly newspapers were selected because they have the largest reader numbers. The family magazines were selected because they focus on the whole family, are not gender orientated and do not focus on a specific target audience, such as agriculture or wildlife. *Financial Mail* and its Afrikaans equivalent, *Finansies & Tegniek* were selected since they were included in the Van Rooyen study and because they might cover articles on mathematics and new technological developments. Mathematicians and information technologists are, however, not their specific target markets.

- **Sampling technique**

As described in Phase 1 of the study, the choice of a specific sampling technique is guided by the research problem and objectives. For Phase 2 of the study, the research problem is to determine the coverage of scientific topics in articles in the media. The sampling technique for the content analysis is consistent with Babbie and Mouton's (2001:387) statement that in content analysis any of the conventional sampling techniques are applicable. Babbie and Mouton (2001:287), as well as Cooper and Schindler (2001:192) describe a non-probability sample that conforms to certain criteria or categories that are theoretically defined as purposive sampling. In Phase 2 of the study judgement sampling is used, since the sample selected conforms to some criterion. The criteria that articles had to meet for inclusion in this study are the following:

- Articles that dealt either directly with an issue of science and technology or with a broad issue for which scientists could provide perspective. Any report or feature that had science as a main theme, focus or subject, was included.
- No articles that dealt exclusively with political or social issues linked to a science topic were included. An example of this was the Nevirapine debate. The South African government's role in the provision of this medication to pregnant HIV-positive women via clinics and state hospitals was widely debated. Although the benefits and risks of the medication came into play, the debate was, to a large extent, of a political nature. Articles about Nevirapine were only included if they revolved around the scientific development of the medication (Van Rooyen, 2002:9).
- Articles concerned with the political debate over the legislation of any medication were excluded, except if it dealt prominently with the benefits or risks of the specific medication.

The data collection for Phase 2 of the study is discussed next.

6.5.7 Phase 2: Data collection

Data was collected over a three-month period from 1 March to 31 May 2004. The researcher monitored the selected articles in the publications on a weekly basis and compiled a Microsoft Excel spreadsheet. The articles were collected according to the broad spectrum of science categories described earlier and 80 articles qualified.

The overall amount of coverage of science and technology was calculated by counting the overall amount of editorial space in the selection of publications and dividing it by the 80 science and technology articles. Average values for editorial space were calculated by using the average number of articles that appeared in six randomly selected issues and multiplying this value by the number of publications studied. Letters from readers or promotional features were not included.

6.5.8 Phase 2: Data analysis

Information on the variables pertaining to the articles was captured in a Microsoft Excel file and a statistician extracted the data from this file to do the analysis by means of the SAS software package.

The first step in content analysis is to decide which units to use to analyse the articles. Different types of units can be used. *Syntactical* units are words, phrases, sentences or sections. Examples of *referential* units are objects, events or persons referred to in the text. *Propositional* units include questions, answers, statements, assertions or arguments, while *thematic* units are repeating patterns of ideas or issues (Cooper & Schindler, 2001:429). Various syntactical units were identified, after which these units were used to identify specific categories:

- Articles were classified according to the source. A distinction was made between articles written by local journalists and articles that were obtained from wire services or foreign publications.
- Articles were further classified as either 'new discoveries' or 'feature' articles. New discoveries were identified by their current value and the use of the inverted pyramid structure, where the 'who, what, where, when, why and how' aspects of the science article received prominence. Feature articles were recognised by their longer format that contained a more detailed analysis of the issue.
- The evaluative tone of the articles was measured by classifying the articles as either 'negative' (a discourse of criticism) or 'positive' (a discourse of promise). The articles were monitored for

their evaluative tone, since according to Bauer *et al.* (1995:32) it is often claimed that media coverage of science and technology is "unduly negative".

- The use of visuals and infographics was also studied. Visuals indicated an article that had been complemented by one or more photographs or graphic images. The term 'infographics' refers to any article accompanied by visual displays with accompanying labels and text. Articles that include visuals or infographics normally receive more prominence. Infographics are also known to be an extremely effective way to package information in an easy-to-read format (Van Rooyen, 2002:10).
- According to Bauer *et al.* (1995:23), "... a specific claim which relates to the general charge of negativism within media science coverage concerns the discourse of risks and benefits". Since the discourse of risks and benefits only applied to science and technology as such, the discourse of articles in this study was monitored according to a categorical scale. These categories included 'only benefits', 'only risks', 'equal proportions of benefits and risks' and 'not in question'. The last category was included because many articles did not deal with the benefits or risks of science *per se*.
- The prominence of articles was measured by the position of the article in the publication. A simple coding system was used that differed for newspapers and magazines respectively. Articles that appeared earlier in a publication was considered to have greater prominence than articles that appeared in the latter part of a publication. The same coding system that Van Rooyen (2002:11) applied was used again: A (p. 1-3); B (p. 4-6); C (p. 7-9); D (p. 10+) and E (supplements) for newspapers, whereas the coding system for magazines was as follows: A (p. 1-10); B (p. 11-30); C (p. 31-50) and D (p. 50+). For this study the length of the articles was not taken into consideration.
- The weight of the scientific fields covered by the articles was measured according to 19 sub-categories. These sub-categories were defined by using various sources to compile the definitions (Van Rooyen, 2002:11). However, Van Rooyen had *Botany* as a separate category, but in this study it is accommodated under the sub-category of *Environment and Ecology*. A new sub-category, namely *Sport Science* is included in this study. The categories are listed below:
  - **Anthropology and Archaeology:** The study of man's nature and development. The study of the buried remains of ancient times
  - **Astronomy:** The science of space, the sun, the moon and the stars
  - **Behaviour:** Facts and theories about human behaviour

- **Biomedicine:** The science of clinical medicine, biochemistry and basic biology (including botany)
- **Cell and Molecular Biology:** The science of the microcosmos, including living cells and their properties
- **Chemistry:** The study of the elements, compounds and the behaviour of substances
- **Computers:** The science and technological developments pertaining to computers
- **Earth Science:** A broad term, which includes geology (the study of rocks and minerals)
- **Environment and Ecology:** The study of the relation of plants, animals and people to one another and their surroundings
- **Food Science and Nutrition:** The science of food and how the body utilises food (including agriculture)
- **HIV/Aids:** Scientific developments in the understanding of HIV/Aids and the combating of the disease
- **Mathematics:** The science of numbers
- **Paleobiology:** The study of fossils
- **Physics:** The study of matter and natural forces
- **Pseudo science:** Assertions that are incapable of being tested or refuted by evidence (e.g. for the purpose of this study astrology columns were excluded)
- **Sport:** The science of the human body pertaining to enhancing quality in sport
- **Technology:** The study of scientific and industrial methods and their use in society and industry
- **Zoology:** The study of animals
- **General science:** Science discussed as a general topic

6.5.9 Coding in content analysis

Content analysis is essentially a coding operation. Communications – oral, written or other – are coded or classified according to some conceptual framework (Babbie & Mouton, 2001:388). The theoretical framework, on which the content analysis is based, was discussed in Chapter 5.

According to Babbie and Mouton (2001:390), the coding operation must be amenable to data processing when evaluating content analysis data quantitatively. Firstly, the end product of the coding must be numerical. If the frequency of certain words, phrases, or other manifest content is counted, then the coding will necessarily be numerical. Even if the researcher is coding latent content on the basis of overall judgements, it is necessary to represent the coding decision numerically. Secondly,

record keeping must distinguish clearly between the units of analysis and the units of observation, especially if the two are different. The initial coding must relate to the units of observation. If science writers are the units of analysis, for example, and the researcher wishes to characterise them through a content analysis of their scientific articles, the primary records would represent scientific articles. The researcher may then combine the scoring of individual scientific articles to characterise each science writer. Thirdly, when counting, it would normally be important to record the base from which the counting is done. The issue of observational base is most easily resolved if every observation is coded in terms of one of the attributes that make up a variable (Babbie & Mouton, 2001:390). See Appendix 7 that demonstrates the coding used in Phase 2 of this study.

6.5.10 Strengths and weaknesses of content analysis

According to Babbie and Mouton (2001:390) the economy in terms of both time and money is probably the greatest advantage of content analysis. Furthermore, there is no requirement for a large research staff and no special equipment is required. Also important is that content analysis permits the researcher to study processes occurring over long periods of time. Finally, content analysis has the advantage of being unobtrusive, in other words, the content analyst seldom has any effect on the subject being studied.

Content analysis unfortunately has disadvantages as well. For instance, it is limited to the examination of recorded communications. Such communications may be oral, written or graphic, but they must be recorded in some fashion to permit analysis. Another problem that is common to content analysis is the valid measure of values in the coding. On the other hand, the concreteness of materials studied in the content analysis strengthens the likelihood of reliability. The researcher can always code and recode and even recode again to make certain that the coding is consistent (Babbie & Mouton, 2001:393).

6.5.11 Phase 2: Reporting statistics

It is typical for content analysis to report tables of results. Simple descriptive statistics tell much about the results by means of these data (Reinard, 2001:172). In Phase 2 of the study, descriptive statistics (as discussed in Phase 1) are provided in table format, as well as in pie and bar charts. In addition to the frequency distributions, mean and standard deviation, cross-tabulation is also used in Phase 2 of the study.

Cross-tabulation is the technique used to analyse results by groups, categories, or classes (Zikmund, 2000:439). The purpose of cross-tabulation is to allow the inspection of differences between groups and to make comparisons. According to Cooper and Schindler (2001:554), nominal measures are used to assess the strength of relationships in cross-classification tables. They are often used together with chi-square or may be used separately.

Lastly, the results are compared with the Van Rooyen study conducted in 2002.

6.6 CONCLUSION

This chapter introduces the empirical component of the study. It has provided a description of the research strategy, design, methods and techniques used to obtain results. The two phases of the research methodology were discussed, namely Phase 1 in which the survey method was used and Phase 2 where content analysis applied. Both methods were linked to the concepts and constructs as described in Chapters 2 to 5.

Subsequently the development of the questionnaire as the measurement instrument for Phase 1 of the study, as well as the procedure for the content analysis in Phase 2 of the study was described, followed by a discussion of the statistical procedures and data analysis for both Phase 1 and Phase 2.

The findings pertaining to Phase 1 and Phase 2 of this study are reported in Chapter 7 and they are interpreted in Chapter 8.

Chapter 7

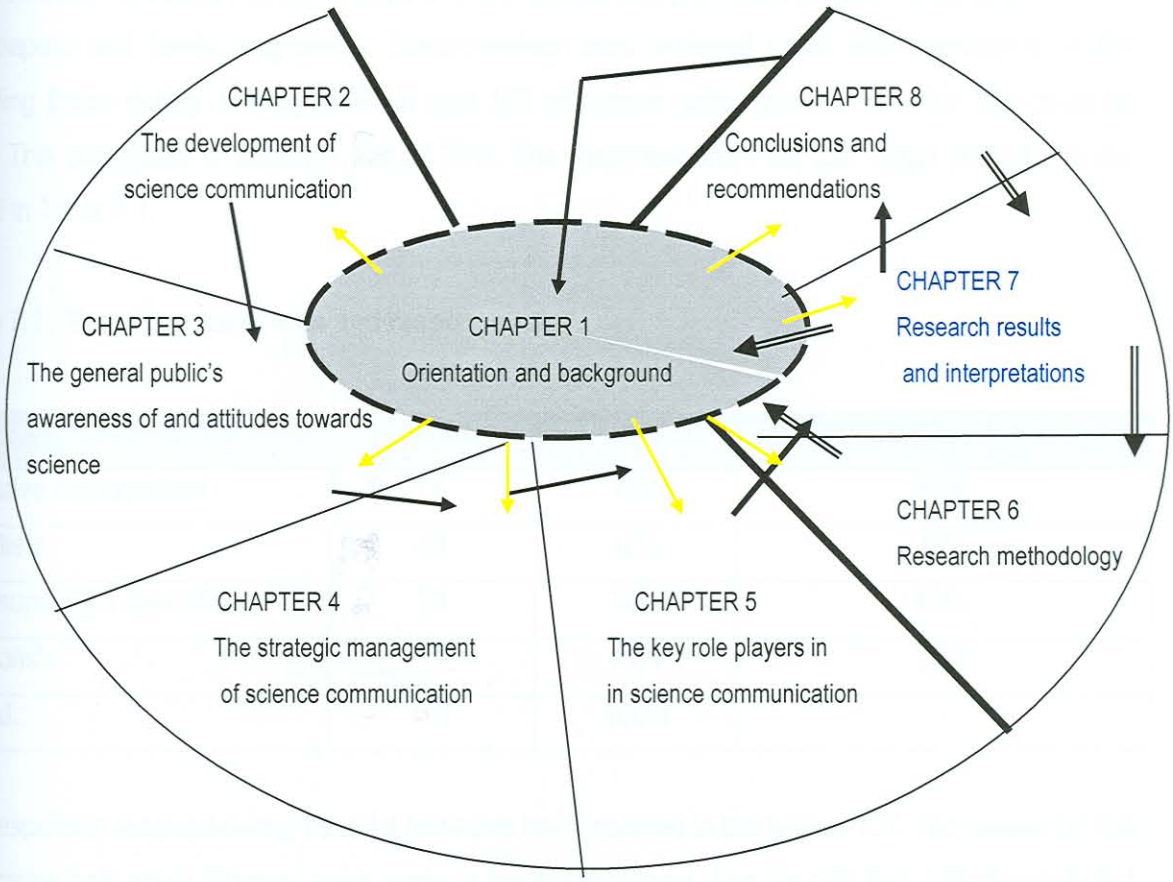
Research results and interpretations

7.1 INTRODUCTION

In this chapter the empirical evidence and interpretation of the research findings constitute the focal point. The results of this study are presented in two phases: Phase 1, the survey and Phase 2, the content analysis. Each result is structured according to the research objectives described in Chapter 1. The presentation of evidence and the simultaneous interpretation in relation to each objective are based on the theory as described in Chapters 2 to 5.

As mentioned earlier, there is a constant interplay between the empirical component of the study and Chapter 1. The specific interaction of Chapter 7 with the rest of the chapters is illustrated in Figure 7.1.

Figure 7.1: Chapter 7 in relation to other components of the empirical phase



Before the results and interpretation of Phase 1 and Phase 2 are discussed, general background information on each phase is provided to put the research results into context.

7.2 PHASE 1: GENERAL BACKGROUND

Every research study is characterised by a certain research strategy and design, as well as by specific research methods and techniques. As a result, every research project is set within a particular context. It is important to take this context into consideration when obtained data is analysed and results are interpreted. This study, for example, is exploratory in nature, but uses a quantitative research strategy because the purpose is not to generalise the findings to the population, but to gather a wide range of opinions on science communication. It is information about the sampling frame and response rate, as well as about the profile of the units of analysis and data sources that help to build the context of the study.

The sampling frame for this study consisted of members of executive management, scientists and communication specialists at universities and technikons, and journalists at daily newspapers, weekly newspapers and family magazines. Questionnaires were e-mailed to all 389 participants in the sampling frame during January 2004. In total 102 responses were received, of which 101 could be used. This constitutes a response rate of 26%. The responses from the four target populations are tabled in Table 7.1.

Table 7.1: Sampling realisation and response rate

SAMPLING FRAME	NUMBER OF RESPONSES		RESPONSE RATE
Executive management	17	17%	37%
Scientists	43	42%	18%
Communication specialists	30	30%	53%
Journalists	11	11%	22%
TOTAL	101	100%	-

The responses received during the pilot test have been included in the total of 102. The reason for this is because only minor changes were made to the questionnaire after the pilot test. Unfortunately two respondents submitted blank questionnaires. The two respondents were contacted immediately, but only one respondent was prepared to complete the questionnaire again.

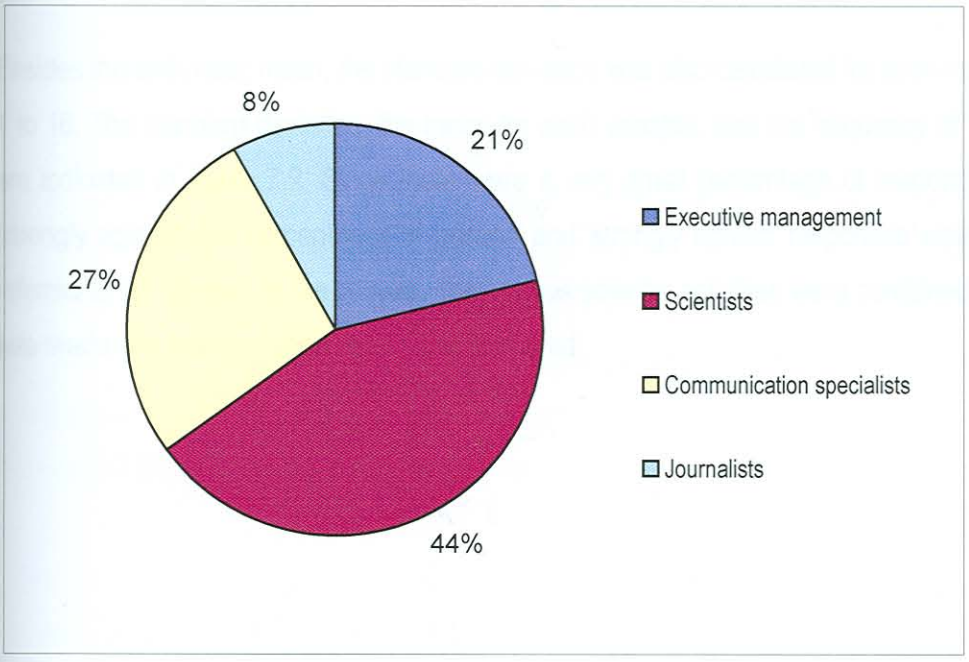
7.3 PHASE 1: RESULTS FOR RESEARCH OBJECTIVES 1 TO 5

In the parahraphs that follow, the analysis of the results is discussed with reference to one measure of location (the mean) and one measure of spread (standard deviation). These measures are the most commonly used descriptive statistical measures.

7.3.1 Objective 1: The importance of science communication

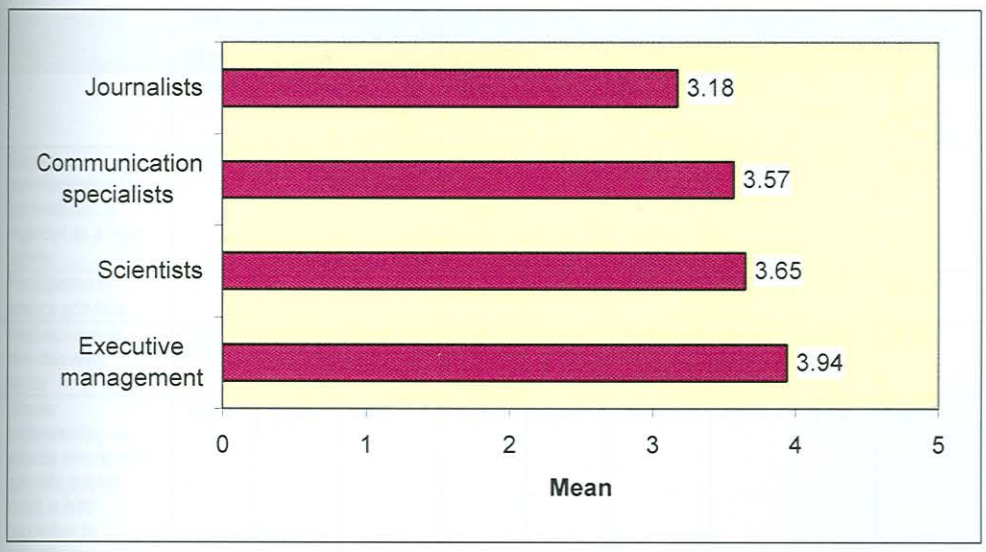
In Questions 1-7 of the questionnaire intended for the members of the executive management, Questions 1-16 of the version for scientists and communication specialists and Questions 1-6 of the journalists' questionnaire, respondents were asked to indicate how important they considered science communication. They were also asked to indicate which of their institutions participate in science communication activities such as science festivals and exhibitions, and which of the institutions had a science centre. The 5-point Likert scale was used in this study and respondents were requested to indicate the extent of their disagreement or agreement with the statements in the questionnaire. Question 1 was asked to all four groups of respondents and respondents were requested to indicate how important or unimportant science communication was regarded at their institution. Figure 7.2 illustrates the respondents' measure of agreement with the statement concerning the importance of variables.

Figure 7.2: Key role players' agreement on the importance of science communication



The mean values for each variable (key role player) with regard to the importance of science communication are depicted in Figure 7.3.

Figure 7.3: Importance of science communication to key role players



As displayed in Figure 7.3, executive management had the highest mean, followed by scientists, then communication specialists and lastly journalists. However, the means for all the variables indicate that respondents were more or less equally agreed and disagreed on the statement that science communication was regarded as a priority. This is consistent with the theoretical perspectives surrounding science communication (Nelkin, 1995:15).

Besides the arithmetic mean, the standard deviation was also calculated for each variable in Questions 1 to 16. The standard deviation, the mean for each variable, and the frequency of 'agreed' responses are indicated in Table 7.2. Since there were a very small percentage of respondents that indicated 'strongly agreed', the percentages of 'agreed' and 'strongly agreed' responses were added up and are referred to as 'agreed' in the results. The various science activities were combined when the analysis was made and the combined values are displayed.

Table 7.2: Importance of science communication for key role players: mean, standard deviation and frequency

STATEMENT	EXECUTIVE MANAGEMENT			SCIENTISTS			COMMUNICATION SPECIALISTS			JOURNALISTS		
	Mean	Std dev	% Agreed of n=17	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30	Mean	Std dev	% Agreed of n=11
Science communication at our institution is regarded as *a high priority.*	3.9	0.97	76%	3.7	1.13	63%	3.6	1.22	63%	3.2	1.47	45%
Participation in science activities	-	-	-	3.2	1.0	44%	3.4	1.2	59%	-	-	-
Institution has its own *discovery centre*	2.8	1.68	41%	2.8	1.03	23%	3.2	1.41	46%	-	-	-
Greater understanding of science among non-scientific publics result in *less opposition* to scientific research.	4.2	0.56	94%	4.3	0.77	86%	4.3	0.64	90%	4.0	1.0	73%
Scientists have a *duty* to communicate their research to the general public.	4.12	0.93	77%	4.4	0.76	93%	4.5	0.57	97%	4.7	0.47	100%
New science discoveries should be communicated to all stakeholders.	4.2	0.88	82%	4.1	0.79	79%	4.5	0.51	100%	4.9	0.30	100%
Social implications of science prohibit scientists to communicate their research.	2.3	0.86	35%	2.5	1.37	33%	3.0	1.22	37%	2.54	0.93	45%
Ethical implications of science prohibit scientists to communicate their research.	2.6	1.23	24%	2.4	1.27	23%	2.9	1.15	27%	2.45	1.13	36%

The standard deviation values for all the variables are relatively low. This indicates that respondents did not differ much in their opinions about the importance of science communication. Less than 50% of South African universities and technikons have their own science discovery centre, as can be seen from the frequency results in Table 7.2. Although respondents indicated that they regard science communication as a priority, participation in science communication activities indicates the opposite, since only 44% of scientists and 59% of communication specialists participate in science activities.

The variables with the highest standard deviation warrant further discussion. The means and standard deviation of all variables for universities and technikons were calculated to determine whether there was a difference of opinion between university and technikon respondents. (Journalists were obviously not included, since they were not located at either universities or technikons.) The results are displayed in Table 7.3.

Table 7.3: **Responses per HEI: mean and standard deviation**

RESPONDENTS	UNIVERSITY MEAN	TECHNIKON MEAN	UNIVERSITY STANDARD DEVIATION	TECHNIKON STANDARD DEVIATION
Executive management	3.9	4.0	1.10	0.82
Scientists	3.6	4.0	1.14	-*
Communication specialists	**3.94**	**3.0**	**1.21**	**1.04**

* There was only 1 scientist respondent from technikons.

Bold indicates a significant difference in mean values between variables.

The mean and standard deviation of the communication specialists' variable indicate a significant difference of opinion regarding the importance of science communication. This difference of opinion may be result from the fact that technikons' main focus is not research, as is the case with universities.

In conclusion, it can be said that there are definite indications of the importance with which science communication is regarded by key role players. However, there are also definite indications of the fact that science communication is not regarded as a high priority, indicating that the results are not as positive.

7.3.2 Objective 2: The relationship between key role players in science communication

Questions 8-14 in the questionnaire for executive management, Questions 17-21 for scientists, Questions 17-24 for communication specialists and Questions 7-9 for journalists addressed the relationships among key role players in science communication. Both the mean and the standard deviation were calculated and are displayed in Table 7.4, together with the percentage of variables that agreed with the statements.

Table 7.4: Agreement in terms of relationship amongst key role players: mean, standard deviation and frequency

Summarised statement	Executive management			Scientists			Communication specialists			Journalists		
	Mean	Std dev	% Agreed of n=17	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30	Mean	Std dev	% Agreed of n=11
Executive management has *trust* in communication specialists.	3.4	0.87	41%	-	-	-	3.3	1.15	53%	-	-	-
Executive management *empower* communication specialists.	3.5	0.80	59%	-	-	-	3.0	1.22	36%	-	-	-
There is a relationship of trust between *executive management* and *communication specialists*	3.6	0.94	65%	-	-	-	3.3	1.15	57%	-	-	-
There is a relationship of trust between *executive management* and *scientists*	**4.1**	0.83	82%	**3.0**	1.16	40%	-	-	-	-	-	-
There is a relationship of trust between *executive management* and *journalists*	3.0	0.87	31%	-	-	-	-	-	-	2.8	0.99	64%
There is a relationship of trust between *communication specialists* and *scientists*	-	-	-	2.9	1.02	33%	3.3	1.15	53%	-	-	-
There is a relationship of trust between *communication specialists* and *journalists*	-	-	-	-	-	-	3.7	0.92	67%	3.3	1.10	54%
There is a relationship of trust between *scientists* and *journalists*	-	-	-	**3.2**	0.78	33%	-	-	-	**2.5**	0.69	9%
A relationship of trust between the key role players will add to a *greater understanding* of science by stakeholders	**3.9**	0.81	71%	4.1	0.68	81%	**4.4**	0.56	97%	-	-	-
A relationship of trust between the key role players will result in *stakeholders trusting information received from the institution*	4.1	0.43	94%	4.2	0.70	86%	4.3	0.70	87%	-	-	-

Bold indicates a significant difference in mean values between the variables.

As can be seen from Table 7.4, the executive management and communication specialists do not agree that there is a relationship of trust and empowerment among them in respect of science

communication. Only 41% of executive management agreed/strongly agreed to have trust in communication specialists, compared to the 53% of communication specialists who were of the opinion that executive management trusted them. On the other hand, 59% of executive management agreed/strongly agreed that they do in fact empower communication specialists, compared to the low percentage of 36% of communication specialists who did not consider themselves empowered by executive management. In the next tables the various frequency distributions for this construct are displayed.

Table 7.5: Trust in the executive management and communication specialists relationship

DESCRIPTOR	SCALE VALUE	EXECUTIVE MANAGEMENT		COMMUNICATION SPECIALISTS	
		FREQUENCY	%	FREQUENCY	%
Strongly disagree	1	6	35.2	3	10
	2	3	17.7	4	13.3
	3	1	5.9	7	23.4
	4	3	17.7	13	43.3
Strongly agree	5	4	23.5	3	10
TOTAL	-	n=17	100	n=30	100

Table 7.6: Empowerment in the relationship between executive management and communication specialists

DESCRIPTOR	SCALE VALUE	EXECUTIVE MANAGEMENT		COMMUNICATION SPECIALISTS	
		FREQUENCY	%	FREQUENCY	%
Strongly disagree	1	-	-	5	16.7
	2	2	11.8	3	10
	3	8	47.1	11	36.6
	4	5	29.3	8	26.7
Strongly agree	5	2	11.8	3	10
TOTAL	-	n=17	100	n=30	100

Of interest is the high number of both executive management members and communication specialists who are not certain that communication specialists are empowered by executive management. Furthermore, as illustrated in Table 7.4, there are differences of opinion among variables regarding the trust between them, as well as about the understanding of science by stakeholders. Table 7.7 displays the means and standard deviations.

Table 7.7: Variations of opinion between key role players' trust and understanding

SUMMARISED STATEMENT	EXECUTIVE MANAGEMENT		SCIENTISTS		COMMUNICATION SPECIALISTS		JOURNALISTS	
	Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
There is a relationship of trust between *executive management* and *scientists*	4.1	**0.83**	3.0	**1.16**	-	-	-	-
There is a relationship of trust between *scientists* and *journalists*	-	-	3.2	**0.78**	-	-	2.5	**0.69**
A relationship of trust between the key role players will add to a *greater understanding of science by stakeholders*	3.9	**0.81**	4.1	0.68	4.4	**0.56**	-	-

It is obvious from Table 7.7 that respondents differed significantly in their opinions regarding a relationship of trust among them. They further differed in opinion about whether a relationship of trust would add to a greater understanding of science by stakeholders. These results imply that there are not yet trust relationships among the key role players in science communication in South Africa.

Questions 25 and 26 in the communication specialists' questionnaire and Questions 10 and 11 in the journalists' questionnaire address the perception of participants of the importance of news received from communication specialists. Table 7.8 and Table 7.9 display the frequency distribution of perceptions of the importance of science news and sceptism of information received from communication specialists, respectively. Another question, Question 36 in the communication specialists' questionnaire, of which the results are displayed in Table 7.9, also addresses the importance of two-way flow of communication. As can be seen from the results in Table 7.10, only 57% of communication specialists agreed that they have to ensure that their institutions follow a two-way flow of information, compared to executive management's 77% of agreement.

Table 7.8: Perception of Importance of science news: communication specialists versus journalists

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		JOURNALISTS	
		FREQUENCY	%	FREQUENCY	%
Strongly disagree	1	3	10	1	9.1
	2	15	50	7	63.6
	3	5	16.7	1	9.1
	4	4	13.3	2	18.2
Strongly agree	5	3	10	-	-
TOTAL	-	n=30	100	n=11	100

Table 7.9: Sceptisism of information received: communication specialists versus journalists

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		JOURNALISTS	
		FREQUENCY	%	FREQUENCY	%
Strongly disagree	1	3	10	3	27.3
	2	15	50	4	36.3
	3	4	13.3	-	-
	4	7	23.4	3	27.3
Strongly agree	5	1	3.3	1	9.1
TOTAL	-	n=30	100	n=11	100

Although a small percentage of both communication specialists and journalists did not agree that journalists are sceptical about information received from communication specialists, the fact remains that very few scientific articles do appear in the media.

7.3.3 Objective 3: The role of communication specialists in science communication

Questions 15-31 in the questionnaire for executive management, Questions 24-27 for scientists and Questions 28-44 for communication specialists address the role of communication specialists and whether they are regarded as strategists, managers or technicians. These questions are derived from

Concept 2. Questions 28-30, 37 and 40-44 attempted to determine the extent to which communication specialists assume the roles of strategist, manager or technician (compare Steyn & Puth, 2000:20-21, as well as Chapter 4 for a discussion of the different roles) and they also include questions about trust and empowerment. Very briefly to summarise the discussion in Chapter 4, the role of *strategist* is determining the consequences of an institution's strategies and policies on its relationships with various stakeholders. Information gathered serves as input in an institution's strategic decision-making process. The role of the *manager* involves the development of a corporate communication strategy (deciding what should be communicated to stakeholders), while the *technician* role involves the implementation of communication plans and campaigns.

Table 7.10: Agreement on the role of communication specialists: mean, standard deviation and percentage

SUMMARISED STATEMENT	EXECUTIVE MANAGEMENT			SCIENTISTS			COMMUNICATION SPECIALISTS		
	Mean	Std dev	% Agreed of n=17	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30
The current role of communication specialists is to:									
... make a *strategic* contribution regarding communication with stakeholders	4.4	0.62	94%	-	-	-	4.0	1.07	80%
... *influence* key strategic decisions of executive management in communicating science to stakeholders	3.5	0.80	59%	-	-	-	3.1	1.11	36%
... *get the institution's name into the media*, specifically regarding science performed at the institution.	4.3	0.77	94%	-	-	-	3.9	0.84	77%
... use their *journalistic skills* to establish what the media will consider newsworthy about the institution	4.3	0.47	100%	- -		-	4.1	0.97	83%
... *facilitate mutual understanding* between the key role players of science communication	**3.9**	0.70	82%	**3.1**	1.12	33%	3.4	0.89	57%
... ensure that scientists communicate their *science* through communication specialists to stakeholders	3.5	0.71	88%	3.05	1.19	33%	3.4	1.00	53%
... assist scientists in communicating their *research* to stakeholders of HEI	3.8	1.07	77%	3.3	1.23	52%	3.2	1.19	53%
... play a vital role in ensuring *a relationship of trust* develops between key role players of science communication	3.6	1.06	71%	3.1	1.13	35%	3.7	1.15	60%
... ensure that our institution follows a *two-way flow of information* in communicating with stakeholders, to enable stakeholders to provide feedback where applicable	3.9	1.0	77%	-	-	-	3.5	1.01	57%

SUMMARISED STATEMENT	EXECUTIVE MANAGEMENT			SCIENTISTS			COMMUNICATION SPECIALISTS		
	Mean	Std dev	% Agreed of n=17	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30
... not only *obtain favourable publicity*, but also to *prevent unfavourable publicity* in the media	3.9	1.0	59%	-	-	-	4.1	0.80	80%
... inform executive management *of societal values/norms* so that they can adjust institutional decisions/strategies accordingly	3.8	1.03	77%	-	-	-	3.2	1.26	27%
... do surveys before starting a science communication plan to find out how *well management and our stakeholders understand each other*	3.7	1.05	65%	-	-	-	2.9	1.12	27%
... disseminate *accurate* information, but not to volunteer *unfavourable* information	3.6	0.80	59%	-	-	-	3.8	0.90	73%
... *influence executive management decisions* to ensure that this institution is regarded by society as being 'trustworthy'	4.1	1.0	82%	-	-	-	3.6	1.13	57%
... *develop mutual understanding* between our management and the stakeholders that the institution affects	4.1	0.97	82%	-	-	-	3.8	0.92	73%
... be a *neutral disseminator* of information rather than a mediator that connects management to stakeholders	3.1	1.09	35%	-	-	-	3.2	1.01	47%
... act as an *advocate* for key internal publics by explaining their views to executive management	3.6	0.80	53%	-	-	-	3.1		40%

Bold indicates a significant difference in mean values between variables.

The mean and standard deviation calculated for the variables do not reveal much about the opinions of the respondents. However, when studying the frequencies, it seems that respondents had different opinions regarding the role of communication specialists. Only one significant discrepancy occurred between the responses of executive management and scientists regarding the role of communication specialists in facilitating mutual understanding between the key role players in science communication. This discrepancy is displayed in bold in Table 7.10.

The frequency of agreement in Table 7.11 also indicates that communication specialists do not agree as much as executive management about the communication specialists' role. Table 7.11 highlights this difference of opinion. Furthermore, Table 7.12 illustrates the discrepancy in opinion amongst

executive management, scientists and communication specialists regarding communication specialists' role to ensure that scientists communicate their science via communication specialists to stakeholders.

Table 7.11: The role of communication specialists as strategists, managers or technicians

DESCRIPTOR	SCALE VALUE	EXECUTIVE MANAGEMENT		COMMUNICATION SPECIALISTS	
		FREQUENCY	%	FREQUENCY	%
Strongly disagree	1	-	-	3	10
	2	2	11.8	4	13.3
	3	5	29.4	12	40
	4	9	52.9	8	26.7
Strongly agree	5	1	5.9	3	10
TOTAL	-	n=17	100	n=30	100

An interesting finding involves the large number (almost half) of the communication specialists who are uncertain that they influence key strategic decisions of executive management in communicating science to stakeholders. There may be two reasons for this uncertainty: firstly, it may be that communication specialists are of the opinion that when they voice their opinion, executive management do not listen; or secondly, it may be that science communication activities are not discussed on a strategic level at HEI.

Table 7.12: The facilitator's role of communication specialists

DESCRIPTOR	SCALE VALUE	EXECUTIVE MANAGEMENT		SCIENTISTS		COMMUNICATION SPECIALISTS	
		FREQ	%	FREQ	%	FREQ	%
Strongly disagree	1	-	-	4	9.5	1	3.3
	2	2	11.8	10	23.8	5	16.7
	3	4	23.5	15	33.4	8	26.7
	4	11	64.7	8	19.0	13	43.3
Strongly agree	5	-	-	6	14.3	3	10
TOTAL	-	n=17	100	n=43	100	n=30	100

The results above display some interesting facts. Firstly, the members of executive management are largely in agreement (88%) that communication specialists have to ensure that scientists communicate their research through communication specialists to stakeholders, while a very low percentage of scientists (33%) and only 53% of communication specialists agree with the statement. Another 33% of scientists are to a large extent uncertain about the facilitator's role of communication specialists.

Two other statements about which executive management and communication specialists differ significantly in terms of their agreement with them refer to the strategic component of communication specialists' tasks. The results are discussed next.

Statement :"... inform executive management of societal values/norms so that they can adjust institutional decisions/strategies accordingly".
Only 27% of the communication specialists agreed/strongly agreed, compared to 77% of executive management who agreed/strongly agreed with the statement.

Statement: "... do surveys before starting a science communication plan to find out how well management and our stakeholders understand one another".
Again, executive management (65%) agreed/strongly agreed, compared to a low percentage of 27% of communication specialists who agreed/strongly agreed with this statement. The reason might be that the members of the executive management are under the impression that communication specialists conduct surveys, which might not be the case, or that communication specialists do not work out a science communication plan at all.

The results of the responses by both executive management and communication specialists indicate that communication specialists are not seen as strategists, but rather as managers or to a smaller extent technicians, since many of the tasks they have to perform fall in the category and description of managers in communication management.

The entire executive management group (100%) agreed that communication specialists have to use their journalistic skills to establish what the media will consider newsworthy about their institutions. This places a huge responsibility on communication specialists to have journalistic skills and/or training in order to be able to provide the correct information and press releases to the media.

7.3.4 Objective 4: Training in science communication

Questions 28-30 in the questionnaire for scientists, Questions 45-50 for communication specialists and Questions 13-14 for journalists are derived from Concept 1, that is, the extent to which training is offered to scientists, communication specialists and journalists to enable them to write science articles. Again, the results on the mean, standard deviation and percentage of frequency of agreement are depicted in table format.

Table 7.13: Training provided in science communication: mean, standard deviation and frequency

SUMMARISED STATEMENT	SCIENTISTS			COMMUNICATION SPECIALISTS			JOURNALISTS		
	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30	Mean	Std dev	% Agreed of n=11
Journalists in South Africa received basic training in science writing to be able to write science articles.	-	-	-	-	-	-	1.8	1.17	9%
Scientists at our institution are equipped to communicate science directly to stakeholders.	2.9	1.12	40%	-	-	-	-	-	-
Communication specialists at our institution received basic training in science writing to communicate science.	-	-	-	2.2	1.10	14%	-	-	-
A *basic course* in science writing is not a requirement to communicate science to various stakeholders.	2.9	1.15	36%	2.2	0.87	7%	2.9	1.14	46%
Our institution offers a course in *science journalism.*	-	-	-	1.9	1.11	7%	-	-	-
Scientists prefer to *communicate directly* with journalists.	**3.7**	0.87	57%	**3.1**	1.09	33%	**2.4**	1.04	19%
Scientists provide enough information to communication specialists to distribute to the media.	2.8	0.96	26%	2.8	1.28	33%	-	-	-
Journalists have a good knowledge about science when interviewing scientists.	2.0	0.94	10%	2.1	0.78	3%	2.1	0.94	9%

Bold indicates a significant difference in mean scores between the respondent groups.

The lack of training resulted in the assumption that journalists are not trained well enough to interview scientists and that scientists do not understand what journalists require. The results further indicate

that scientists should provide communication specialists with more information to enable the latter to communicate science information to stakeholders, including the general public and the media.

The standard deviation values for almost all the variables are relatively low. This implies that respondents did not differ much in their opinions regarding training. However, the mean, standard deviation and percentage of frequency of agreement reflect a significant difference of opinion between the responses of scientists and communication specialists, as well as between those of scientists and journalists regarding the statement that scientists prefer to communicate directly with journalists. The fact that scientists prefer to communicate directly with journalists, indicates that the relationship of trust and mutual understanding between scientists and communication specialists has not been established yet. Scientists might still fear that their research would not be conveyed correctly to the stakeholders by communication specialists.

Similarly, the variables 'universities' and 'technikons' yielded relatively low means and relatively high standard deviations. These values are derived from the communication specialists' responses. The results of the differences mentioned above are displayed in the next table.

Table 7.14: Training provided in science communication: responses per HEI

STATEMENT	UNIVERSITY		TECHNIKON	
	MEAN	STD DEV	MEAN	STD DEV
A basic course in science writing is not a requirement to communicate science to various stakeholders.	1.8	1.89	2.5	2.58
Our institution offers a course in science journalism.	2.2	2.28	1.4	1.41

The significant difference of opinion between universities and technikons regarding the requirement of a basic course in science writing can be due to the fact that technikons do not have many scientists and therefore science communication is not an important task assigned to communication specialists. The significant difference of opinion about the statement that institutions offer a course in science journalism reflects the strong possibility that a science journalism course is not offered at many institutions.

The majority of communication specialists and journalists agreed that they did not receive any science writing training. The frequency distribution of the data values for training received is indicated in Table 7.15.

Table 7.15: Training received by communication specialists and journalists

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		JOURNALISTS	
		FREQ	%	FREQ	%
Strongly disagree	1	7	23.3	5	45.5
	2	13	43.3	5	45.5
	3	8	26.7	-	-
	4	2	6.7	-	-
Strongly agree	5	-	-	1	9.0
TOTAL	-	n=30	100	n=11	100

Table 7.15 indicates that only two communication specialists and only one journalist were trained in science writing. The eight communication specialists' uncertainty about receiving basic science writing training was probably due to the fact that they interpreted the question wrongly. Perhaps there were more than one or two communication specialists at the institution and the respondent was uncertain whether the other communication specialists received such training or not. Another explanation for their uncertainty could be that the respondents attended a short course in science writing (one or two days) and the respondent was uncertain whether that would apply to the specific statement.

In the following table the frequency distribution of results about science writing training are displayed.

Table 7.16: Science writing training: communication specialists versus journalists

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		CUMULATIVE PERCENTAGE	JOURNALISTS		CUMULATIVE PERCENTAGE
		FREQ	%	%	FREQ	%	%
Yes	1	4	13.8	13.8	1	9.1	9.1
No	2	25	86.2	100	10	90.9	100
Missing	-	1	-	-	-	100	-
TOTAL	-	n=30	100	-	n=11	100	-

The results of Table 7.16 again raise concern. Only 13.8% of the communication specialists received any science writing training, while the majority (86.2%) did not receive any training in science writing or science journalism. Furthermore, the results reflect that only one of the journalist respondents who

participated in the study had received science writing training or completed a course in science journalism. The fact that such a small percentage of communication specialists and journalists received training in respect of science writing indicates that there is indeed a lack of proper training in science writing in South Africa. Training in science communication writing is imperative for communication specialists and journalists to be able to convey the correct facts received from scientists to the general public. Without proper training, incorrect interpretations of what is meant by scientists can have detremendous effects, especially when research findings of scientists contain risks for human beings. Proper training in science communication is also important to ensure that a relationship of trust and mutual understanding amongst key role players in science communication is established.

7.3.5 Qualification and training of respondents

As described in the theoretical part of this study, training in science writing is vital. Only one journalist confirmed to have received science journalism training as was exhibit in Table 7.15. In the tables below, the qualifications of communication specialists for their current employment are displayed. The results pertaining to the academic qualifications of the communication specialists, as well as how related this qualification is to public relations, are displayed in Tables 7.17 and 7.18 respectively.

Table 7.17: Communication specialists' qualifications

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		CUMULATIVE PERCENTAGE
		FREQUENCY	%	%
Certificate	1	-	-	-
Diploma	2	7	23.3	23.3
B degree	3	5	16.7	40
Honours	4	12	40	80
Master's	5	6	20	100
Doctorate	6	-	-	-
TOTAL	-	**n=30**	**100**	-

The largest percentage of communication specialists had obtained an honours degree. None of the respondents had acquired a doctoral degree, which may be due to the fact that in most cases the maximum requirement for employment is a master's degree. Only 20% of the respondents were in possession of a master's degree.

Table 7.18: The relation of communication specialists' qualifications to public relations

DESCRIPTOR	SCALE VALUE	COMMUNICATION SPECIALISTS		CUMULATIVE PERCENTAGE
		FREQUENCY	%	%
Yes	1	17	56.7	56.7
No	2	13	43.3	100
TOTAL	-	n=30	100	-

The results about the relatedness of communication specialists' qualifications to public relations raise concern. Altogether 43.3% of the communication specialists at HEI had qualifications that are not related to public relations. A possible reason for this relatively high data value may be that communication specialists interpreted the question in a narrower sense, or that they probably have either a marketing or communications qualification, but did not relate those qualifications to public relations.

7.3.6 Objective 5: Coverage of scientific topics in the mass media

Questions 31-33 in the questionnaire intended for scientists, Questions 56-58 for communication specialists and Questions 17-21 for journalists addressed media contact, while Questions 51-57 for communication specialists and Questions 15, 16, 22 and 23 for journalists addressed the amount of coverage.

The mean values of the variables 'communication specialists' and 'journalists' indicate a significant difference of opinion about the contact communication specialists had with the media during the past year. The difference of opinion may result from the fact that communication specialists had contact with journalists, but such contact did not pertain to any science activity. Another reason might be that communication specialists perhaps had contact with the media on a regular basis, but that contact involved only one or two media representatives. Table 7.19 provides the mean, standard deviation and frequency percentage of agreement regarding media contact.

Table 7.19: Key role players' contact with the media: mean, standard deviation and frequency

SUMMARISED STATEMENT	EXECUTIVE MANAGEMENT			SCIENTISTS			COMMUNICATION SPECIALISTS			JOURNALISTS		
	Mean	Std dev	% Agreed of n=17	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30	Mean	Std dev	% Agreed of n=11
Journalists are *sceptical* of science information received from communication specialists.	-	-	-	-	-	-	2.6	1.07	26%	2.5	1.44	36%
Communication specialists/Scientists at our institution had contact with the media *more than three times* during last year.	-	-	-	4.1	1.03	40%	**4.5**	0.94	70%	**3.6**	0.67	55%

Bold indicates a significant difference in mean scores between the respondent groups.

Table 7.20 displays the values of the mean, standard deviation and frequency percentage of agreement for the variables 'scientists', 'communication specialists' and 'journalists' in terms of their opinions regarding coverage of science articles in the various media.

Table 7.20: Coverage of scientific articles in the mass media: mean, standard deviation and frequency

SUMMARISED STATEMENT	SCIENTISTS			COMMUNICATION SPECIALISTS			JOURNALISTS		
	Mean	Std dev	% Agreed of n=43	Mean	Std dev	% Agreed of n=30	Mean	Std dev	% Agreed of n=11
The general coverage of science in *national newspapers* is efficient.	-	-	-	1.9	0.96	3%	2.0	1.0	9%
The general coverage of science in *local newspapers* is efficient.	-	-	-	1.9	0.98	3%	2.0	1.0	9%
The general coverage of science in *magazines* is efficient.	-	-	-	2.3	1.17	17%	2.3	1.19	18%
The general coverage of science on *radio* is efficient.	-	-	-	2.2	1.0	13%	2.5	1.04	18%
The general coverage of science on *TV* is efficient.	-	-	-	2.7	1.18	30%	2.6	1.12	28%
Our institution is satisfied with the *amount of coverage* of science in the media.	-	-	-	2.3	0.83	7%	-	-	-
Scientific articles *do not sell* newspapers.	-	-	-	3.2	1.30	37%	3.4	1.36	45%
The media *sensationalises* science.	**3.8**	1.01	67%	**2.8**	1.15	27%	**2.7**	1.49	36%

Bold indicates a significant difference in mean scores between the respondent groups.

The standard deviation values for all variables are relatively low. Again this indicates that the respondents did not differ much in their opinions about the coverage of scientific articles in the mass media. However, regarding the statement that the mass media sensationalises science, there was a significant difference of opinion between the responses of scientists and communication specialists, as

well as between those of scientists and journalists. Scientists (67%) agreed/strongly agreed that the mass media sensationalises science, in contrast to low percentages of communication specialists (27%) and journalists (36%) who agreed/strongly agreed with the statement.

It seems from the results that communication specialists feel that scientific articles do not appear efficiently in the media. Even radio and television coverage of science is unefficient. It can be concluded that communication specialists are of the opinion that the coverage of science by the mass media in general is unefficient.

7.4 PHASE 2: RESULTS OF THE CONTENT ANALYSIS

7.4.1 Objective 6: Content analysis of scientific articles

In Phase 2 of this study 16 South African publications were monitored over a period of three months, from 1 March to 31 May 2004. South African regional and national print media titles that reflect a geographical and cultural diversity in its target markets and that are produced by South African-based companies were selected.

As was indicated in the discussion of the sampling frame of the study (Section 6.5.6) the printed media were divided into three groups, namely daily newspapers, including *The Pretoria News, Die Beeld, Die Burger, Die Volksblad, Sowetan, This Day, The Mercury* and *Cape Argus;* weekly national newspapers, including the *Mail & Guardian, Sunday Times* and *Rapport,* and five family magazines namely *Financial Mail, Finansies & Tegniek, De Kat, Huisgenoot* and *You.* Family magazines were selected because they focus on the whole family, are not gender orientated and do not focus on a specific target audience, such as agriculture or wildlife. *Financial Mail* and its Afrikaans equivalent, *Finansies & Tegniek* were selected, because they might cover articles on mathematics and new technological developments, although mathematicians and information technology do not constitute their specific target markets.

7.4.2 Results for Objective 6: content analysis of printed media articles

The results under every heading first provide an overall assessment across the different groups of publications (i.e. the daily and weekly newspapers and family magazines) to form an overall impression of the status of the South African media. Thereafter, the groups are divided to assess the situation within each group and finally the results are compared with the study of Van Rooyen conducted in 2002. Associations of importance are also discussed. (See Appendix 7 for the units that were analysed and the coding that was used for the analysis.)

7.4.2.1 Amount of coverage

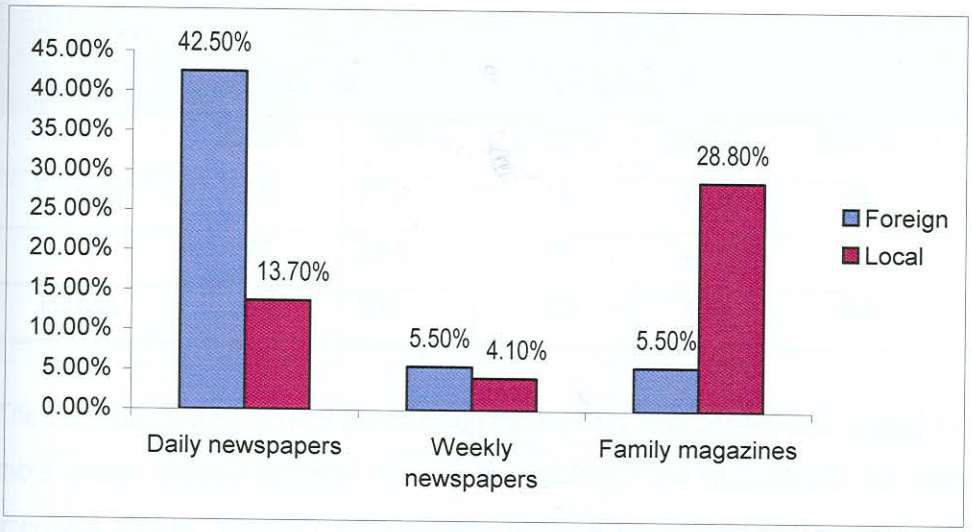
In the editorial content studied during the three months only 0.9% was dedicated to science and technology. The only daily newspaper that has a reserved space for science matters is *Die Burger*, which is focused on the Cape region. *Die Volksblad* has a section for agriculture on a regular basis, but once again, its target group is the Free State. Not one national paper has a column devoted to science or science-related issues. Furthermore, whenever any scientific news was published, it originated almost without exception from international sources, such as CNN and the BBC.

In the Van Rooyen study (2002:13), 1.8% of the editorial content studied dealt with science and science-related matters, compared to the 0.9% dedication to science and technology articles in the current study.

7.4.2.2 Local versus foreign sources

Although local journalists are responsible for the published articles, the larger percentage of sources was obtained from foreign publications, such as the *Daily Mail* and wire services including Reuters, Sapa and Associated Press. According to the data values, 53% of the science and technology coverage in this particular sample of the South African media quoted foreign sources, compared to 47% that came from local scientists and sources. The percentage of foreign and local sources per unit of analysis is illustrated in Figure 7.4.

Figure 7.4: Usage of foreign versus local news sources



The daily newspapers use by far more foreign than local sources – 42.5% out of 100%. Table 7.21 displays the frequency distribution of the variables 'foreign' and 'local'.

Table 7.21: Usage of foreign versus local news sources per print medium

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	Frequency	%	Frequency	%	Frequency	%
Foreign	31	75.6	4	57.1	4	16
Local	10	24.4	3	42.9	21	84
TOTAL	**n=41**	**100**	**n=7**	**100**	**n=25**	**100**

As indicated by the frequency distribution data values both daily and weekly newspapers use more foreign sources to obtain their science information, while the opposite is true for magazines, they use a far greater percentage of local sources than foreign sources.

In conclusion, although the comparison of foreign versus local sources may not be a reason for concern, the individual percentages of variables, especially the high use of foreign sources by daily newspapers, are causing concern. A comparison of the sources as shown by the results of this study and the results of the study previously conducted by Van Rooyen (2002:14) is displayed in Table 7.22.

Table 7.22: Frequency of usage of foreign versus local news sources: 2002 and 2004

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	2002 %	2004 %	2002 %	2004 %	2002 %	2004 %
Foreign	59	75.6	73	57.1	44	16
Local	41	24.4	27	42.9	56	84
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

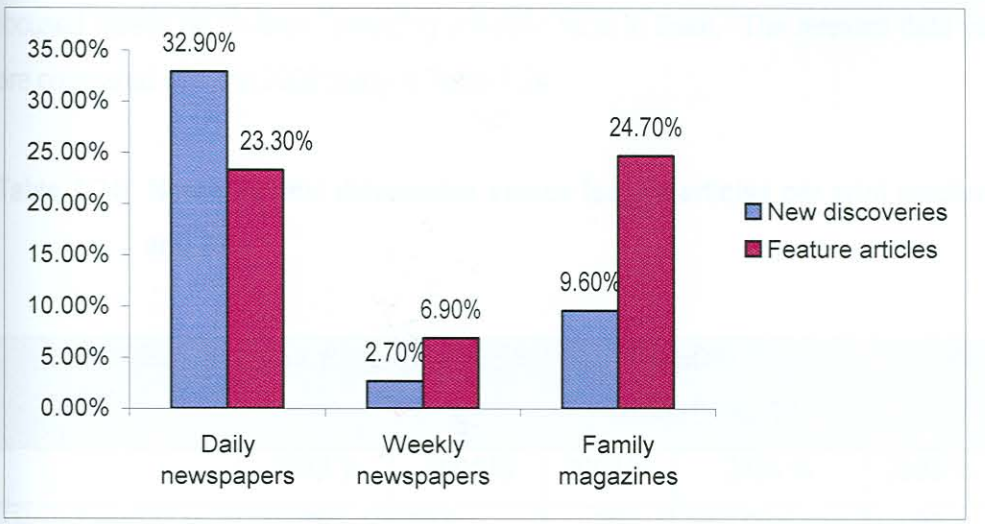
The data values indicate that the situation for the daily newspapers deteriorated from 2002 to 2004, as more foreign sources are used currently than in 2002. The situation with the weekly newspapers has improved slightly, although more or less equal usage is made of foreign and local sources. The

magazines look by far the best, as there was an increase in usage of local sources for science information from 56% to 84%.

7.4.2.3 Coverage according to 'new discoveries' and 'feature' articles

Scientific articles were classified as either 'new discoveries' of 'feature' articles. New discoveries were identified by their current value and the use of the 'who, what, when, where and how' aspects in the scientific article. Feature articles were recognised by their longer format containing a more detailed analysis of the issue. An example of a 'new discovery' article was the discovery that bird influenza can also attack human beings and the results could cause death. An example of a 'feature' article was the discovery of deserts on Mars similar to those found on earth. The sampled print media published almost an equal number of new discoveries (45%) and feature (55%) articles. These marginals are displayed below in Figure 7.5.

Figure 7.5: New discoveries versus feature articles on science



As one would have expected, the daily newspapers publish the largest number of new discovery articles, compared to the opposite situation with weekly newspapers and magazines. Daily newspapers focused more on hard news and due to the large number of newsworthy events, they have to limit each article to include only the bare facts. Magazines on the other hand, investigate the 'story behind the story', they have more space to publish longer articles and are able to include more visuals with their articles, therefore the largest number of feature articles was published by magazines. The table below displays the frequency distribution data values of these variables.

Table 7.23: New scientific discoveries versus feature articles per print medium category

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	Frequency	%	Frequency	%	Frequency	%
New discoveries	24	58.5	2	28.6	7	28
Feature articles	17	41.5	5	71.4	18	72
TOTAL	**n=41**	**100**	**n=7**	**100**	**n=25**	**100**

The daily newspapers published mostly new discoveries (58.5%) compared to 41.5% feature articles. An interesting fact is that the science coverage in the weekly newspapers was published mostly in feature format (71.4%). As can be expected, magazines also published more feature articles (72%). Articles in magazines are usually longer, in-depth type articles. In this study the *Huisgenoot* and *You* focused mostly on children, providing scientific facts to them. The relevant data values of this study are compared with the 2002 study in Table 7.24.

Table 7.24: New scientific discoveries versus feature articles per print medium category: 2002 and 2004

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	2002 %	2004 %	2002 %	2004 %	2002 %	2004 %
New discoveries	75	58.5	79	28.6	33	28
Feature articles	25	41.5	21	71.4	67	72
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

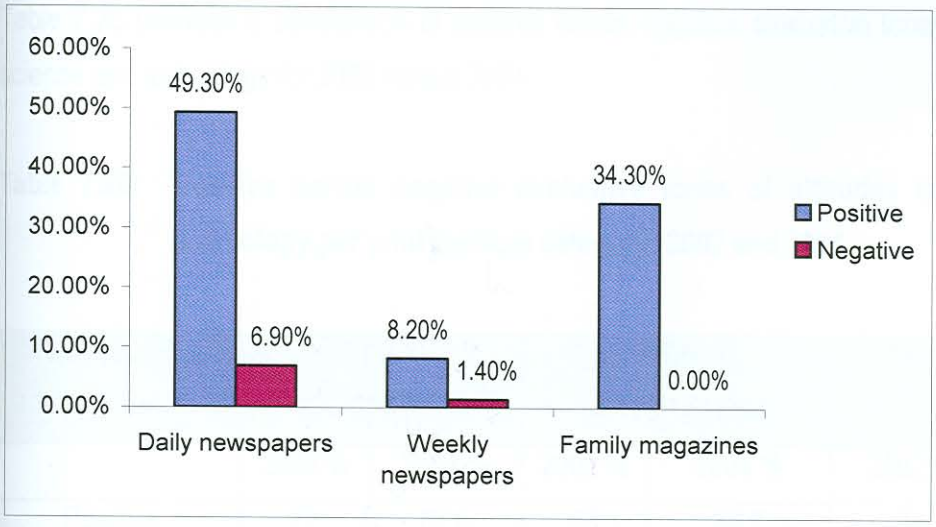
The data values of new discoveries between 2002 and 2004 decreased for the daily newspapers, weekly newspapers and magazines. Although it is positive to see more feature articles in the various printed media, the ideal would be that daily newspapers cover more new discoveries related to science and technology.

7.4.2.4 Evaluative tone of coverage

The evaluative tone of the scientific articles was monitored, since it is often claimed that media coverage of science and technology is "unduly negative" (Bauer *et al.*, 1995:32). An example of an "unduly negative" article is an article that was published critising scientists for using mice in their experiments in biochemisty. Scientists claim they only use a small number of mice (15 for the complete experiment), but the media critised them for using the animals at all.

In this study, the data values provide evidence that the South African media has a positive attitude towards science and technology. Overall, the evaluative tone of the coverage was more positive (92%) than negative (8%) in the sample of publications. These results are illustrated in Figure 7.6.

Figure 7.6: Evaluative tone of coverage in scientific articles



The low marginal of 8.2% of negative articles that appeared overall during the three-month period in the printed media made it evident that the printed media has a positive attitude towards science and technology. In Table 7.25 the individual frequency distribution of the data values of the variables is demonstrated.

Table 7.25: Positive versus negative evaluative tones of attitudes towards science and technology per print medium category

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	Frequency	%	Frequency	%	Frequency	%
Positive	36	87.8	6	85.7	25	100
Negative	5	12.2	1	14.3	0	0
TOTAL	**n=41**	**100**	**n=7**	**100**	**n=25**	**100**

The daily newspapers published 87.8% positive articles; the weekly papers 85.7% and the magazines did not have one article with a negative attitude towards science and technology (i.e. 100% positive). Table 7.26 provides a comparison of positive versus negative evaluative tones of attitudes towards science and technology for 2002 versus 2004.

Table 7.26: Positive versus negative evaluative tones of attitudes towards science and technology per print medium category: 2002 and 2004

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	2002 %	2004 %	2002 %	2004 %	2002 %	2004 %
Positive	71	87.8	63	85.7	78	100
Negative	29	12.2	37	14.3	22	0
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

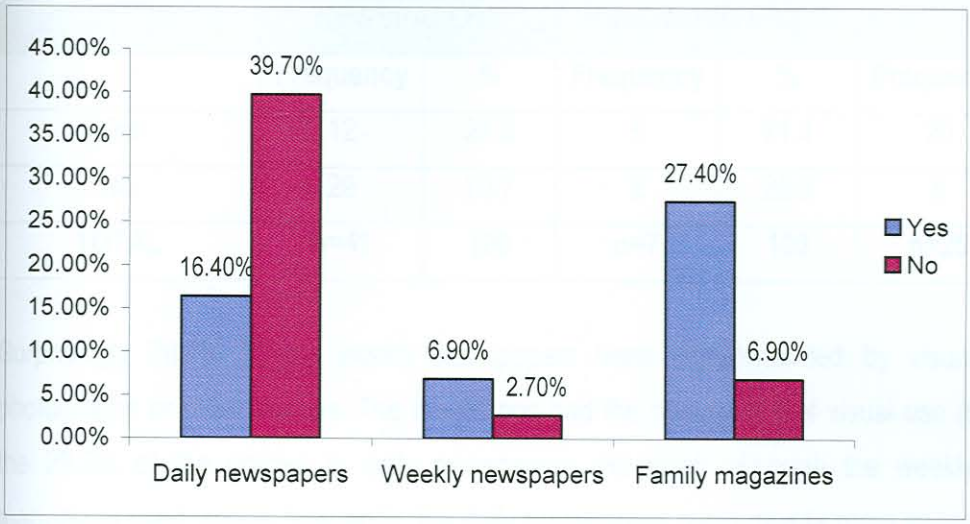
The daily newspapers, weekly newspapers and magazines covered more positive articles in 2004 than in 2002. The reason for this may be found in the awareness campaigns conducted by the government of South Africa to enhance the understanding of science communication in South Africa.

7.4.2.5 Use of visuals and infographics

The classification of 'visuals' was awarded to any article that was accompanied by one or more photographs or graphic images. The term 'infographics' applied to any article accompanied by 'informative graphics' – visual displays with accompanying labels and text. In this study, only 27% of

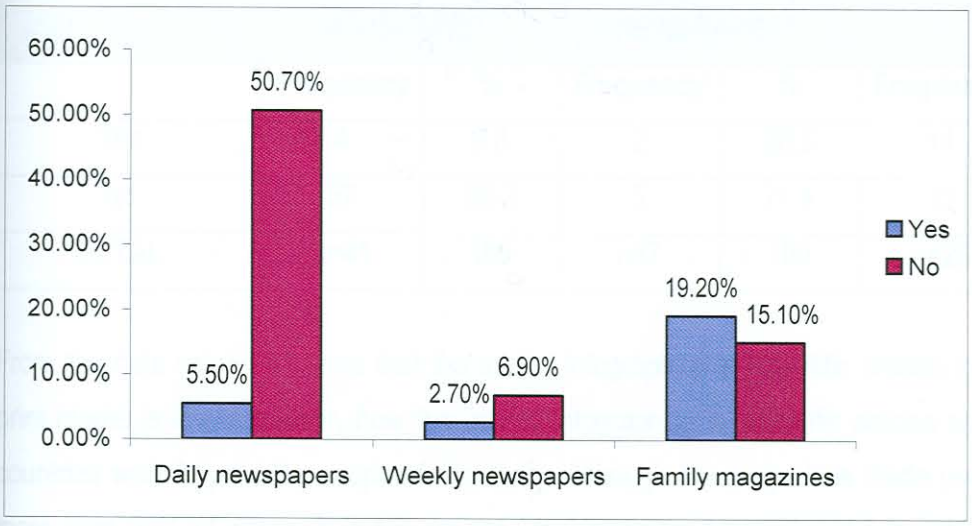
the studied articles were complemented by infographics, while 51% were accompanied by visuals. These results in this regard are illustrated in the next two figures.

Figure 7.7: Use of visuals with scientific articles



The percentage of use of visuals in both daily and weekly newspapers is rather low. Even magazines did not publish as many photographs as one would have expected.

Figure 7.8: Use of infographics with scientific articles



Overall, the use of infographics with science articles is extremely low for all three publications. Tables 7.27 and 7.28 display the frequency distribution of data values for visuals and infographics respectively.

Table 7.27: Usage of visuals in scientific articles per print medium category

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	Frequency	%	Frequency	%	Frequency	%
Yes	12	29.3	5	71.4	20	80
No	29	70.7	2	28.6	5	20
TOTAL	**n=41**	**100**	**n=7**	**100**	**n=25**	**100**

Surprisingly 70.7% in the weekly newspapers were complemented by visuals in the form of photographs or other images. The magazines had the best record of visual use (80%), compared to the 29.3% of the articles in daily newspapers. However, although the weekly newspapers and magazines used visuals frequently, the daily newspapers could devote more space to photographs or images with their articles.

Table 7.28: Usage of infographics in scientific articles per print medium category

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	Frequency	%	Frequency	%	Frequency	%
Yes	4	9.8	2	28.6	14	56
No	37	90.2	5	71.4	11	44
TOTAL	**n=41**	**100**	**n=7**	**100**	**n=25**	**100**

From the data values it seems that the use of infographics in scientific articles in the South African print media is low. However, how the use of infographics in scientific articles compares with other countries were beyond the scope of this study. Although the magazines made use of infographics in more than 50% of cases, it is still not the ideal situation. More use of infographics may appeal to readers, since infographics offer information colourfully and easy to read, but further research is required to determine the value of infographics to readers.

Table 7.29: Comparison of usage of visuals per print medium category: 2002 and 2004

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	2002 %	2004 %	2002 %	2004 %	2002 %	2004 %
Yes	40	29.3	28	71.4	81	80
No	60	70.7	72	28.6	19	20
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

The comparison of this study with the study conducted in 2002 clearly provides evidence of the decrease in usage of visuals or images in scientific articles by daily newspapers. Surprisingly, the opposite occurred with the weekly newspapers, where the situation has been completely reversed, while the use of visuals in magazines stayed almost exactly the same as in 2002.

Table 7.30: Comparison of usage of infographics per print medium category: 2002 and 2004

SOURCES	DAILY NEWSPAPERS		WEEKLY NEWSPAPERS		FAMILY MAGAZINES	
	2002 %	2004 %	2002 %	2004 %	2002 %	2004 %
Yes	9	9.8	5	28.6	4	56
No	91	90.2	95	71.4	96	44
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

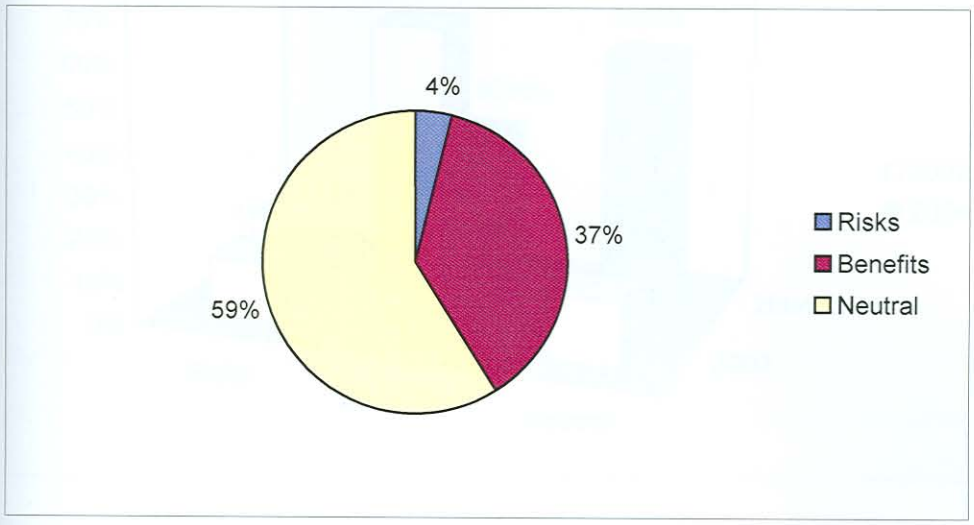
The data values displayed in Table 7.30 imply the same usage of infographics for daily newspapers in both studies. However, the use of infographics in the weekly newspapers and especially in the magazines has increased significantly since 2002. This change can perhaps be attributed to the weekly newspapers and magazines realising that colour, and specifically photographs, catch readers' attention. People are constantly in a hurry, and reading an infographic saves readers' time. The use of infographics may even increase the circulation of the print media due to the reasons explained above.

7.4.2.6 Discourse of benefits and risks

The largest proportion of articles (59%) did not indicate directly the benefits and/or risks pertaining to science and technology, while 37% seemed to promote the benefits of science and technology. There

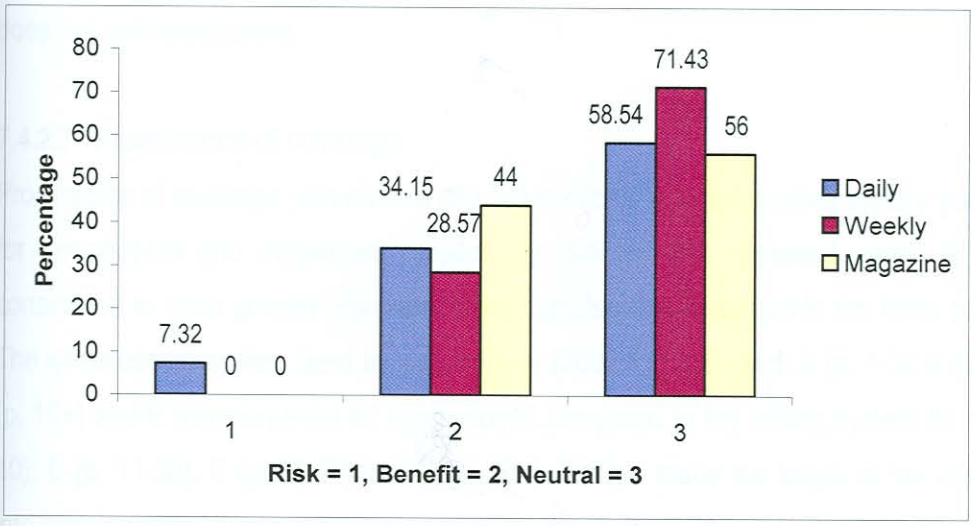
were no articles that equally supported the benefits and risks of science. The marginals of the three publications are demonstrated in Figure 7.9 below.

Figure 7.9: Marginal of Risks, Benefits and Neutral scientific articles in the total publications



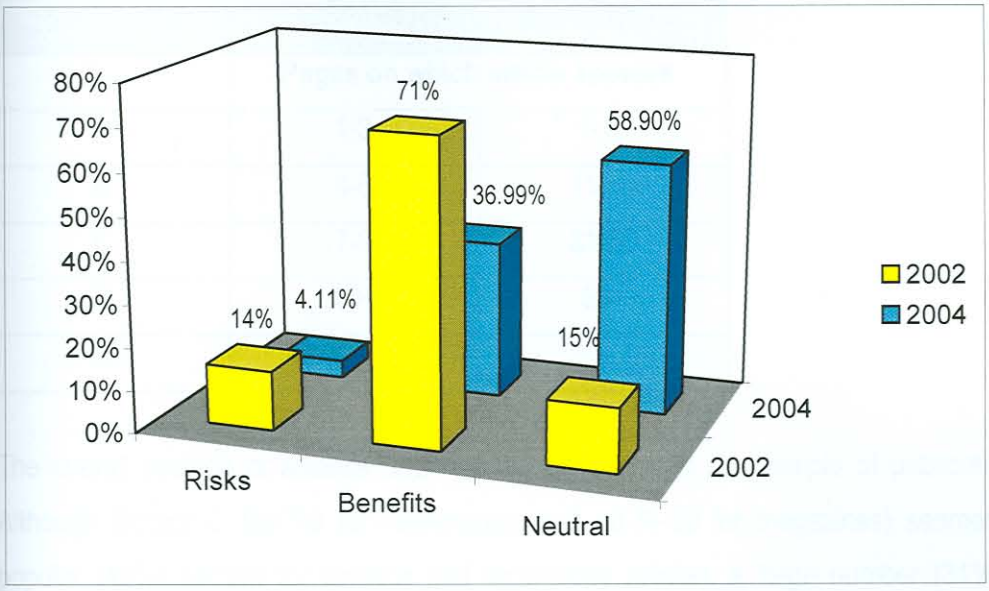
The daily and weekly newspapers, as well as the magazines all reflected the positive discourse trend in the coverage of science and technology. However, for all three publications the data values indicate that the articles appeared to be neutral. This finding is illustrated in Figure 7.10.

Figure 7.10: Discourse of benefits and risks



In the comparison of the current study with the 2002 study, the data values of articles pertaining to science risk or benefit appeared to be more positive, as is illustrated in Figure 7.11.

Figure 7.11: Comparison of Risks, Benefits and Neutral articles: 2002 and 2004



An interesting fact is that the articles about the risks of science and technology decreased from 14% to 4.11%. However, neutral articles increased, while articles about the benefits of science and technology also decreased. One of the reasons for this trend may be that the media are not prepared to report on the risks of science and technology and rather prefer to report by means of neutral articles. The fact that articles about the benefits of science and technology decreased, may be blamed on scientists not providing enough information for publication, or may result from the media's opinion that positive news does not sell newspapers.

7.4.2.7 Prominence of coverage

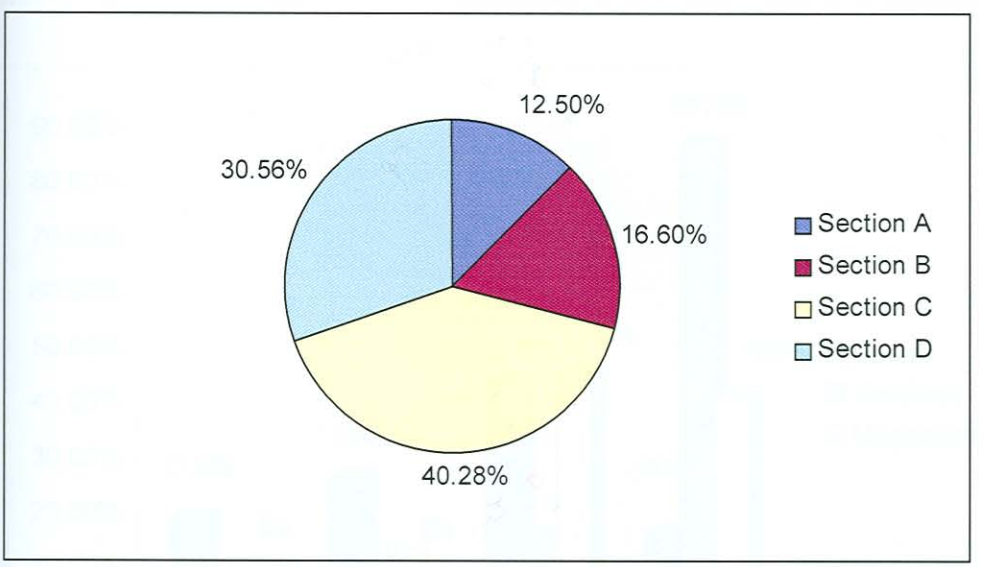
Prominence of coverage was divided into five sections. A simple coding system was used that differed for newspapers and magazines respectively. Articles that appeared earlier in a publication was considered to have greater prominence than articles that appeared in the latter part of a publication. The same coding system used by Van Rooyen (2002:11) was used: A (p. 1-3); B (p. 4-6); C (p. 7-9); D (p. 10+) and E (supplements) for newspapers, compared to the coding system for magazines: A (p. 1-10); B (p. 11-30); C (p. 31-50) and D (p. 50+). For this study the length of the articles was not taken into consideration. These sections are displayed in Table 7.31.

Table 7.31: Divisions of prominence of articles

SECTION	NEWSPAPERS	MAGAZINES
	Pages on which article appears	
A	1-3	1-10
B	4-6	11-30
C	7-9	31-50
D	10+	50+
E	Supplements	-

The overall position of science and technology articles in the sample of publications is conflicting. Although Section C (pp 7-9 for newspapers and pp 31-50 for magazines) seemed to be the most popular (40%) section for science and technology articles, a large number (31%) of articles also appeared in Section D (pp 10+ for newspapers and pp 50+ for magazines). A fair amount of coverage was, however, also positioned in Section B (pp 4-6 for newspapers and pp 11-30 for magazines). There were no scientific articles during the period of analysis that appeared in Section E. These results are illustrated in Figure 7.12.

Figure 7.12: Prominence of coverage in the total publications



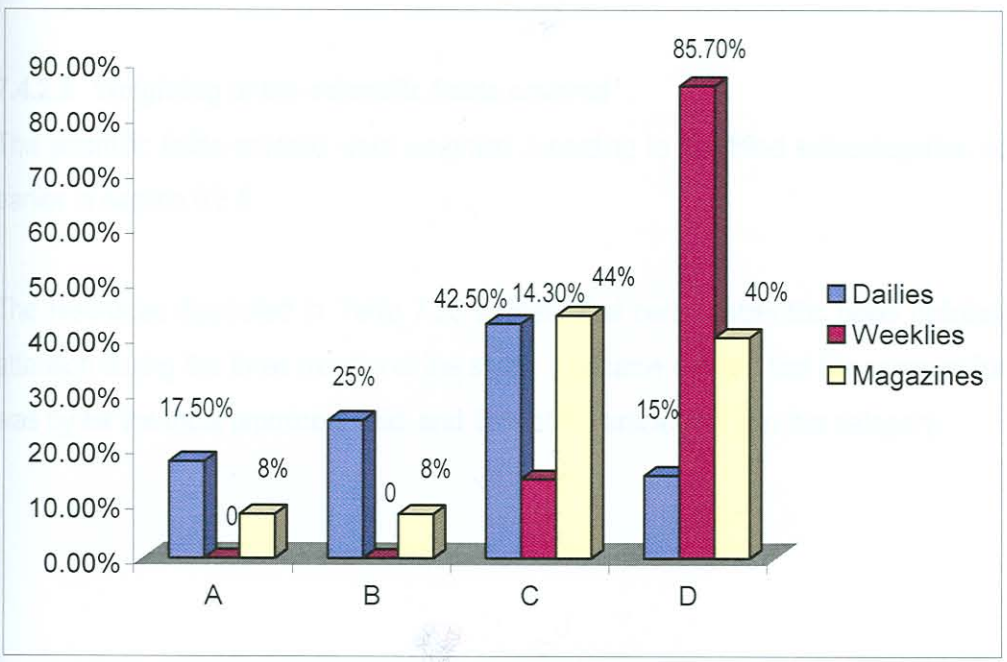
In Table 7.32 a breakdown of Sections A to E of the different print media is displayed.

Table 7.32: Prominence of science and technology articles

SECTION	DAILY NEWSPAPERS	WEEKLY NEWSPAPERS	MAGAZINES
A	17.5%	0	8%
B	25%	0	8%
C	42.5%	14.3%	44%
D	15%	85.7%	40%
E	-	-	-
TOTAL	**100%**	**100%**	**100%**

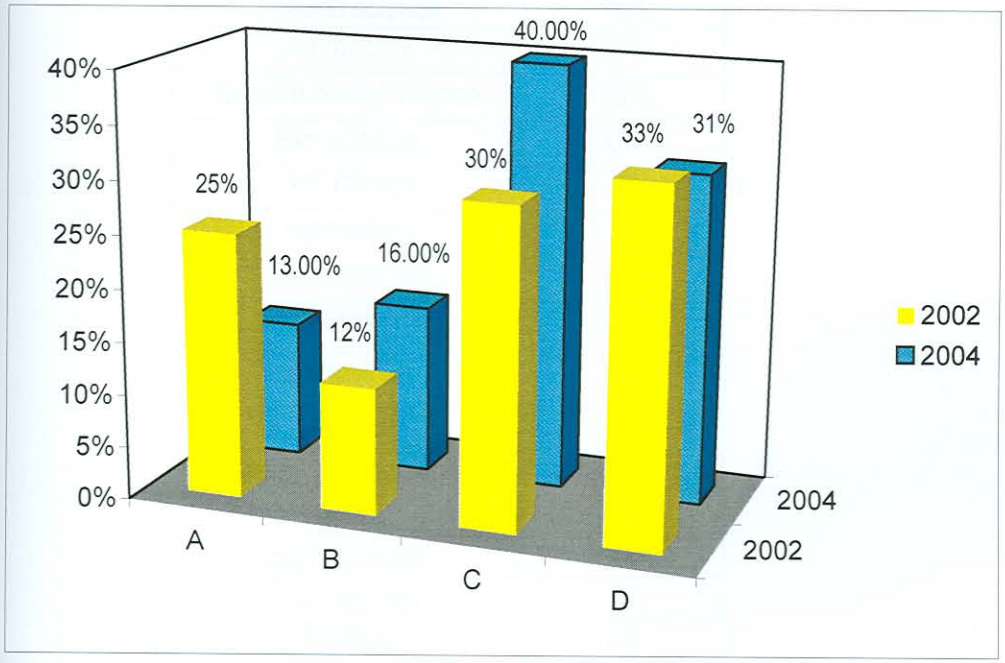
It was surprising to note that the weekly newspapers did not give prominence to science and technology articles, their highest coverage appears in Section D (85.7%), compared to the daily newspapers that had their highest appearance in Section C (42.5%). Magazines also have their highest appearance in Sections C (44%) and D (40%). Daily newspapers devoted the highest percentage to Section A (17.5%), which is on pages 1-3 in the newspaper. This may be because the weekly newspapers make use of more feature articles, and long and in-depth scientific articles would be more appropriate on later pages of the newspaper. The data values of Table 7.32 are demonstrated graphically in Figure 7.13.

Figure 7.13: Prominence of coverage of scientific articles



The comparison with 2002 is displayed in Figure 7.14 and discussed afterwards.

Figure 7.14: Comparison of prominence of coverage: 2002 and 2004



According to the data values of the studies of 2002 and 2004, science and technology articles certainly received less prominence in the front pages of publications in 2004. However, more articles appeared in Section C in 2004 than in 2002. The data values also revealed that the appearance of scientific articles in Sections B and D remained more or less the same.

7.4.2.8 Weighting of the scientific fields covered

The scientific fields covered were weighted according to identified sub-categories as was mentioned earlier in section 6.5.8.

The results as illustrated in Table 7.33 indicate that certain scientific fields definitely received more attention during the three months of the study. It became evident that the category for pseudo science was by far the most prominent field, and 18% of the articles fell into this category.

Table 7.33: Scientific fields covered in selected print media: 1 March to 31 May 2004

CATEGORY	PROPORTION
Pseudo science	18%
Astronomy	11%
Environmental science	10%
Biomedicine	8%
Cell biology	7%
Technology	6%
Sport science	6%
Food science	6%
Behaviour	6%
General	4%
Mathematical science	3%
HIV	3%
Earth science	3%
Anthropology	3%
Physics	2%
Zoology	1%
Paleobiology	1%
Computer science	1%
Chemistry	1%

The daily newspapers focused mostly on pseudo science (30%), followed by biomedicine (15%), while the weekly newspapers' strongest focus was on cell biology and food science (both 29%), followed by anthropology, HIV and pseudo science (all at 14%). In the case of the magazines the strongest focus fell on environmental science (24%), followed by astronomy (16%). It became evident that many of the articles that appeared in the newspapers were not based on solid scientific evidence or verified by scientists, but rather involved 'interesting to know' facts that the general public would like to read – therefore the high percentage of pseudo science coverage in articles. In the following table, the comparison between topics covered in 2002 and 2004 is displayed.

Table 7.34: Comparison of topics covered in selected print media: 2002 and 2004

Category	2002	2004
Anthropology	2%	3%
Astronomy	14%	11%
Behaviour	4%	6%
Biomedicine	18%	8%
Cell biology	5%	7%
Chemistry	1%	1%
Computer science	3%	1%
Earth science	1%	3%
Environmental science	9%	10%
Food science	6%	6%
HIV	12%	3%
Mathematical science	0.2%	3%
Paleobiology	1%	1%
Physics	0.4%	2%
Pseudo science	5%	18%
Sport science	-	6%
Technology	12%	6%
Zoology	5%	1%
General	1%	4%

In the Van Rooyen study (2002:18) it was explained that the high percentage of astronomy articles (14%), could perhaps be attributed to South African Mark Shuttleworth's travel to the international space station in April 2002. However, during the period of analysis for this study, other interesting astronomical discoveries were made, for example new deserts on Mars, which could not be linked up with some well-known person. Of concern is the fact that so many pseudo science articles were published. These articles might be of statistical value to readers, but they definitely do not enhance the benefits of science.

7.5 SIGNIFICANT DIFFERENCE IN THE USE OF INFOGRAPHICS

The statistical analysis of the data also yielded one significant difference. The Chi-square test was used to make categorical inferences about the relationship between the categorical variables studied. Only one significant difference occurred between the two categorical variables "yes" and "no" of making use of infographics in scientific articles. The data was skewed towards the daily newspapers and magazines.

This means that more magazines make use of infographics, compared with the large percentage of daily newspapers that do not make use of infographics in science and technology articles.

7.6 CONCLUSION

In this chapter the empirical results of the study were presented. First, there was a focus on the descriptive statistics of Phase 1 of the study. Results were presented, addressing the empirical component of Objectives 1 to 5 that were theoretically discussed in Chapters 2 to 5. Next, the empirical results of Objective 6 were discussed where the focus was on content analysis supported with descriptive statistics. Lastly, the results of the content analysis of this study were compared with the results of the study conducted by Van Rooyen in 2002.

In Chapter 8 detailed conclusions and recommendations based on the main results represented in this chapter will be discussed.

Chapter 8

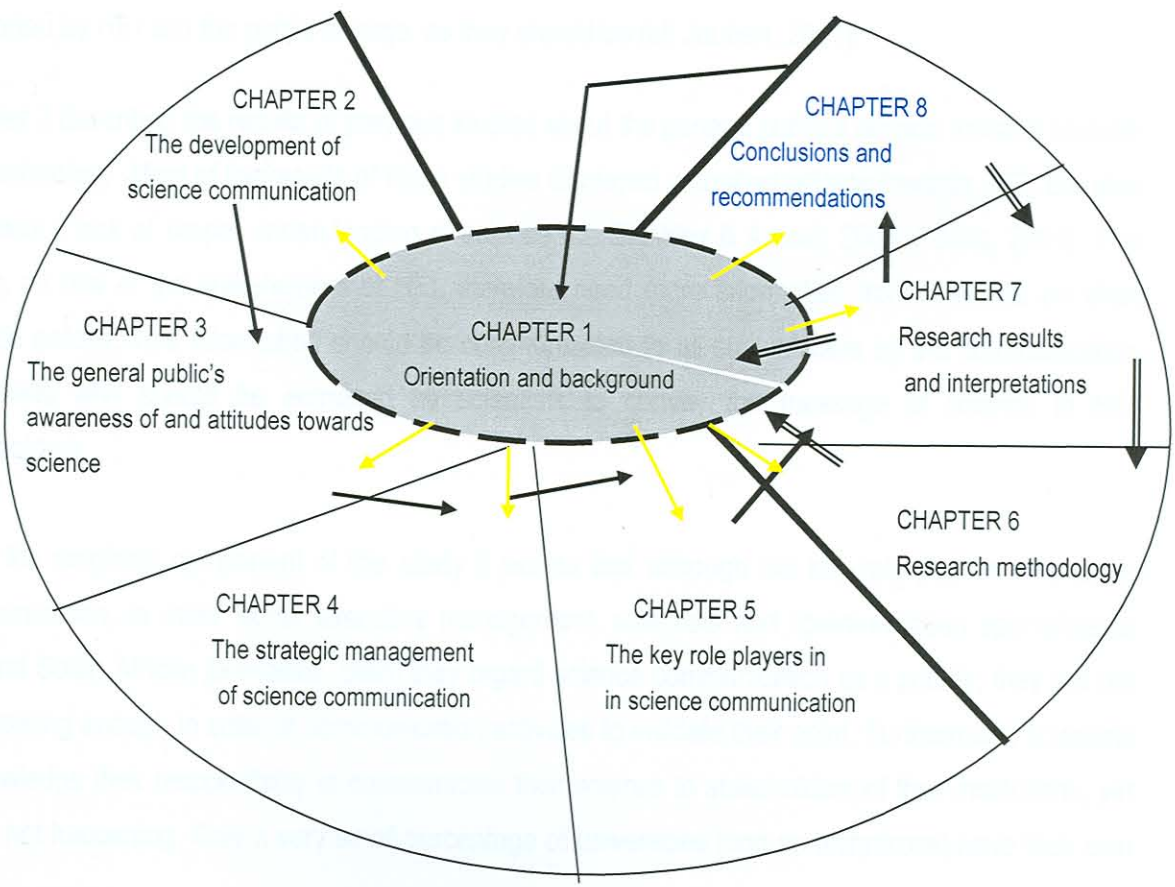
Conclusions and recommendations

8.1 INTRODUCTION

As stated by Rubin *et al.* (2000:12), "... the objective of academic research, whether by sociologists, political scientists, or anthropologists, is to try and find answers to theoretical questions within their respective fields". A very broad range of perspectives (theoretical and empirical) was covered in the preceding seven chapters. The main themes that emerged from the theoretical perspectives tested in Chapter 7 were described in Chapter 1 and formed the basis for this study. Chapter 8 is dedicated to a summary of the most important theoretical and empirical conclusions of Phase 1 and Phase 2, the identification of the limitations of the study, as well as recommendations for future research.

Following the visual representation used in all previous chapters, the interconnectedness of Chapters 1, 6, 7 and 8 is illustrated by Figure 8.1.

Figure 8.1: Chapter 8 in relation to other components of the empirical phase



8.2 CONCLUSIONS PER STATED OBJECTIVES

This study consisted of a theoretical as well as an empirical component. In the sections that follow, the main conclusions that were drawn from the theoretical and empirical component are summarised. As was explained previously, the general aim and objectives of the study were investigated by means of six objectives. Conclusions about these objectives are presented under each objective's heading. Phase 1, the survey research, is discussed under Objectives 1 to 5, while Phase 2, the content analysis, is discussed under Objective 6.

8.2.1 Objective 1: The importance of science communication

The current situation concerning science communication was described in Chapter 2, based on the information theory and the mass communication theory. It became evident that without information about the science that affects everyone's daily life, people would not even realise the risks and benefits of science or be interested in science. Information about science should be communicated to the masses, which in this particular study would be the stakeholders of HEI, including literate and illiterate, urban and rural and young and old people. HEI host the majority of South Africa's scientists and stakeholders of these institutions include the general public and the media. Although there are some initiatives around science communication activities, these activities are not optimised or supported by HEI and the public at large, as they should be (cf. Joubert, 2001).

Chapter 3 described the results of previous studies about the general public's attitude towards science and technology. Most of the results of these studies displayed a positive attitude towards SET, but also indicated a lack of proper understanding of science (cf. Blankley & Arnold, 2000; Pouris, 2001). The public, as one of the stakeholders of HEI, therefore need more information from scientists on what science entails. This information should be communicated to all stakeholders by the communication specialists who should be entrusted by scientists to convey the message of science to HEI stakeholders.

From the empirical component of this study it seems that although the key role players in science communication, in other words executive management, scientists and communication specialists at HEI and South African journalists, claim they regard science communication as a priority, they are not participating enough in science communication activities to validate their point. Furthermore, scientists acknowledge their responsibility to communicate their science to stakeholders of their institutions, yet this is not happening. Only a very small percentage of universities (and no technikons) have their own

science centre. The fact that technikons' main focus is not on scientific research, results in technikons not regarding science as important as would have been expected.

In Chapter 2 the information theory and mass communication theory were described and in Chapter 3 the stakeholder theory was discussed. The chapters respectively highlighted the importance of science information and the distribution thereof to stakeholders of HEI. However, the empirical results imply that science communication does not take place effectively yet. The information of science does not reach all stakeholders, including the literate and illiterate, urban and rural and young and old people of society effectively, but more research is required to determine the reasons why not all stakeholders receive the message of science successfully.

Overall, the results of the empirical component of Objective 1 indicate that more effort is required to enhance the awareness, importance and priority of science communication to ensure a sustainable environment. Further research is also required to include all other stakeholders (being the receivers of science communication) to determine their perception of the importance of science.

8.2.2 Objective 2: The relationship between key role players in science communication

Chapters 1 and 5 of the study, which refers to the relationships that should exist between key role players of science communication as well as with stakeholders, highlighted the importance of relationships at HEI. However, based on the theory in Chapters 1 and 5 it seems as if there is currently not a relationship of trust and empowerment among the key role players in science communication (cf. De Beer, 2001). The members of the executive managements at HEI should place enough trust in and empower communication specialists to participate in planning and implementation of science communication activities.

The theory furthermore reveals that scientists and journalists do not really understand one another in an interview situation, thus causing the wrong scientific facts to reach stakeholders (cf. National Association of Science Writers, 2001). One strong argument for this misunderstanding is a lack of proper training for all key role players of science communication (cf. Metcalfe, 2002).

The empirical component of the study indicates that:

- key role players in science communication do not have proper relationships with one another;
- there is a lack of trust and mutual understanding among key role players;

- there is a lack of empowerment of communication specialists;
- the lack of a relationship of trust and mutual understanding can be one of the reasons why very few scientific news reach the media and subsequently the general public.

These findings correlate with the theory of excellence in communication and corporate communication management. Unless communication specialists receive proper training, are trusted and empowered to act as managers where science communication is concerned and are accepted as the facilitator in the relationship between key role players, science communication might not become as powerful as it should be.

8.2.3 Objective 3: The role of communication specialists in science communication

The theoretical component of Objective 3 outlines the communication function at HEI. Communication specialists are the spokespeople at HEI and have an important role to fulfil as facilitators (cf. Mersham & Skinner, 1995). Communication departments are also expected to provide advice to executive management regarding technical and communication strategy dimensions. They are furthermore expected to build relationships with internal and external stakeholders. They need to be boundary spanners, planners, implementators and evaluators of the science communication plans after implementation (cf. Grunig, 1992). However, this is not always the case, since communication specialists need to be managers and technicians at the same time, and on occasion they are requested for their input into strategic issues regarding science communication (cf. De Beer, 2001).

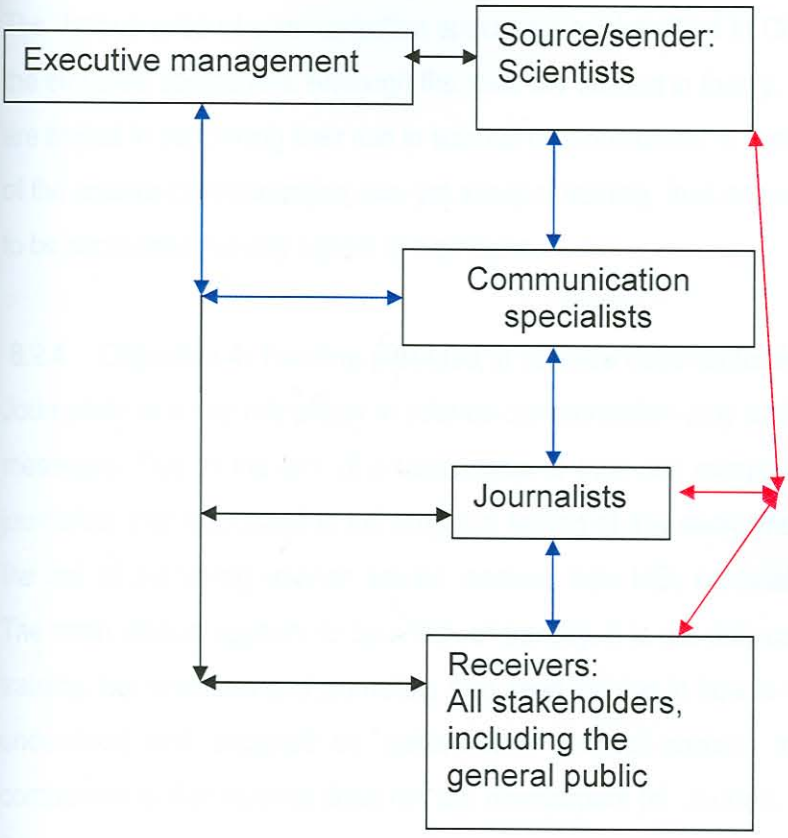
Three conclusions are presented from the empirical component:

- First, executive managements largely agree that communication specialists should interact with scientists and assist as facilitators to distribute the science message to the media and other stakeholders. However, scientists disagree, since they doubt the training of communication specialists to understand the science that should be communicated.
- Secondly, although the members of executive management and communication specialists agree that communication specialists make a strategic contribution regarding communication with stakeholders, executive management and communication specialists both indicated that communication specialists influence key strategic decisions to a lesser extent. This clearly indicates and confirms the role of executive management as strategists and communication specialists as the managers where science communication is concerned.

- The third conclusion drawn from the empirical component concerns the facilitating and/or mediating function of communication specialists in ensuring that scientists communicate their science through communication specialists to stakeholders. The empirical results imply that scientists and communication specialists are not as positive towards the facilitating function as are the executive management, probably due to a lack of trust in communication specialists' ability to interpret science messages correctly because of a lack of training in science writing.

In Figure 8.2 a proposed model for distributing science messages is illustrated to describe the most appropriate solution to the relationship amongst key role players. Communication specialists are the spokespersons of HEI, but in a situation where executive management and scientists have direct access to stakeholders, communication specialists have no control over the process and flow of information. In acting as facilitator between the institution and stakeholders, communication specialists serve the institution best by aiding the flow of news and information. The free flow of information should be encouraged, which will lead to more opportunities for positive coverage of news at an institution. Journalists are more likely to return to such an institution for experts to quote in their articles and to interview for radio and television. They are also more likely to trust releases and other information from this institution and specifically from its communication specialists (National Association of Science Writers, 2001). Communication specialists' role as facilitator would imply that as far as possible, they should act as facilitators at all times, especially where information could be prejudicial to the institution. Communication specialists should have the authority to decide what information may be conveyed to the media and other stakeholders. However, it would be impossible for communication specialists to be everywhere at the same time and scientists would have to communicate directly with all stakeholders. Yet, scientists should be encouraged that when communicating directly with the stakeholders do it in conjunction with communication specialists and where possible in their presence.

Figure 8.2: The proposed preferred relationship between key role players in science communication at HEI



Source: Own visualisation

There is a new concept in research at HEI that is called contract research. Contract research involves typically scientists, an external partner (in most cases an industrial company) and the research office or research business unit at HEI. However, there might be more role players involved, depending on the research project. The research business units at HEI were especially established to act as facilitators between scientists and industry. The role of these units is to ensure a proper contract is in place between scientists and industry and to protect the intellectual property of the research. In the case of contract research, the research business unit takes over the role of communication specialists to ensure that a relationship of trust and mutual understanding evolves between scientists and their industry partners. However, the scientist who worked from the start together with the industry partner

has to communicate the results of the study directly to the industry partner. In the case of contract research, the sender is the scientist and the receiver will be the industry partner, without any facilitation from communication specialists at HEI.

The various roles of communication specialists as described in Chapter 5 are linked to the results of the empirical component. Although the roles are defined in theory, in reality communication specialists are limited in performing their role in science communication. It is expected of them to fulfil all functions of the science communication role, yet a lack of training, trust and empowerment increase their inability to be successful in every aspect of their tasks.

8.2.4 Objective 4: Training provided in science communication

Journalists as a key role player in science communication play a vital role in the distribution of science messages. Due to the lack of a relationship of trust and mutual understanding of nearly half of the journalists that responded to the empirical testing of this study, these journalists are not likely to take the risk of publishing science articles received from HEI, especially from communication specialists. The main reason appears to be a lack of training. It is not only communication specialists who need training, but scientists and journalists also need training in how to write science articles that would be understood and accepted by stakeholders. Another concern that emerged from the theoretical component is that science does not sell newspapers (cf. Joubert, 2001). This cliché might be one of the reasons why very few science articles to appear in the media.

Conclusions from the empirical component can be summarised as follows:

- The lack of training in basic science might be one of the reasons why journalists and scientists misunderstand each other and why they often do not reach some mutual understanding during an interview.
- The results of the empirical component indicate that scientists do not provide enough information to be communicated to stakeholders, including the general public.
- The low indication of HEI offering a course in science journalism raises a concern.
- Most importantly, however, is the indication that communication specialists and journalists do not receive any training in science writing and the fact that journalists do not have knowledge about science.

The conclusion that a lack of training might be one of the reasons why a proper relationship of trust and mutual understanding does not exists between communication specialists and journalists, is emphasised by the reflection of the profile of respondents. This is substantiated by the fact that no communication specialists at HEI received any science writing training; a very high percentage of communication specialists' qualifications were not related to public relations; and only a small percentage had obtained a master's degree.

8.2.5 Objective 5: Coverage of scientific topics in the mass media

The media constitute an important distributor of messages to large audiences. Without the participation of the media in distributing the message of science, science communication is therefore doomed to fail (Nelkin, 1995). In Chapter 5 the role of the media is described in detail and the conclusion reached from the theoretical perspective is that the media overall should be utilised more effectively. However, the use of the media cannot be effective unless a relationship of trust and mutual understanding is present. Furthermore, if information on science matters does not reach the media, no messages can be distributed. It is therefore imperative that all key role players in science communication should aim to enhance a trust relationship with the media at large.

The empirical component was applied to test the theoretical perspective. The results imply that communication specialists and scientists do not have as much contact with the media as one would have expected. The results also indicate that far too little coverage of science is currently affected by the various media. A relationship of trust and mutual understanding should contribute to a lesser application of the gatekeeping function and would ensure that science is regarded as a higher priority in the agenda setting function of the media.

8.2.6 Objective 6: Content analysis of scientific articles

The theoretical perspective of Objective 6 has already been discussed in the conclusions of Phase 1 of the study. However, the role of the mass media cannot be overemphasised and the role of communication specialists and journalists are equally important (cf. Mersham & Skinner, 1995). The way in which the media covers science articles or broadcasts cannot be controlled to a large extent by scientists or communication specialists. Once again, a positive relationship between the key role players of science communication and the training of all role players in the communication of science are imperative for correct scientific facts to reach the general public.

The theoretical conclusions are substantiated by the empirical results of the content analysis. The small percentage of SET articles published during the research period (1 March to 31 May 2004) indicates a lack of SET coverage in the South African media. Furthermore, as the results have pointed out, the local media is too dependent on foreign sources in the provision of science articles. This is an indication that the situation has not improved since the previous study performed by Van Rooyen in 2002.

It seems that the number of published feature articles has improved since the previous study, especially in the weekly newspapers. However, time and economic restraints probably add to the apparent lack of devoted science writers in South Africa, while the lack of training may be a further reason for the smaller percentage of feature articles published in the daily newspapers. The positive evaluative tone of coverage and the discourse of benefits point to a positive attitude towards science.

The beneficial properties of visuals and infographics have been highlighted by several research studies, yet it seems as if the local media has not caught up with the trend yet, as there has been no significant improvement since the study conducted by Van Rooyen in 2002. There is a need for concern with regard to the prominence of coverage of scientific articles, as the front-page coverage of science is highly insignificant. However, possible reasons for this imbalance are hard to define and beyond the scope of this study.

8.3 HOLISTIC VIEW OF THE RESEARCH PHENOMENON

The description of theoretical and empirical conclusions would not be completed without a summative view on the research phenomenon, that is the role of communication specialists in science communication at HEI in South Africa. Such a view is presented as a means of summarising the key aspects from the previous chapter and the preceding conclusions.

As was indicated previously, the ultimate purpose of the empirical investigation was to provide an exploratory answer to the general aim and the objectives of this study. Therefore, the objectives need to be answered as part of the answer to the general aim. Beside the fact that key role players of science communication indicated that in their opinion science communication was regarded a priority, the results of their actual participation in science communication activities made it clear that in practice science communication did not enjoy such a high priority.

There is definitely room for improvement to establish a proper relationship of trust among the key role players in science communication as the model in figure 8.2 proposes. Interesting results were obtained from the questions about the role of communication specialists in science communication. Executive management and communication specialists agreed that communication specialists should act as managers in science communication and the implementation of science communication activities. The lack of proper training has a further negative result in that the coverage of science and technology in the South African mass media amounts to only a small percentage. It can be argued that if the key role players were trained properly in science communication, the understanding of science would improve, which would also enhance the general public's realisation of the importance of science communication. The above arguments are also applicable to the coverage of scientific articles in the media. Results have indicated that, overall, the coverage of science by the printed media is too low. In comparison to the 2002 study by Van Rooyen, there seems to be not much improvement in the mass media coverage of science.

8.4 RECOMMENDATIONS

Recommendations are presented in relation to the objectives, thus also contributing to the holistic understanding and future management of science communication.

8.4.1 The importance of science communication to key role players

In Chapter 2 a map of science activities illustrated what future actions regarding science communication could be taken. Joubert (cf. 2001) highlighted certain specific processes that should be implemented to improve an awareness of science communication. However, the empirical results of this study suggest that not much has happened since Joubert's recommendations in 2001. South Africa still needs a national forum to conduct an audit and formulate a structured, reasoned national science communication action plan for South Africa. In formulating such a plan, communication specialists need exposure to best practices in the field so that opportunities are not missed and scarce resources not wasted on unnecessary schemes that are not successful. Although the Department of Science and Technology in South Africa provided funding for some science communication activities in the past, more feedback should be given to the science communication community about who would be funded and for what projects. Furthermore, the Government of South Africa should encourage HEI to organise public debate sessions where scientists and the general public can discuss controversial issues regarding science and research in the open.

HEI in South Africa, especially universities, have three core activities. First, and most important, is the provision of academic training to students. Second, and equally important, is the conducting of research and thirdly, initiation and participation in community projects. Unfortunately many South African universities and technikons, in terms of promoting and communicating research to the institutions' stakeholders, as well as participating in community projects, neglect these two activities. HEI should be encouraged towards and credit should be given for interdepartmental collaboration in the field of science communication and participation in community projects. Ultimately, scientists themselves must embrace their role in science communication, for without them communication specialists and science journalists have nothing to say.

8.4.2 Establishment of a relationship of trust and mutual understanding between key role players in science communication

From executive management to scientists to communication specialists and journalists, a relationship of trust must be encouraged. However, to achieve a workable situation as set out in Figure 8.2, an effort should be made to enhance mutual understanding. The lack of trust and understanding between scientists and journalists, which is an impediment to the progress of science journalism, must be stopped.

Executive management should encourage scientists to provide information to communication specialists, who then should convey the scientific facts to the media and other stakeholders of the HEI. HEI should also consider implementing activities such as targeted, competitive grants to support innovative communication of research at community level (complementing development communication initiatives), annual popular science writing competitions for postgraduate students, and many more.

8.4.3 Improvement of the role of communication specialists at HEI

Science communication in South Africa would be stimulated if the science communication specialists could meet regularly and exchange ideas with communication specialists from other countries. Communication specialists should also be trusted and empowered to create structured opportunities for scientists and journalists to meet and interact. They should create and support a science writers' network in South Africa; develop and promote databases of science writers and media-friendly scientists; collect science articles from scientists and prepare them for publication together with supporting visuals; facilitate linkages and collaboration with corporate sectors, and participate in international networking and visiting expert programmes.

However, all the above cannot be achieved without support from executive management and collaboration from scientists at HEI.

8.4.4 Provision of training in South Africa in science communication

A valuable information source for the public about SET is the mass media. Unfortunately, South Africa lacks science journalists and above all, proper training. Currently, science journalism is generally not a subject presented by South African universities or technikons, except as a module of communication management at the University of Stellenbosch and Rhodes University. A further drawback is that scientists and journalists do not have good relationships – due to a lack of trust on both sides. Added to this problem is a lack of confidence in communication specialists to act as facilitators in science communication. The assumption can be made that if more science articles appear in newspapers, it would definitely not influence the sale of newspapers negatively – on the contrary, it might even increase the sale of newspapers. Training in science communication can further promote the success of a relationship between executive management, communication specialists, scientists and science journalists.

According to Joubert (cf. 2001), training could include numerical issues for those journalists who have difficulty coping with large numbers, percentages and statistics, and for those who do not understand probabilities and therefore battle with risk reporting and the presentation of research outcomes. Others may need help with research methods, or with accessing and interpreting research articles and Internet material. Scientists, however, also need communication skills. For many scientists public communication does not come naturally, and even when they are prepared to become involved, they need some help. Journalists, again, are often intimidated by science and do not know where to find credible science articles and media-friendly scientists. Therefore, training is required for scientists to enable them to communicate with journalists and the general public; for communication specialists to enable them to act as facilitators and to facilitate the communication process between scientists and journalists as well as to provide journalists with the correct information; and for journalists to enable them to communicate the correct scientific facts to stakeholders in an interesting way.

There has never been a better time for HEI to realise that they should provide training to many of their most important stakeholders. At first, a short course could be offered to the key role players of science communication in writing science articles, and after that a module in existing communication courses

could be considered to reach the ultimate goal of a postgraduate degree programme in science communication.

8.4.5 The improvement of the amount of coverage of science in the mass media

South Africa needs strategies, high-level commitment and support to improve the quality and quantity of local science in local broadcasts. Science need to be integrated into popular, peak-time programmes such as local dramas, historical and other documentaries, talk shows, and even soap operas. There is also a need for regular science inserts on news broadcasts and science fillers between programmes. Although newspapers are one of the most important mediums to distribute news, it is a medium that is not utilised to its fullest potential. Another perhaps more effective medium is radio, since it can reach many more households and even illiterate publics. The Internet is also a very effective medium to reach large audiences at once. The communication specialists at HEI could much more effectively promote research findings, profile science achievers, and build media relationships between researchers and journalists. Although communication specialists should facilitate these contacts with the media, they would not succeed without the trust and empowerment of their executive management HEI and without the facts from scientists to convey to the mass media.

8.4.6 Enhancement of the quality of scientific articles in the media

The media in South Africa have four focus areas, namely the environment, health/medical, technology and education. For scientific articles to be published, or for a journalist to attend a science communication activity, the activity should relate to one of these focus areas. The fact that South Africa's media do not even have a category dedicated to science raises a grave concern. Therefore, local scientists need a better insight into how the media work. They must make it their business to build relationships with journalists and freelance science writers eager to publicise new research. Furthermore, the media should be encouraged to devote a certain minimum amount of space in their publications to scientific articles.

Science writers must include interesting styles of writing such as fiction, poetry, satires, skits, discussions, and so on. Furthermore, misleading scientific information, a continuous decay of creativity in presentation, distortion in translation, inconsistency in organising the contents, lapses in the use of language and many more deviations should be abandoned.

8.5 LIMITATIONS

8.5.1 Theoretical limitations

A single study cannot, and should not, attempt to cover all aspects of a particular field of enquiry, as the delimitations of this study set out in Chapter 1 indicates. Seeing that this was an exploratory study, the theories that provided the theoretical base for the study were not discussed in-depth. Based on all the perspectives that were discussed, the following other research efforts can be focused on, for example:

- The role of stakeholders in science communication
- The various audiences (stakeholders), i.e literate and illiterate, urban and rural and young and old people with whom HEI communicate
- The role of HEI in development communication
- Analysis of other mass media in science communication (the content analysis of this study focused only on the printed media in South Africa)

8.5.2 Empirical limitations

Survey research was conducted to supplement the theoretical component of the study. Although the research was exploratory in nature, a quantitative approach was used. The motivation behind the use of quantitative research was to obtain as wide a range of perspectives as possible, and not to gather in-depth information. The survey research was expanded to include a content analysis of selected printed media.

Unfortunately the response rate in this study was low, even after reminders had been sent out. One reason could be that scientists and journalists are busy and in many occasions, e-mails concerning surveys are simply deleted. Participants in general have reached such a level of exposure to survey research that most of them are not willing to participate in it any more.

The term 'stakeholders' were not identified and explained to participants in the study and therefore might have been interpreted differently by participants than what the researcher required.

The content analysis focused only on selected print media, although there are many other branches of the media that could have been included, for example, television, radio and the Internet. The reason for focusing on this particular media was because the current study was to be compared with a study

with the same objective of analysis that was conducted in 2002. A lack of time and finances also played a role.

8.6 RECOMMENDATIONS FOR FUTURE RESEARCH

8.6.1 A continuation of the present study

It is recommended that this study be replicated, but by means of personal interviews conducted with key role players of science communication. This would improve the response rate and clear any uncertainties that might have occurred in the questionnaire. Secondly, focus group discussions with key role players, as well as different media groups and representatives from the general public would complete the communication loop, that is a perspective from other role players that need to convey the messages of science. Thirdly, the exploratory study could be formalised by means of causal studies, including hypotheses or propositions. Finally, future studies could benefit if the recipients of science communication, the general public, for example, were to be included in the study.

8.6.2 Research topics

Opportunities for future research in science communication are virtually limitless. Based on the limitations of this study, the following recommendations can be made for future research:

- In-depth research is required to investigate whether journalists focus only on sensation when writing about science.
- A "lack" of coverage as used to illustrate the small percentage of scientific articles published, is difficult to define and according to Bauer *et al.* (cf.1995), "... such a judgement is inherently political, and different stakeholders in the scientific community and the media are likely to have different views". More research is required to assess the view of readers and to express the amount of scientific coverage in terms of other areas of coverage.
- Further research is also required to determine why scientific articles very seldom reach the front page of the South African media and why a new science discovery is not regarded as important as a political struggle or violent attack.
- The researcher agrees with Van Rooyen (cf. 2002) that Phase 2 of this study should be repeated at regular intervals. If conducted over a longer period (one year perhaps), the results might be even more reliable. This would compensate for irregularities in breaking news stories (e.g. Mark Shuttleworth's space voyage in April 2002 when the Van Rooyen study was conducted) and would enhance the validity of comparison studies.

8.7 CONCLUDING REMARK

Communication specialists play a vital role at HEI to act as facilitator between HEI and its stakeholders, and therefore communication specialists should be equipped with the necessary training and skills development to fulfil their role optimally in the relationship between the key role players and stakeholders of HEIs in science communication. By providing the required power and trust to communication specialists to act on behalf of their institutions with stakeholders, all key role players as well as stakeholders in science communication at HEI would be benefited positively.

In the realm of science communication, South Africa faces the same problems as First World countries, together with the myriad problems of an impoverished Third World continent. The country was able to pull off at least one miracle, a relatively peaceful transition into a new South Africa. It is now time to focus on ways to achieve closer relationships between science and society, to the benefit of science and all the people in the country.

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Appendix 1: E-mail to participants

Dear Respondent

I kindly request you to spend a few minutes in reading the attached letter.

Your participation in this survey is crucial for me to obtain a sample as large as possible for my PhD study. Please assist me by completing the questionnaire. It will only take a few minutes.

It would be highly appreciated if you could send the questionnaire to me by 31 March 2004.

Please note: if you merely reply on this message I will receive an empty questionnaire. It is therefore important for you to save this file onto your hard drive for the following reasons:

1. To ensure that the data is saved.
2. To complete the questionnaire in your own time, which means you do not have to be on-line whilst completing the questionnaire. You can complete it, connect to the Internet and merely attach the file called "SC Survey".

I am going to give you a step-by-step process to follow to ensure that you save the data correctly:

1. As you click on the attachment, the computer will prompt you with the following message:
What do you want to do with this file? "Open it" or "Save it to disk"
2. Click on the "Save it to disk" option.
3. Then click OK
4. The computer will now prompt you with a window called "Save as".
5. You need to select a directory where you would like to save this document.
6. At the top of this window, there is a line stating "Save in".
7. Next to this line there is a drop down list.
8. From this drop down list please select the directory called "My documents".
9. At the top of this window where it states "Save in" the word "My documents" must now appear next to the line stating "Save in".
10. At the bottom of the same window there is a space called "File name". Please make sure that the name that appear in this box next to the line stating "File name" indicates the file name "SC Survey".
11. If this is the case, click on "Save".
12. If this is not the case please name the file "SC Survey" and then press "Save".
13. The document is now saved in the "My documents" directory on your hard drive with the file name "SC Survey".
14. Please go to the "My documents" directory and open the file named "SC Survey"
15. Please start completing the questionnaire.
16. Carefully follow the steps in the questionnaire to ensure that you have saved all your answers.
17. Close the document.
18. Please send me an e-mail and attach the file named "SC Survey" from your "My documents" directory.

I will now receive a completed questionnaire.

Thank you once again for your willingness to participate in this project.

Kind regards
Elsabé Conradie
Director: Marketing and Communication (Acting)
University of Pretoria
Lynnwood Road
Pretoria, 0002
Tel +27 12 420 2211
Fax +27 12 420 2262
Cell +27 82 908 4289

Appendix 2: Cover letter (e-mail) to participants

University of Pretoria

Pretoria 0002 Republic of South Africa
Tel (012) 420-4111
http://www.up.ac.za

Department of Marketing and Communication

3 January 2004

Dear Respondent

RE: SCIENCE COMMUNICATION AT HIGHER EDUCATION INSTITUTIONS

Attached to this letter is a questionnaire developed as part of my Doctoral degree in Communication Management. The title of my thesis is: "*The role of the communication specialist in science communication at higher education institutions: A South African study*".

I hereby request that you take time to complete this questionnaire. I know that you, being a **executive member/scientist/communication specialist/journalist** will have a prevailing idea of how important science communication is and specifically the role of the communication specialist at higher education institutions. It is thus of paramount importance that, in answering this questionnaire, you provide your opinion on the importance of science communication and the role of the communication specialist within your institution. Please ensure that you answer ALL the questions in the questionnaire. Your participation in this research project is of great importance in order to obtain the status of science communication in South Africa.

You are kindly requested to complete the questionnaire electronically, and to send it back to me. Please ensure that you follow the step-by-step process as indicated in the questionnaire. This will eliminate any possible problems. If you are uncertain about anything please do not hesitate to contact me via e-mail on: elsabe.conradie@up.ac.za, or tel (012) 420 2211, cell 082 908 4289.

It would be highly appreciated if you could complete this questionnaire as soon as possible and return it to the abovementioned e-mail address, no later 31 March 2004.

I thank you for your willingness to participate in this very exciting project and hope that this will be the start of many lasting relationships amongst the South African higher education community and journalists.

Yours sincerely

Elsabé Conradie
Director: Marketing and Communication (Acting)

Appendix 3: Questionnaire in MS Word format to executive management

SCIENCE COMMUNICATION AT HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA

The questionnaire will follow a step-by-step process. Please follow the steps very carefully to ensure that all the data is captured.

Step 1:

Click on the file and save as button to save under 'my documents' to ensure that you have saved this document as "SC Survey" in your directory.

Step 2:

Please read the following section to ensure that you understand the example.

In each of the statements in the section below, please use the scale 1=Strongly disagree and 5=Strongly agree, to indicate your answer. Please mark your answer with an 'X' in the appropriate box.

FOR EXAMPLE:

	Please mark your answer with an 'X' in the appropriate box.				
Our institution regards science communication as:	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree
1.. a high priority.	1	2 X	3	4	5
2.. effective in our institution.	1	2	3	4 X	5

PLEASE NOTE FOR THE PURPOSE OF THIS RESEARCH, COMMUNICATION SPECIALIST INCLUDES PUBLIC RELATION OFFICERS, LIAISON OFFICERS, MARKETING STAFF.

Step 3:

Section A consists of 7 questions. Please answer each question by following the instructions provided below.

Section A: Importance of science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements:
1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion …	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use V0 1-3			
1… science communication at our institution is regarded as a high priority.	1	2	3	4	5	V1		4	
2… greater understanding of science among non-scientific publics result in less opposition to scientific research.	1	2	3	4	5	V2		5	
3… scientists have a duty to communicate their research to the general public.	1	2	3	4	5	V3		6	
4… new science discoveries should be communicated to all stakeholders of higher education institutions.	1	2	3	4	5	V4		7	
5… social implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V5		8	
6… ethical implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V6		9	
7. This institution has a science discovery centre.	1	2	3	4	5	V7		10	

Step 4:

Click on the save button to ensure that your answers are saved.

Step 5:

Section B consists of 7 questions. Please answer each question by following the instructions provided below.

Section B: Relationship between the key role players

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

A relationship between key role players in science communication is important in our institution, therefore ...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly	For office use			
8... we as executive management has *trust* in communication specialists to communicate science related issues with the media.	1	2	3	4	5	V8		11	
9... we as executive management *empower* communication specialists to communicate science related issues with the media.	1	2	3	4	5	V9		12	
10... there is a relationship of trust between executive management and *communication specialists* at this institution.	1	2	3	4	5	V10		13	
11... there is a relationship of trust between executive management and *scientists* at this institution.	1	2	3	4	5	V11		14	
12... there is a relationship of trust between executive management at this institution and *journalists*.	1	2	3	4	5	V12		15	
13... a relationship of trust between role players will add to a greater understanding of science by stakeholders.	1	2	3	4	5	V13		16	
14... a relationship of trust between the key role players will result in stakeholders trusting information received from this institution.	1	2	3	4	5	V14		17	

Step 6:

Click on the save button to ensure that your answers are saved.

Step 7:

Section C consists of 17 questions. Please answer each question by following the instructions provided below.

Section C: The role of communication specialists in science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion the current role of communication specialists in this institution is to …	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
15… make a strategic contribution regarding communicating with stakeholders.	1	2	3	4	5	V15		18	
16… influence key strategic decisions of executive management in communicating science to stakeholders.	1	2	3	4	5	V16		19	
17… get the institution's name into the media, specifically regarding science performed at the institution.	1	2	3	4	5	V17		20	
18… use their journalistic skills to establish what the media will consider newsworthy about the institution.	1	2	3	4	5	V18		21	
19… facilitate mutual understanding between the key role players of science communication.	1	2	3	4	5	V19		22	
20… ensure that scientists communicate their science through communication specialists to stakeholders.	1	2	3	4	5	V20		23	
21… assist scientists in communicating their research to stakeholders of higher education institutions.	1	2	3	4	5	V21		24	
22… play a vital role in ensuring a relationship of trust develops between key role players of science communication.	1	2	3	4	5	V22		25	
23… ensure that our institution follows a two-way flow of information in communicating with stakeholders, to enable stakeholders to provide feedback where applicable.	1	2	3	4	5	V23		26	
24… not only obtain favourable publicity, but also to prevent unfavourable publicity in the media.	1	2	3	4	5	V24		27	
25… inform executive management of societal values/norms so that they can adjust institutional decisions/strategies accordingly.	1	2	3	4	5	V25		28	
26…do surveys before starting a science communication plan to find out how well management and our stakeholders understand each other.	1	2	3	4	5	V26		29	
27…disseminate accurate information, but not to volunteer unfavourable information.	1	2	3	4	5	V27		30	
28…influence executive management decisions to ensure that this institution is	1	2	3	4	5	V28		31	

regarded by society as being 'trustworthy'.									
29...develop mutual understanding between our management and the stakeholders that the institution affects.	1	2	3	4	5	V29		32	
30...be a neutral disseminator of information rather than a mediator that connects management to stakeholders.	1	2	3	4	5	V30		33	
31... act as an advocate for key internal publics by explaining their views to executive management.	1	2	3	4	5	V31		34	

Step 8:

Click on the save button to ensure that your answers are saved.

Section D: Demographic information

Please answer the following questions by marking an "X" in the appropriate box.

32. Gender:

Male	
Female	

33. Please indicate your language preference:

English	
Afrikaans	

34. Do you speak any other South African language?

Yes	
No	

35. If your institution has a course in science writing/journalism, please provide the name of the degree/diploma/subject:

_____

36. Please provide the name/s of the tertiary institutions, that you are aware of, that offer science writing/journalism education/training.

_____

For office use		
V32		35
V33		36
V34		37
V35		38
V35		39
V36		40

37. Please indicate the name of the institution of which you are an employee.

				For office use		
UCT	US	RAU	UP			
UNISA	PUCH / UNW	WITS	KZN	V37		41
UWC	MEDUNSA	UNO	UFH			
UFS	UPE	RU	UT			
UV	UZ	CAPE TECH	VAAL TECN			
DIT	TNG	TNW	PE T			
TUT	ECT	TFS	MT			
TSA	PENT	TWR	OTHER			

Step 12:

Click on the save button to ensure that your answers are saved.

Step 13:

Close this document. When sending this questionnaire to my e-mail address: elsabe.conradie@up.ac.za please ensure that you have attached the file "SC Survey" to the e-mail.

THANK YOU FOR YOUR PARTICIPATION!

Appendix 4: Questionnaire in MS Word format to scientists

SCIENCE COMMUNICATION AT HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA

The questionnaire will follow a step-by-step process. Please follow the steps very carefully to ensure that all the data is captured.

Step 1:

Click on the file button and save as to save under 'my documents' to ensure that you have saved this document as "SC Survey" in your directory.

Step 2:

Please read the following section to ensure that you understand the example.

In each of the statements in the section below, please use the scale 1=Strongly disagree and 5=Strongly agree, to indicate your answer. Please mark your answer with an 'X' in the appropriate box.

FOR EXAMPLE:

	Please mark your answer with an 'X' in the appropriate box.				
Our institution regards science communication as:	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree
1. a high priority.	1	2 X	3	4	5
2. effective in our institution.	1	2	3	4 X	5

PLEASE NOTE FOR THE PURPOSE OF THIS RESEARCH, COMMUNICATION SPECIALIST INCLUDES PUBLIC RELATION OFFICERS, LIAISON OFFICERS, MARKETING STAFF.

Step 3:

Section A consists of 16 questions. Please answer each question by following the instructions provided below.

Section A: Importance of science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion science communication at our institution is ...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use V0 ☐☐☐ 1-3			
1... regarded as a high priority.	1	2	3	4	5	V1		4	
2... important because we participate in science **exhibitions.**	1	2	3	4	5	V2		5	
3... important because we participate in **National Science, Engineering and Technology Weeks.**	1	2	3	4	5	V3		6	
4... important because we participate in **mobile centres.**	1	2	3	4	5	V4		7	
5... important because we participate in **SASOL Scifest.**	1	2	3	4	5	V5		8	
6... important because we participate in **SASOL Techno X.**	1	2	3	4	5	V6		9	
7... important because we have our own science discovery centre.	1	2	3	4	5	V7		10	
8... important because our scientists participate in talk shows at schools.	1	2	3	4	5	V8		11	
9... important because our scientists talk to journalists to promote science.	1	2	3	4	5	V9		12	
10... important because our scientists write news releases to promote science.	1	2	3	4	5	V10		13	
11... important because our scientists participate in open days organised by our institution.	1	2	3	4	5	V11		14	
In my opinion ...									
12... greater understanding of science among non-scientific publics result in less opposition to scientific research.	1	2	3	4	5	V12		15	
13... scientists have a duty to communicate their research to the general public.	1	2	3	4	5	V13		16	
14... new science discoveries should be communicated to all stakeholders of higher education institutions.	1	2	3	4	5	V14		17	

15... **social** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V15		18	
16... **ethical** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V16		19	

Step 4:

Click on the save button to ensure that your answers are saved.

Step 5:

Section B consists of 7 questions. Please answer each question by following the instructions provided below.

Section B: Relationship

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

A relationship between key role players in science communication is important in our institution, therefore...	Strongly disagree	Disagree	Neutral (Neither disagree	Agree	Strongly agree	For office use			
17... there is a relationship of trust between scientists and *executive management* at our institution.	1	2	3	4	5	V17		20	
18... there is a relationship of trust between scientists and *communication specialists* at our institution.	1	2	3	4	5	V18		21	
19... there is a relationship of trust between scientists at our institution and *journalists*.	1	2	3	4	5	V19		22	
20... a relationship of trust between the role players will add to a greater understanding of science by stakeholders.	1	2	3	4	5	V20		23	
21... a relationship of trust between the role players will result in stakeholders trusting information received from our institution.	1	2	3	4	5	V21		24	
In my opinion	1	2	3	4	5				
22... scientists at our institution have had contact with the media more than 3 times during last year.	1	2	3	4	5	V22		25	
23... the media has contacted our institution more than 3 times during last year to obtain science information.	1	2	3	4	5	V23		26	

Step 6:

Click on the save button to ensure that your answers are saved.

Step 7:

Section C consists of 17 questions. Please answer each question by following the instructions provided below.

Section C: The role of communication specialists in science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements:
1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree

In my opinion the current role of communication specialists in our institution is to...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
24... facilitate mutual understanding between the key role players of science communication.	1	2	3	4	5	V24		27	
25... ensure that scientists communicate their science through communication specialists to stakeholders.	1	2	3	4	5	V25		28	
26... assist scientists in communicating their research to stakeholders of higher education institutions.	1	2	3	4	5	V26		29	
27... play a vital role in ensuring a relationship of trust develops between key role players of science communication.	1	2	3	4	5	V27		30	

Step 8:

Click on the save button to ensure that your answers are saved.

Step 9:

Section D consists of 11 questions. Please answer each question by following the instructions provided below.

Section D: Training

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
28... scientists at our institution are equipped to communicate science directly to stakeholders.	1	2	3	4	5	V28		31	
29... a basic course in science writing is not a requirement to communicate science to various stakeholders.	1	2	3	4	5	V29		32	

Step 10:

Click on the save button to ensure that your answers are saved.

Step 11:

Section E consists of 3 questions. Please answer each question by following the instructions provided below.

Section E: Media

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion ...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
30... scientists prefer to communicate directly with journalists.	1	2	3	4	5	V30		33	
31... scientists provide enough information to communication specialists to distribute to the media.	1	2	3	4	5	V31		34	
32... journalists have a good knowledge about science when interviewing scientists.	1	2	3	4	5	V32		35	
33... the media sensationalises science.	1	2	3	4	5	V33		36	

PLEASE CONTINUE ON NEXT PAGE...

Section F: Demographic information

Please answer the following questions by marking an "X" in the appropriate box.

34. Gender:

Male	
Female	

35. In which year were you born? Please provide your answer in a four-digit format (e.g. 1965).

_____

36. Please indicate your language preference:

English	
Afrikaans	

37. Do you speak any other South African language?

Yes	
No	

38. Please indicate your highest tertiary education level

Certificate	
Diploma	
Degree	
Honours	
Masters	
Doctorate	
Other	

39. Please indicate if you have received any science writing training. If your answer is YES, please continue with questions 40, 41 and 42. If your answer is NO, please continue with question 43.

Yes	
No	

For office use		
V34		37
V35		38-42
V36		43
V37		44
V38		45
V39		46

For office use		
V40		47
V41		48
V42		48
V43		49

40. Where did you receive your science writing training?

Locally	
Internationally	
Both	

Please specify the town and country:

_____

41. What type of science writing training did you receive?

Formal (e.g. University, Technikon)	
Informal (e.g. PR Association)	
Both	

Please specify the institution:

_____

42. Please indicate the highest level of **science writing (journalism) training** that you have received.

As an undergraduate subject	
As a degree in journalism	
As a post graduate subject	
As a post graduate degree in science journalism	
As a diploma course in science journalism	
As a certificate course in science journalism	
As a short course in science writing (e.g. a few days)	

43. If your institution has a course in science writing/journalism, please provide the name of the degree/diploma/subject:

_____

44. Please provide the name/s of the tertiary institutions, that you are aware of, that offer science writing/journalism education/training.

_____

45. Please indicate the name of the institution of which you are an employee.

UCT	US	RAU	UP	For office use		
UNISA	PUCH / UNW	WITS	KZN	V45		76
UWC	MEDUNSA	UNO	UFH			
UFS	UPE	RU	UT			
UV	UZ	CAPE TECH				
DIT	TNG	TNW	PE T			
TUT	ECT	TFS	MT			
TSA	PENT	TWR				
VAAL TECH	OTHER					

Step 12:

Click on the save button to ensure that your answers are saved.

Step 13:

Please answer the following section. If you choose not to complete this section, you can still submit your completed questionnaire without this information.

OPTIONAL INFORMATION: PARTICULARS OF RESPONDENTS

May I please have the following personal information? This information will only be used if I might want to follow-up with you on some of your answers.
Name:

E-mail:

Telephone number:

Employer:

Current position:

Step 14:

Click on the save button to ensure that your answers are saved.

Step 15:

Close this document. When sending this questionnaire to my e-mail address: elsabe.conradie@up.ac.za please ensure that you have attached the file "SC Survey" to the e-mail.

THANK YOU FOR YOUR PARTICIPATION!

Appendix 5: Questionnaire in MS Word format to communication specialists

SCIENCE COMMUNICATION AT HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA

The questionnaire will follow a step-by-step process. Please follow the steps very carefully to ensure that all the data is captured.

Step 1:

Click on the file button and save as to save under 'my documents' to ensure that you have saved this document as "SC Survey" in your directory.

Step 2:

Please read the following section to ensure that you understand the example.

In each of the statements in the section below, please use the scale 1=Strongly disagree and 5=Strongly agree, to indicate your answer. Please mark your answer with an 'X' in the appropriate box.

FOR EXAMPLE:

	Please mark your answer with an 'X' in the appropriate box.				
Our institution regards science communication as:	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree
1. a high priority.	1	2 X	3	4	5
2. effective in our institution.	1	2	3	4 X	5

PLEASE NOTE FOR THE PURPOSE OF THIS RESEARCH, COMMUNICATION SPECIALIST INCLUDES PUBLIC RELATION OFFICERS, LIAISON OFFICERS, MARKETING STAFF.

Step 3:

Section A consists of 16 questions. Please answer each question by following the instructions provided below.

Section A: Importance of science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion science communication at our institution is ...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use V0 1-3			
1... regarded as a high priority.	1	2	3	4	5	V1		4	
2... important because we participate in science **exhibitions.**	1	2	3	4	5	V2		5	
3... important because we participate in **National Science, Engineering and Technology Weeks.**	1	2	3	4	5	V3		6	
4... important because we participate in **mobile centres.**	1	2	3	4	5	V4		7	
5... important because we participate in **SASOL Scifest.**	1	2	3	4	5	V5		8	
6... important because we participate in **SASOL Techno X.**	1	2	3	4	5	V6		9	
7... important because we have our own science discovery centre.	1	2	3	4	5	V7		10	
8... important because our scientists participate in talk shows at schools.	1	2	3	4	5	V8		11	
9... important because our scientists talk to journalists to promote science.	1	2	3	4	5	V9		12	
10... important because our scientists write news releases to promote science.	1	2	3	4	5	V10		13	
11... important because our scientists participate in open days organised by our institution.	1	2	3	4	5	V11		14	
In my opinion ...									
12... greater understanding of science among non-scientific publics result in less opposition to scientific research.	1	2	3	4	5	V12		15	
13... scientists have a duty to communicate their research to the general public.	1	2	3	4	5	V13		16	
14... new science discoveries should be communicated to all stakeholders of higher education institutions.	1	2	3	4	5	V14		17	

15... **social** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V15		18	
16... **ethical** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V16		19	

Step 4:

Click on the save button to ensure that your answers are saved.

Step 5:

Section B consists of 11 questions. Please answer each question by following the instructions provided below.

Section B: Relationship

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

A relationship between key role players in science communication is important in our institution, therefore...	Strongly disagree	Disagree	Neutral (Neither disagree	Agree	Strongly agree	For office use			
17... our executive management has trust in communication specialists to communicate science related issues with the media.	1	2	3	4	5	V17		20	
18... our executive management empower communication specialists to communicate science related issues with the media.	1	2	3	4	5	V18		21	
19... there is a relationship of trust between communication specialists and *executive management* at our institution.	1	2	3	4	5	V19		22	
20... there is a relationship of trust between communication specialists and *scientists* at our institution.	1	2	3	4	5	V20		23	
21... there is a relationship of trust between communication specialists at our institution and *journalists*.	1	2	3	4	5	V21		24	
22... there is collaboration between communication specialists at our institution and communication specialists of other higher education institutions.	1	2	3	4	5	V22		25	
23... a relationship of trust between the role players will add to a greater understanding of science by stakeholders.	1	2	3	4	5	V23		26	
24... a relationship of trust between the role players will result in stakeholders trusting information received from our institution.	1	2	3	4	5	V24		27	

In my opinion....									
25... journalists do not regard news releases received from communication specialists at higher education institutions as being important.	1	2	3	4	5	V25		28	
26... journalists are sceptical of science information received from communication specialists.	1	2	3	4	5	V26		29	
27... communication specialists at our institution have had contact with the media more than 3 times during last year.	1	2	3	4	5	V27		30	

Step 6:

Click on the save button to ensure that your answers are saved.

Step 7:

Section C consists of 17 questions. Please answer each question by following the instructions provided below.

Section C: The role of communication specialists in science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements:
1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree

The current role of communication specialists in our institution is to...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
28... make a strategic contribution regarding communicating with stakeholders.	1	2	3	4	5	V28		31	
29... influence key strategic decisions of executive management in communicating science to stakeholders.	1	2	3	4	5	V29		32	
30... get the institution's name into the media, specifically regarding science performed at the institution.	1	2	3	4	5	V30		33	
31... use their journalistic skills to establish what the media will consider newsworthy about the institution.	1	2	3	4	5	V31		34	
32... facilitate mutual understanding between the key role players of science communication.	1	2	3	4	5	V32		35	
33... ensure that scientists communicate their science through communication specialists to stakeholders.	1	2	3		5	V33		36	

34... assist scientists in communicating their research to stakeholders of higher education institutions.	1	2	3	4	5	V34		37	
35... play a vital role in ensuring a relationship of trust develops between key role players of science communication.	1	2	3	4	5	V35		38	
36... ensure that our institution follows a two-way flow of information in communicating with stakeholders, to enable stakeholders to provide feedback where applicable.	1	2	3	4	5	V36		39	
37... not only obtain favourable publicity, but also to prevent unfavourable publicity in the media.	1	2	3	4	5	V37		40	
38... inform executive management of societal values/norms so that they can adjust institutional decisions/strategies accordingly.	1	2	3	4	5	V38		41	
39... do surveys before starting a science communication plan to find out how well management and our stakeholders understand each other.	1	2	3	4	5	V39		42	
40... disseminate accurate information, but not to volunteer unfavourable information.	1	2	3	4	5	V40		43	
41... influence executive management decisions to ensure that our institution is regarded by society as being 'trustworthy'.	1	2	3	4	5	V41		44	
42... develop mutual understanding between our management and the stakeholders that the institution affects.	1	2	3	4	5	V42		45	
43... be a neutral disseminator of information rather than a mediator that connects management to stakeholders.	1	2	3	4	5	V43		46	
44... act as an advocate for key internal publics by explaining their views to executive management.	1	2	3	4	5	V44		47	

Step 8:

Click on the save button to ensure that your answers are saved.

Step 9:

Section D consists of 11 questions. Please answer each question by following the instructions provided below.

Section D: Training

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion…	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
45…communication specialists at our institution received basic training in science writing to communicate science.	1	2	3	4	5	V45		48	
46… a basic course in science writing is not a requirement to communicate science to various stakeholders.	1	2	3	4	5	V46		49	
47… our institution offers a course in Science Journalism.	1	2	3	4	5	V47		50	
48… scientists prefer to communicate directly with journalists.	1	2	3	4	5	V48		51	
49… scientists provide enough information to communication specialists to distribute to the media.	1	2	3	4	5	V49		52	
50… journalists have a good knowledge about science when interviewing scientists.	1	2	3	4	5	V50		53	
51… the general coverage of science in the national newspapers is efficient.	1	2	3	4	5	V51		54	
52… the general coverage of science in the local newspapers is efficient.	1	2	3	4	5	V52		55	
53… the general coverage of science in magazines is efficient.	1	2	3	4	5	V53		56	
54… the general coverage of science on the radio is efficient.	1	2	3	4	5	V54		57	
55… the general coverage of science on TV is efficient.	1	2	3	4	5	V55		58	

Step 10:

Click on the save button to ensure that your answers are saved.

Step 11:

Section E consists of 3 questions. Please answer each question by following the instructions provided below.

Section E: Media

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
56. Our institution is satisfied with the amount of coverage of science in the media.	1	2	3	4	5	V56		59	
57. Science articles do not sell newspapers.	1	2	3	4	5	V57		60	
58. The media sensationalises science.	1	2	3	4	5	V58		61	

Section F: Demographic information

Please answer the following questions by marking an "X" in the appropriate box.

59. Gender:

Male	
Female	

60. In which year were you born? Please provide your answer in a four-digit format (e.g. 1965).

_____

61. Please indicate your language preference:

English	
Afrikaans	

62. Do you speak any other South African language?

Yes	
No	

63. Please indicate your highest tertiary education level

Certificate	
Diploma	
Degree	
Honours	
Masters	
Doctorate	
Other	

64. Is your qualification related to public relations?

Yes	
No	

65. Please indicate if you have received any science writing training. If your answer is YES, please continue with questions 66, 67 and 68. If your answer is NO, please continue with question 69.

Yes	
No	

For office use		
V59		62
V60		63-66
V61		67
V62		68
V63		69
V64		70
V65		71

For office use		
V66		72
V67		73
V68		74
V69		75

66. Where did you receive your science writing training?

Locally	
Internationally	
Both	

Please specify the town and country:

_____

67. What type of science writing training did you receive?

Formal (e.g. University, Technikon)	
Informal (e.g. PR Association)	
Both	

Please specify the institution:

_____

68. Please indicate the highest level of **science writing (journalism) training** that you have received.

As an undergraduate subject	
As a degree in journalism	
As a post graduate subject	
As a post graduate degree in science journalism	
As a diploma course in science journalism	
As a certificate course in science journalism	
As a short course in science writing (e.g. a few days)	

69. If your institution has a course in science writing/journalism, please provide the name of the degree/diploma/subject:

_____

70. Please provide the name/s of the tertiary institutions, that you are aware of, that offer science writing/journalism education/training.

_____

_____

71. Please indicate the name of the institution of which you are an employee.

UCT	US	RAU	UP	For office use		
UNISA	PUCH / UNW	WITS	KZN	V71		76
UWC	MEDUNSA	UNO	UFH			
UFS	UPE	RU	UT			
UV	UZ	CAPE TECH				
DIT	TNG	TNW	PE T			
TUT	ECT	TFS	MT			
TSA	PENT	TWR				
VAAL TECH	OTHER					

72. Please provide the number of communication specialists at your institution.

For office use		
V72		76-77

73. How many of the communication specialists at your institution are involved in science weeks, exhibitions, etc?

For office use		
V73		78-79

Step 12:

Click on the save button to ensure that your answers are saved.

Step 13:

Please answer the following section. If you choose not to complete this section, you can still submit your completed questionnaire without this information.

OPTIONAL INFORMATION: PARTICULARS OF RESPONDENTS

May I please have the following personal information? This information will only be used if I might want to follow-up with you on some of your answers.
Name:

E-mail:

Telephone number:

Employer:

Current position:

Step 14:

Click on the save bu5tton to ensure that your answers are saved.

Step 15:

Close this document. When sending this questionnaire to my e-mail address: elsabe.conradie@up.ac.za please ensure that you have attached the file "SC Survey" to the e-mail.

THANK YOU FOR YOUR PARTICIPATION!

Appendix 6: Questionnaire in MS Word format to journalists

SCIENCE COMMUNICATION AT HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA

The questionnaire will follow a step-by-step process. Please follow the steps very carefully to ensure that all the data is captured.

Step 1:

Click on the file button and save us to save under 'my documents' to ensure that you have saved this document as "SC Survey" in your directory.

Step 2:

Please read the following section to ensure that you understand the example.

In each of the statements in the section below, please use the scale 1=Strongly disagree and 5=Strongly agree, to indicate your answer. Please mark your answer with an 'X' in the appropriate box.

FOR EXAMPLE:

	Please mark your answer with an 'X' in the appropriate box.				
Our institution regards science communication as ...	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree
1... a high priority.	1	2 X	3	4	5
2... effective in our institution.	1	2	3	4 X	5

PLEASE NOTE FOR THE PURPOSE OF THIS RESEARCH, COMMUNICATION SPECIALIST INCLUDES PUBLIC RELATION OFFICERS, LIAISON OFFICERS, MARKETING STAFF.

Step 3:

Section A consists of 6 questions. Please answer each question by following the instructions provided below.

Section A: Importance of science communication

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use V0		1-3	
1... science communication is regarded as a high priority.	1	2	3	4	5	V1		4	
2... greater understanding of science among non-scientific publics result in less opposition to scientific research.	1	2	3	4	5	V2		5	
3... scientists have a duty to communicate their research to the general public.	1	2	3	4	5	V3		6	
4... new science discoveries should be communicated to all stakeholders of higher education institutions.	1	2	3	4	5	V4		7	
5... **social** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V5		8	
6... **ethical** implications of science prohibit scientists to communicate their research to non-scientists.	1	2	3	4	5	V6		9	

Step 4:

Click on the save button to ensure that your answers are saved.

Step 5:

Section B consists of 6 questions. Please answer each question by following the instructions provided below.

Section B: Relationship

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

A relationship between key role players in science communication is important in Higher Education Institutions (HEI), therefore…	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
7… there is a relationship of trust between journalists and *executive management* of HEI.	1	2	3	4	5	V7		10	
8… there is a relationship of trust between journalists and *scientists* at HEI.	1	2	3	4	5	V8		11	
9… there is a relationship of trust between journalists and *communication specialists* at HEI.	1	2	3	4	5	V9		12	
In my opinion…									
10… journalists do not regard news releases received from communication specialists at HEI as being important.	1	2	3	4	5	V10		13	
11… journalists are sceptical of science information received from communication specialists.	1	2	3	4	5	V11		14	
12… the media has contacted HEI more than 3 times during last year to obtain science information.	1	2	3	4	5	V12		15	

Step 6:

Click on the save button to ensure that your answers are saved.

Step 7:

Section C consists of 2 questions. Please answer each question by following the instructions provided below.

Section C: Training

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion…	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
13… journalists in South Africa received basic training in science writing to be able to write science articles.	1	2	3	4	5	V13		16	
14… a basic course in science writing is not a requirement to communicate science to various stakeholders.	1	2	3	4	5	V14		17	

Step 8:

Click on the save button to ensure that your answers are saved.

Step 9:

Section D consists of 6 questions. Please answer each question by following the instructions provided below.

Section D: The media

Use the following scale to indicate the **extent of your disagreement or agreement** with the statements: 1=Strongly disagree, 2=Disagree, 3=Neutral (Neither disagree nor agree), 4=Agree, 5=Strongly agree. Please mark with an "X".

In my opinion…	Strongly disagree	Disagree	Neutral (Neither disagree nor agree)	Agree	Strongly agree	For office use			
15… scientists prefer to communicate directly with journalists.	1	2	3	4	5	V15		18	
16… journalists have a good knowledge about science when interviewing scientists.	1	2	3	4	5	V16		19	
17… the general coverage of science in the **national newspapers** is efficient.	1	2	3	4	5	V17		20	
18… the general coverage of science in the **local newspapers** is efficient.	1	2	3	4	5	V18		21	

19... the general coverage of science in **magazines** is efficient.	1	2	3	4	5	V19		22	
20... the general coverage of science on the **radio** is efficient.	1	2	3	4	5	V20		23	
21... the general coverage of science on **TV** is efficient.	1	2	3	4	5	V21		24	
22... science articles do not sell newspapers.	1	2	3	4	5	V22		25	
23... the media sensationalises science.	1	2	3	4	5	V23		26	

Step 10:

Click on the save button to ensure that your answers are saved.

PLEASE CONTINUE ON THE NEXT PAGE:

Section F: Demographic information

Please answer the following questions by marking an "X" in the appropriate box.

24. Gender:

Male	
Female	

25. Please indicate your language preference:

English	
Afrikaans	

26. Do you speak any other South African language?

Yes	
No	

27. Please indicate your highest tertiary education level

Certificate	
Diploma	
Degree	
Honours	
Masters	
Doctorate	
Other	

28. Is your qualification related to public relations?

Yes	
No	

29. Please indicate if you have received any science writing training. If your answer is YES, please continue with questions 30, 31 and 32. If your answer is NO, please continue with question 33.

Yes	
No	

For office use		
V24		27
V25		28
V26		29
V27		30
V28		31
V29		32

For office use		
V30		33
V31		34
V32		35
V33		36

30. Where did you receive your science writing training?

Locally	
Internationally	
Both	

Please specify the town and country:

_____

31. What type of science writing training did you receive?

Formal (e.g. University, Technikon)	
Informal (e.g. PR Association)	
Both	

Please specify the institution:

_____

32. Please indicate the highest level of **science writing (journalism) training** that you have received.

As an undergraduate subject	
As a degree in journalism	
As a post graduate subject	
As a post graduate degree in science journalism	
As a diploma course in science journalism	
As a certificate course in science journalism	
As a short course in science writing (e.g. a few days)	

33. Please provide the name/s of the tertiary institutions, that you are aware of, that offer science writing/journalism education/training.

_____

34. Please indicate the name of the newspaper / magazine of which you are an employee.

BEELD	PTA NEWS	STAR	BURGER	For office use		
ARGUS	NATAL MERCURY	SOWETAN	MAIL & GUARDIAN	V34		37
SUNDAY TIMES	RAPPORT	VOLKSBLAD	HUISGENOOT			
FINANCIAL MAIL	FINANSIES & TEGNIEK	THIS DAY				

Step 11:

Click on the save button to ensure that your answers are saved.

Step 12:

Please answer the following section. If you choose not to complete this section, you can still submit your completed questionnaire without this information.

OPTIONAL INFORMATION: PARTICULARS OF RESPONDENTS

May I please have the following personal information? This information will only be used if I might want to follow-up with you on some of your answers.

Name:

E-mail:

Telephone number:

Employer:

Current position:

Step 13:

Click on the save bu5tton to ensure that your answers are saved.

Step 14:

Close this document. When sending this questionnaire to my e-mail address: elsabe.conradie@up.ac.za please ensure that you have attached the file "SC Survey" to the e-mail.

THANK YOU FOR YOUR PARTICIPATION!

Appendix 7: Coding used in the content analysis

Coverage	Name of paper	New Discovery	Negative	Visuals	Infographics	Risk	Anthropology	Astronomy	Behaviour	Biomedicine	Cell &	Chemistry	Computer	Earth sci	Environm	Food sc	HIV	Mathema	Paleobiol	Physics	Pseudo sc	Sport	Technolo	Zoology	General
		Feature	Positive			Benefit	Archaeology				Molecular				Ecology	Nutrition									
						Not in quest					Biology														
Overseas	Daily	ND	P			NQ				C															
Overseas	Daily	ND	P			BEN				C															
Overseas	Daily	ND	P			NQ															C				
Overseas	Daily	FEATURE	N			R															C				
Overseas	Daily	ND	P			NQ			C																
Local	Daily	ND	P			BEN											B								
Overseas	Daily	ND	P			NQ																			C
Overseas	Daily	ND	P			BEN																C			
Overseas	Daily	ND	P			BEN															C				
Overseas	Daily	ND	P			NQ																			C
Overseas	Daily	ND	N			R				C															
Overseas	Daily	ND	P			NQ				C															
Overseas	Daily	FEATURE	P			BEN				C															
Local	Daily	ND	P			NQ					B														
Local	Daily	ND	P			BEN														C					
Overseas	Daily	ND	P			NQ													D						
Local	Daily	ND	P			NQ																			D
Overseas	Daily	ND	N			BEN															D				
Overseas	Daily	ND	P			NQ															D				
Overseas	Daily	ND	P			BEN					B														
Overseas	Daily	ND	P			BEN				B															
Overseas	Daily	ND	P			BEN															B				
Overseas	Daily	ND	P			NQ						B													
Local	Daily	FEATURE	N			BEN															B				
Overseas	Daily	FEATURE	P			NQ															C				
Overseas	Daily	FEATURE	P			NQ															C				
Overseas	Daily	ND	P			NQ																			C
Overseas	Daily	ND	N			R															C				
Overseas	Daily	ND	P			NQ															C				
Overseas	Daily	FEATURE	P	Y		NQ									A										
Overseas	Daily	FEATURE	P	Y	Y	NQ		A																	
Overseas	Daily	FEATURE	P	Y	Y	NQ		A																	
Overseas	Daily	FEATURE	P	Y	Y	BEN			A																
Local	Daily	FEATURE	P	Y		NQ																	A		
Overseas	Daily	FEATURE	P	Y		NQ	A																		
Overseas	Daily	FEATURE	P	Y		NQ		A																	
Overseas	Daily	FEATURE	P	Y		NQ															D				
Local	Daily	FEATURE	P	Y		BEN																D			
Local	Daily	FEATURE	P	Y	Y	NQ		B																	
Local	Daily	FEATURE	P	Y		BEN					B														
Local	Daily	FEATURE	P	Y		NQ										B									
Local	Weekly	FEATURE	P	Y		BEN										C									
Local	Weekly	FEATURE	P	Y	Y	NQ	D																		
Overseas	Weekly	ND	P			NQ					D														
Local	Weekly	FEATURE	N	Y		BEN										D									
Overseas	Weekly	FEATURE	P	Y		NQ															D				
Overseas	Weekly	FEATURE	P	Y	Y	NQ					D														
Overseas	Weekly	ND	P			NQ											D								
Local	Magazine	FEATURE	P	Y	Y	NQ		D																	
Local	Magazine	FEATURE	P	Y	Y	NQ		D																	
Local	Magazine	FEATURE	P	Y	Y	NQ		D																	
Local	Magazine	FEATURE	P	Y	Y	BEN									D										
Overseas	Magazine	FEATURE	P	Y	Y	NQ									D										
Overseas	Magazine	FEATURE	P	Y	Y	NQ									D										
Overseas	Magazine	FEATURE	P	Y		NQ									D										
Overseas	Magazine	FEATURE	P	Y		BEN									D										
Local	Magazine	FEATURE	P	Y		NQ									D										
Local	Magazine	ND	P	Y		BEN																	C		
Local	Magazine	ND	P		Y	BEN																	C		
Local	Magazine	ND	P	Y		BEN																	C		
Local	Magazine	ND	P			NQ							B												
Local	Magazine	FEATURE	P		Y	BEN												A							
Local	Magazine	FEATURE	P		Y	BEN												A							
Local	Magazine	FEATURE	P	Y		NQ										B									
Local	Magazine	FEATURE	P		Y	BEN		C																	
Local	Magazine	FEATURE	P	Y		NQ																		C	
Local	Magazine	FEATURE	P	Y		NQ			C																
Local	Magazine	FEATURE	P	Y		NQ			C																
Local	Magazine	ND	P	Y	Y	BEN																			D
Local	Magazine	ND	P	Y		NQ																C			
Local	Magazine	ND	P	Y		NQ																C			

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Local	Magazine	FEATURE	P	Y	Y	BEN								C									
Local	Magazine	FEATURE	P	Y	Y	BEN								C									

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