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Post-World cup, there has been a sense that South Africa needs to get down to work, with a renewed commitment to delivery, monitoring and performance. The articles in this edition review current research to identify major constraints and blockages and to propose new ways forward in relation to three critical aspects of education, skills development and innovation.

Proposals to refine the school curriculum and the impact of the public sector strike make Fabian Arends's review of the recent research literature around the vexed issue of teacher supply and demand very timely. He shows that if current trends continue, there may be an absolute shortage of teachers but more significantly, shortages relate to key subjects and school levels - and hence, addressing future shortages in a targeted manner requires prioritization of appropriate data to inform planning.

Contributing to deepen debate begun in the course national consultative summits around higher education, further education and training, and skills development over the past six months, Michael Cosser presents an analysis of the main problems of alignment and articulation in the post-schooling sector based on a review of research undertaken and on unfolding developments in the higher education and training policy arena. He identifies two possible policy options to create new education and training pathways that can expand and differentiate the post-schooling landscape.

Michael Gastrow tackles an issue that has not yet received much attention - the significance of the media in shaping the public understanding of science. He shows not only that there is very little coverage of controversial biotechnology issues in local media, but also, that there are strong biases in the framing of coverage, and poor communication between scientists, the media and government. Addressing these gaps can have a positive effect on public awareness, and the potential for biotechnology to advance national priorities.

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## TEACHER SHORTAGES? THE NEED FOR MORE RELIABLE INFORMATION AT SCHOOL LEVEL

Fabian Arends

Education researchers in South Africa concur that there are teacher shortages in schools. We are not sure whether current projections give a true reflection of teacher demand or shortages, and whether the situation is actually better or worse than generally thought. How should we understand teacher demand and what prevents us from getting a comprehensive understanding of teacher supply and demand issues?

The main argument presented in this review of the recent research literature is that more teachers leave the teaching profession than new recruits enter. If this trend continues, we will be faced with a problem. However, most

projections are based on teacher attrition at aggregated levels, which does not provide the full picture of shortages. Whether or not we have enough teachers can only be understood at the level of the school and the subject. The main problem preventing such a comprehensive understanding is the lack of appropriate data.

Crouch and Perry (2003) argued that the South African education labour market has not been as turbulent as common sense argument would suggest, at least in comparison with what we forecast for the future. The socio-economic dynamics in this segment of the labour market are also not markedly different from those in other sectors. A general conclusion by researchers is that

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interaction between demand and supply in the education labour market is not unique or different from other labour markets in South Africa, and that the attrition rate is not markedly different when compared internationally. The teacher attrition rate in South Africa is currently estimated between 5 and 5.5% (Peltzer et al. 2005), which is in line with international trends (DoE 2006). Attrition in Singapore is estimated at 3% annually, compared to 14% in the United States of America (USA) overall and 20% in USA high-need schools.

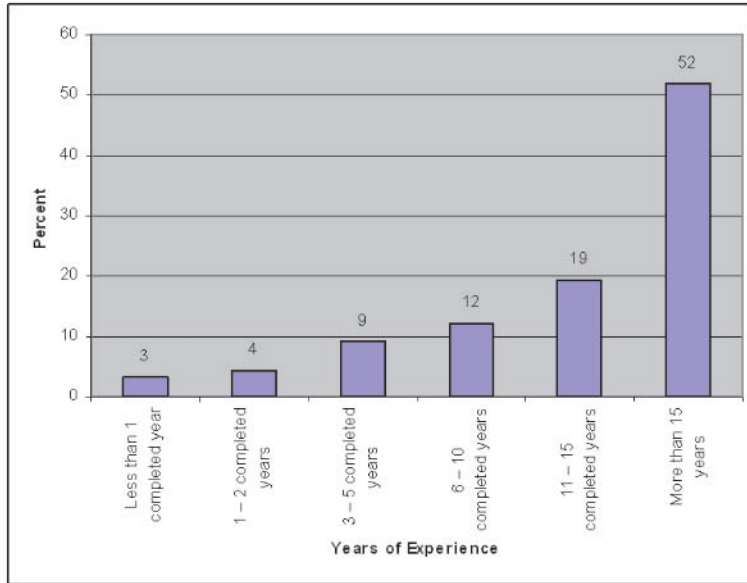
However, you do not have to be a mathematician or statistician to see that our figures of projections - estimates of the number of teachers who exited the profession - and outputs - education graduates from higher education institutions - simply do not add up. Projections from the 2005 HSRC study of supply and demand, commissioned by the Education Labour Relations Council (ELRC), estimated that between 18 000 and 22 000 teachers annually leave the teaching profession voluntarily or forcibly (Peltzer et al 2005). The assumption is that the 18 000 to 22 000 educators who exit the teaching profession need to be replaced by an equal number of teachers. With an estimated output of 6 000 to 10 000 new teacher graduates annually from higher education institutions, some who might not enter teaching or who might teach abroad, we could face a serious teacher shortage in the near future.

There is thus potentially an absolute shortage of teachers due to attrition, but the question is, who is filling current and vacant posts? The age distribution of educators within the profession gives insight into the balance between the inflows of young professionals, the proportion of mature experienced professionals and those cohorts nearing retirement.

A recent HSRC study commissioned by the former national Department of Education indicated that more than half of the teachers surveyed have more than 15 years teaching experience, and more than 60% are older than 40 years of age (see Figures 1 and 2). Less than 5% were younger than 30 years of age and 25% were 50 years of age and older (10% were 55 and older). The 2005 ELRC study identified two peaks in age specific attrition rates - one among educators aged 55 and above (66% accountable to retirement

and 18% to resignation) and the other among educators aged 25 to 34 years of age (where resignation accounts for 80% and mortality for 15%).

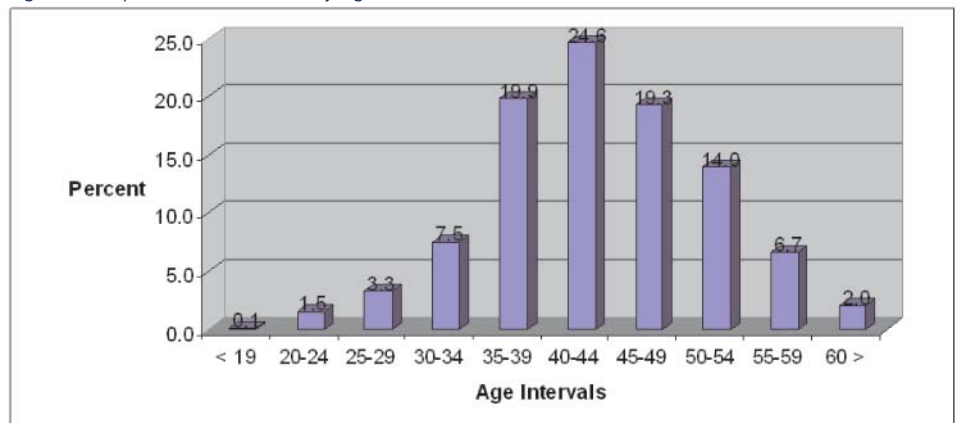
Figure 1: Proportion of educators by Years of Experience



There are two possible causes of this low proportion of young teachers. Crouch (2005) found that the more qualified and experienced educators tend to stay in the teaching profession and the younger, less qualified left the profession early. Further research is required to ascertain the proportion of newly qualified young teachers who in fact do not enter the teaching profession.

It could also reflect how few young people have chosen teaching as a profession over the last ten years. Recent research shows that it is difficult to attract new recruits to the teaching profession, and to study towards a teaching qualification, especially the traditional constituency of African women.

Figure 2: Proportion of Educators by Age Interval



Research by Michael Cosser (2009) on a cohort of learners who were in grade 12 in 2005, shows that while 3% of those learners planned to enroll in education programmes, 5% actually did so in 2006. What this statistic suggests is that poor grade 12 results pushed more students than wished to study education, into education programmes (Chisholm 2009). Cosser (2009) argues however, that the commitment to the notion of studying education is far stronger than the commitment to the notion of

entering the teaching profession. Aspirant teachers have less faith in finding a job in their chosen profession and believe that their chosen profession has far less status in the community than do aspirant veterinary practitioners, accountants and engineers (Cosser and Sehlola 2009).

The majority of teachers, 67%, is and historically has been, women. Today, teacher education is forced to compete with other occupations to attract talented employees and the effects of this competition are evident. Educator attrition is generally higher for females than males (Peltzer et al, 2005). As labour market opportunities for women have improved, more women have chosen to enter other occupations, particularly those with

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strong academic skills who can find alternatives where they will receive a higher return on their skills (Eide, Goldhaber and Brewer, 2004).

To complicate matters further, there is evidence to suggest that young African women, the traditional constituency for the profession, are not enrolling for teacher training or for any other education programme at higher education institutions because of insufficient personal or household resources (Paterson and Arends, 2008). The relatively low numbers of African students studying teacher education in the 25-and-under category could be explained with reference to the disadvantaged school and socio-economic environment that large numbers of young Africans must overcome to enrol in higher education. As a consequence of a variety of factors (for example, older completion of Grade 12, time spent in seeking funding or taking care of household responsibilities) it is possible that African women who register for a teacher training programme are older than their white classmates, and enter the teaching profession at a much later stage of their lives (Paterson and Arends, 2008).

Taken together, these trends could account for the small proportion of teachers aged 30 years and younger (Figure 2), and highlight key features of the imbalance in supply and demand.

Supply and demand is not simply about the

right numbers but about the right kind of teachers for subject fields and levels. The majority of teachers in South Africa is qualified - 89% has either a professional or academic qualification (DoE 2009) - but the most important question is whether these professionals are assigned to teach classes matching their subject specialisation. The cause of out-of-field teaching lies in the lack of fit between teachers' fields of training and their teaching assignments. It would seem that many teachers are assigned by their principals or school management teams to teach classes that do not match their training or education.

To illustrate the problem, we present data from the recent Teacher Qualification Survey (DoE 2009) for one key subject field - the number of mathematics teachers in different school phases who have relevant qualifications. Of the 828 Intermediate Phase Mathematics teachers in the survey, 94% had a professional qualification, but only 34% of these had a professional qualification with mathematics as a subject. Of the 226 Further Education and Training (Grades 10 to 12) mathematics teachers, 81% obtained a professional qualification, and 36% an academic qualification. Fifty percent of the teachers with a professional qualification had mathematics as a subject, and 21% of the teachers with an academic qualification had mathematics as a subject. Even though the majority of teachers in the education system do have qualifications, there is not an

adequate match between their subject specialization and what they teach.

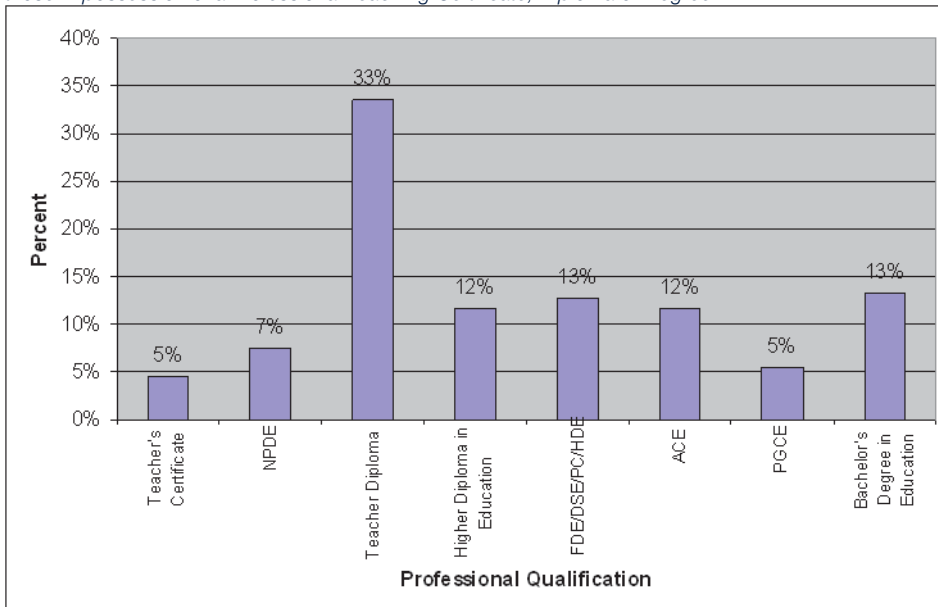
Matching teachers with posts is challenging, because the qualification profiles of teacher are not linked to their subject specialization. Another concern is that although many teachers may claim to have specialized in specific subjects there is a lack of clarity of the reasons why are they not teaching in that specialism. The dynamics of the utilisation of educators is influenced by decision-making at school level, and it is not simply that the best qualified educators are granted 'permission' to teach in areas in which they are qualified (Peltzer et al 2005). And even if this is the case, the possibility exists that teachers are teaching subjects for which they are not qualified but have many years of teaching experience.

Thus, clearly, determining the actual shortage of teachers by school and by learning area is an extremely complex task that will require complex mathematical modeling, to take into account the actual attrition or the replacement demand of an ageing workforce or the gender constraints on future supply or the need for subject specialisation.

The challenge of matching teacher supply and demand is about meeting the need for scarce and critical skills in schools - both providing them for education and finding them for education (Chisholm 2009). This means not only expanding the numbers of graduates and teachers in the areas of mathematics, science and technology, but improving the quality of teacher education overall so that the quality of those mathematics, science and technology graduates is adequate. The issues of education and teacher quality however, must be the subject of a separate review.

Teacher labour markets are controlled through a system of post provisioning and teacher deployment that suffers weaknesses common to centralized systems (Chisholm 2009). Their aim is to achieve greater equity and meet demand. The problem is that they do not. We have projections on teachers leaving the profession, but we do not have any information on their qualification status and subject specialization. Provincial departments of education have no monitoring mechanism in place to assess whether educators with the

Figure 3: Percentage of teachers according to their highest teaching qualification as a percentage of those in possession of a Professional Teaching Certificate, Diploma or Degree



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appropriate qualification status and subject specialization are optimally used within their subject fields. Some of the information required is available in provincial Department of Education databases and some data is available in sample surveys. But there is no comprehensive database containing all the variables required to provide a comprehensive assessment of teacher supply and demand. What do we need to know at the school level to ascertain whether there is a shortage of teachers in a particular subject?

- Number of teachers teaching a subject, by number of classes and level.
- Number of learners by school, and number of learners by subject and grade.
- Subject specialization of teachers linked to their qualifications
- Subjects taught, classes taught by week, training in years.
- Teachers age relative to retirement

In conclusion, the teacher shortage in education, particularly the shortage of mathematics and science teachers, has been hotly debated in the media. This short review article does not claim to provide a comprehensive model for understanding teacher supply and demand at the school level but highlights that data does exist that can provide better insight than the blunt aggregate measures used to date. Teacher attrition and recruitment data provides a macro

picture of supply and demand of teachers but the dynamics at local level are much more complex. Teacher shortages can only be understood and determined at the school level, by taking into account the age distribution of teachers and the relation of educators to learner enrolment, either comprehensively in the primary phase, or related to subjects in the secondary phase. Administrative databases are good data sources with the ability to indicate whether out-of-field teaching in core subjects is common in both public and private high schools in South Africa. This analysis must be augmented with research investigating the dynamics of out-of-field teaching at school level.

Improved collection, management, analysis and interpretation of education information would not only assist departmental planning but would also provide insight into the contested policy issue of the nature of teacher shortages.

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## CREATING NEW EDUCATION AND TRAINING PATHWAYS: HOW DO WE EXPAND AND DIFFERENTIATE POST-SCHOOLING OPPORTUNITIES?

**Michael Cosser**

The unbundling of the erstwhile Department of Education to create the departments of Basic Education and Higher Education and Training has paved the way for redrawing the post-school landscape and forced a re-examination of the entire education and training pathway system. The major implications are that Further Education and Training (FET) colleges now belong within the higher education and training stable and that universities are no longer the only institutions,

but also, that the division changes the way we view the intersection between further and higher education. At present, the National Senior Certificate (NSC) - the qualification achieved at the end of the senior secondary phase of schooling - and the National Certificate (Vocational) (NC(V)) - the qualification achieved at the end of the three-year FET college programme - are offered at the same level 4 of the National Qualifications Framework (NQF). The legislative change

clearly points to the NC(V) now falling within the higher education and training band, if only at level 5 of the NQF.

Not only does the NC(V) now belong, legislatively, within the higher education and training fold; but recent evidence (Muller, 2010) suggests that it is in fact cognitively more demanding than the NSC. To this legislated and cognitive misalignment, we may add historical misalignment. A review of



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recent research on different aspects of the present model of education and training in South Africa reveals major problem points in the pathways of learners wanting to progress up the educational ladder.

The first is a lack of articulation and progression across the post-schooling system. HSRC research shows that four-fifths of graduates from programmes in FET colleges that are meant to lead to a NSC at NQF level 4 already have achieved a senior certificate at level 4 prior to enrolment. Most of them reverted to a learning programme lower than their NSC to achieve NATED (National Education curriculum, or "N" - DoE, 2001) FET college qualifications. Similarly, while the admission requirement for entry into an auxiliary nursing programme is a grade 10 (the first year of the programme leading to the NSC), according to the South African Nursing Council many entrants have also achieved a senior certificate prior to enrolment. The same articulation problem occurs within learnership programmes: HSRC research

labour market.

More strongly however, the clamour for university study highlights the dearth of institutional options at the intermediate level. HSRC longitudinal national research studies have shown that more than half of all grade 12 learners plan to proceed to university after leaving school. Only between 15% and 20% actually go on to university the following year. Clearly, there is a disjuncture between aspiration and actualization, but equally, universities do not have the capacity to accommodate the demand (Cosser with Du Toit, 2002; Cosser, 2009).

The effect is a funneling of students into higher education who would have pursued other post-schooling options, were they available. Such funneling comes at a cost. The attrition rate in universities is notoriously high (between 40% and 50%), suggesting that notwithstanding the need to enhance access to higher education - particularly of black African students (Cosser 2010) - many of the

education in FET colleges is not a NEET solution: FET colleges are not the most appropriate vehicle for a social engineering project to get youth off the streets and into meaningful activity. Such a project distorts the original mission of the FET college, to develop technological skills at the intermediate level that will form the backbone of the "technicians and associate professionals" arsenal.

The NEET issue is not merely a problem of educational pathways, but also of unemployment. Particularly for such youth, but for all college graduates, employment prospects are a concern. Although there are no systematic tracking mechanisms in FET colleges at present, there are indications, from a recent HSRC-conducted FET audit, that students emerging from colleges with a vocational national certificate (NC(V)) are not finding employment. This is partly because employers are skeptical of the value of the NC(V) qualification - ironically demanding a national senior certificate or preferring N-qualifications - and partly because of the low absorptive capacity of the labour market. It may be too early to assess the real success of the NC(V), however, given its very recent introduction.

Three major issues - the dearth of learning opportunities at the intermediate level, the attempt to distort the central purpose of the FET college by creating for it a remedial focus, and the mismatch between FET college provision and labour market absorption - suggest that the FET college cannot embody the only institutional type between the school and the university for meeting young people's aspirations for further learning.

Researchers have argued for the need to expand and differentiate learning options at the intermediate level (Lolwana 2010, Cloete 2009). The present pathways model is narrow in its focus and nebulous in its orientation. FET college provision effectively leaves behind those students seeking to pursue the kind of single-purpose education formerly offered by technical, education, nursing and agricultural colleges. Thus, neither the needs of the youth unemployed and under-educated, nor of youth seeking a technological education, nor of youth wanting more focused learning opportunities, are accommodated. Bringing FET colleges, SETAs, and other skills

*HSRC research found that 72% of young unemployed learners have a qualification at NQF level 4 when they enrol for a learnership - the overwhelming majority (92% of this group) have enrolled for a learnership programme at a level lower than or equal to NQF level 4.*

found that 72% of young unemployed learners have a qualification at NQF level 4 when they enrol for a learnership - the overwhelming majority (92% of this group) have enrolled for a learnership programme at a level lower than or equal to NQF level 4. For all these learners, educational achievement has been a game of snakes and ladders in which progression is haltingly and falteringly slow.

A second problem point concerns the inadequacy of public provision. Private vocational education has been found to be far more popular than public education in the FET sector, having grown exponentially in the 1990s. The growth of private vocational education suggests that there are too few institutional options at the intermediate level to cater for the demand for further learning. It also suggests that public FET colleges are not perceived to provide credible programmes in sought-after technical and vocational learning areas that will lead to uptake in the

students should be enrolling in different types of institution for qualifications other than degrees. And though many universities provide comprehensive support for students ill-prepared for university study - in the form of bridging programmes, extended curricula, intensive and sustained academic development and the like - at what cost is such remediation provided? Universities cannot continue to bear the human and financial resource brunt of failures in the schooling system and lack of options in the post-schooling system.

A different kind of problem occurs in the course of the secondary system. Learner attrition after grade 9 and throughout the FET levels (grades 10 to 12) has resulted in an estimated 2.8 million 20 to 24-year-olds not being in employment, education or training (NEET) (Cloete, 2009) - youth whom the erstwhile Department of Education proposed re-educating in FET colleges. But remedial

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development initiatives formerly housed in the Department of Labour into the fold of the DHET has major positive implications for the restructuring of the post-schooling landscape and creating new education and training pathways. Two options seem to be available to policy-makers. The first is to use the existing framework, to strengthen institutions and expand programme provision. The motivation is that after almost two decades of institutional change and restructuring, a period of consolidation and institution building is required. Such a strategy could involve not only reconfiguring the FET college programme and qualifications mix (PQM) to include NC(V), N and the skills programmes currently on offer, but also, broadening vocational provision by:

- expanding the scope of the NC(V) in primary agriculture and including secondary agriculture
- providing nursing education programmes to fill the gap left by the closure of nursing training colleges; and
- catering more specifically, through the mounting of bridging programmes and the reintroduction of the NSC, for those learners not in employment, education or training (NEET).

It could entail regulation of private vocational education and training to better complement public provision, and clarifying the coordinating role of SETAs. At the same time, the DHET would need to mediate the implementation of the rules of progression to obviate the kinds of misalignment outlined

above, to ensure that learning is progressive rather than repetitive or regressive.

The second option is to reconfigure the entire education and training landscape - as I argue in a forthcoming publication (Cosser, 2011). In brief, the model I propose divides education and training into two phases, basic education and post-basic education. Basic education is synonymous with twelve years of schooling. Post-basic education would comprise three stages. The first two allow for an expansion of the number and type of institutions providing

*What is clear from this review of research on post-schooling pathways however, is that we need a vigorous national debate to consider how best to tackle the critical problem points. The status quo cannot prevail. Would it be better to streamline and strengthen the existing system, or to create a new systemic model?*

*The education authorities will need to pursue one or a combination of these policy options in order to create credible, relevant and viable pathways for learners through the education and training system and into the labour market.*

post-basic education at the intermediate level - notably agricultural, nursing, technology, education and community colleges. The third stage would be university education. Such a three-stage arrangement could address the simultaneous need for expansion and differentiation identified by Lolwana (2010).

The major innovation in the model is the proposal for the establishment of the community college (Cosser 2011), as mooted during the discussions that led to the formulation of the ANC's education policy in the 1990s. The community college as here envisaged is a multi-purpose institution catering for the needs of students who have dropped out of secondary school or completed a matric that does not permit

university entrance; have failed grade 12 and wish to repeat the year; wish to proceed from an NSC to an NC(V) programme; wish to complete the first two years of a university degree; or who wish to achieve credit for occasional courses that could accumulate towards a full qualification. The practicalities of establishing community colleges as new institutional types will need to be carefully researched.

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## FRAMING THE DISCOURSE: THE PUBLIC UNDERSTANDING OF BIOTECHNOLOGY IN THE MEDIA

**Michael Gastrow**

Modern biotechnology is commonly seen to have originated in 1973, when the first patent on recombinant DNA techniques opened up prospects of designing organisms and reaping economic benefits from them. The production of genetically modified soya in 1996, and the birth of Dolly the cloned sheep in 1997, propelled biotechnology into the public discourse, and the world media began to play a key part in influencing public debates about genetic modification and cloning. This included controversies related to Genetically Modified Organisms (GMOs), which

understand the interplay between biotechnology, public attitudes, and the media. The broad theoretical framework within which to situate these questions is found in the literature related to the public engagement with science. This literature addresses questions such as: what kind of relationships should exist between the public and scientific institutions, what role should the public play in the policy-making process, what kinds of knowledge and attitudes are relevant to these relationships and processes, and how should we measure them?

phenomenon. Firstly, biotechnology projects need to mobilize support, whether from firms, governments, academics, or the good will of the public. Secondly, imagined future scenarios and reasoned arguments more or less determine this support in society. Thirdly, the technology movement is not homogenous and may have internally conflicting goals. Fourthly, the actors of this movement encounter a public sphere where they are (re)presented in a manner that informs attitudes and public perceptions of the technology. Finally, a technology movement is not a unified movement, but rather consists of integrated competition among actors, for example over public good will or regulatory arrangements (Bauer & Gaskell, 1999; Bauer, 2002).

*Since biotechnology has the potential to contribute towards addressing several national priorities, including aspects of health, food security, and environmental sustainability, it is important for public agencies to have a clear understanding of how media representations of biotechnology advance or impede the development of the sector in South Africa.*

stimulated debates about food safety, genetic integrity, labeling policies, and the traceability of food, as well as controversies related to the ethics of human cloning for reproductive or therapeutic purposes, and other health applications of biotechnology, such as stem cell research.

Since biotechnology has the potential to contribute towards addressing several national priorities, including aspects of health, food security, and environmental sustainability, it is important for public agencies to have a clear understanding of how media representations of biotechnology advance or impede the development of the sector in South Africa. For example, a high level of public awareness, coupled with access to fair, objective, and scientifically accurate reporting and information, is more likely to lead learners and students into biotechnology career pathways, more likely to stimulate entrepreneurial activity, and more likely to lead to fair and positive outcomes where there are controversies.

Clear conceptual, theoretical and methodological frameworks are required to

The earliest paradigm through which to view the relationship between science and the public emerged in the 1950s, when scientific literacy was seen as the key measure of the public's engagement with science (Bauer et al., 2007; Miller, 1998, 2004; Laugksch, 2000). In the 1970s, the focus shifted onto attitudes, rather than knowledge (Gregory and Lock, 2008; Allum et al, 2008; Bauer et al., 2000). However, unpacking the determinants of literacy and attitudes required an analysis that examined attitudes towards science as social constructs. Thus, during the mid 1990s, the Science in Society paradigm emerged. This model held that the relationship between science and the public is not based only on literacy or attitudes, but also on the public's social, cultural and political environments (Bauer et al., 2007).

A core literature on the role of the media in the public sphere of biotechnology has been developed using such a framework, in which biotechnology is considered a 'social movement'. Martin Bauer of the London School of Economics is a central figure in this literature, which ascribes several key characteristics to biotechnology as a social

These characteristics inform the core heuristic that shapes many studies of biotechnology in the media, one that is centred around the idea of the public sphere, as expressed for example by Habermas (1989). This heuristic was developed by Bauer in his 2002 paper, 'Arenas, platforms, and the biotechnology movement', and was applied in a large research project to measure media representations of biotechnology in Europe (Bauer, 2005). This saw the relationships between policy making, the media and public opinion as complex. On the one hand, many actors, for example in politics and business, refer to the media as an index of public opinion - i.e. it is partially a reflection of public opinion. On the other hand, the media circulate messages widely and thus inform public opinion too. It is also important to recognise that powerful actors have an influence over controlling and framing news, including representations of biotechnology. These include actors from governments, firms, lobby groups, non-profit interest groups or pressure groups, scientists, and the press itself. These actors compete to frame biotechnology-related issues in their own interests (Krimsky, 1991). The contribution of these actors and relationships to the trajectory of biotechnology is a key empirical question (for example in Bauer, 1991, 1995).

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There have been many studies illustrating the utility of analyzing media outputs as sources of technology-related information for the public, for example Wade and Schramm (1969), Robinson (1972), Griffin (1990), Mazur (1981), Coleman (1993) and Dunwoody & Peters (1992). There have also been several empirical investigations focused on biotechnology in the media. Gaskell et al (1999) studied coverage by the Washington Post through the 1980s and 1990s. Other examples include studies by Beall and Hayes (1996), Priest and Talbert (1994) and Marks et al (2000). More recent empirical research includes Nisbet and Lewenstein's (2002) paper analyzing coverage of biotechnology in the elite press in the USA, as well as Bauer (2005) and Bonfadelli's (2005) analyses of biotechnology in the European media, using the same data-set from 12 European countries.

A recent small scale study undertaken for the National Advisory Council on Innovation and the National Biotechnology Advisory Committee

sought to determine how biotechnology is reported in the South African media, how biotechnology is understood by members of the media, and whether these factors are advancing or impeding the development of biotechnology in South Africa. The methodology for this particular study combined key informant interviews and an analysis of media outputs. Interviews were conducted with science journalists, science editors, and academics. The media analysis followed international best practice methodologies (e.g. Nisbet & Lewenstein 2002; Bauer, 2005, and Bonfadelli, 2005). This drew on the archives of selected print and online news publications by searching for articles featuring biotechnology-related terms. These articles were coded according to 'frames' (latent content), themes (explicit content), tone (reporting on risks, benefits and controversies) and the key actors mentioned in the text. This methodology allowed for the construction of a profile of media coverage of biotechnology.

Analysis of both the media outputs database and of the key informant interviews found that biotechnology is generally under-reported in

the South African media. Searches of the full online archives of one regional newspaper found no references to biotechnology at all, while another regional newspaper featured only four articles over a period of three years. Even an opinion-leading publication (the Mail & Guardian) featured only 16 articles over a period of six years. On the other hand, a search of a leading online news site rendered hundreds of articles. Thus, access to media representations of biotechnology is greatest in the online media; at the same time, much of the South African population does not have access to the online media. This may hamper the cultivation of public awareness of biotechnology, particularly amongst the less privileged. Since radio and television are primary media for much of the population that do not have access to the internet, these media might be appropriate for public policy interventions.

*One of the key policy objectives proposed by most interview respondents was to aim for objective and balanced reporting, rather than 'sensationalism'.*

*The question of sensationalism in the media is a normative association not amenable to objective measurement.*

The media analysis revealed that biotechnology is mostly reported within the frame of scientific progress, and to a smaller extent within the frame of ethical enquiry. Within these frames, two dominant thematic loci were identified by both the media analysis and the key informant interviews identified, namely 1) genetically modified plants and animals for human consumption and 2) health applications of biotechnology. However, these two thematic loci are reported in substantially different ways. The most striking of these differences is with respect to the reporting of controversies, where GMOs tend to be reported on unfavourably (reporting on risks but not benefits), and health applications favourably (reporting on benefits but not risks). Articles about GMO plants and animals had a focus on the related risks to public health and the environment, together with a common concern about the ethics and business practices of the multinational firms that now control a large proportion of the world's supply of agricultural seeds. On the other hand, health applications, mostly related to breakthroughs in stem cell research conducted abroad, were celebrated for their benefits with little focus on the risks.

There are two general attitudinal approaches to the reporting of biotechnology, and debates are often polarised with little middle ground. One approach focuses on the science of biotechnology, with the view that it is the acceptable role of science to ask questions and push technical boundaries. The other approach adopts a moralizing point of view that focuses on the ethical implications of the science, rather than the science itself. This approach is often made from a reactionary or religious point of view which perceives biotechnology to be unethical and "playing god".

Normative reactions from readers can be gauged by examining online postings commenting on articles, and these follow a similar pattern, indicating that debates about biotechnology are polarised in society as well as in the media. However, this polarisation is

rarely if ever about the validity of the science itself - the focus is on the ethical implications.

The two thematic loci also displayed differences in terms of their narrative origin. Debates about stem cell research were all related to events taking place in the USA, South Korea, and other locations outside of South Africa. In contrast, debates about GMO plants and animals were often related to events in South Africa, and had direct relevance to domestic priorities. Thus, interventions seeking to mediate controversies should be targeted at debates about GMO applications of biotechnology. For example, efforts to bring scientists and journalists closer together, or efforts to create a space for open dialogue between firms and NGOs, might achieve more through a focus on GMOs than on biotechnology in general.

One of the key policy objectives proposed by most interview respondents was to aim for objective and balanced reporting, rather than 'sensationalism'. The question of sensationalism in the media is a normative association not amenable to objective measurement. However, proxy measurements can be used to provide indicators of unbalanced reporting. Viewed as a whole, the media analysis sample revealed a predominance of unbalanced reporting: 66%



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of articles reporting on a controversy reported only risks or only benefits, rather than both. This is a concerning finding that merits a policy response.

Fair and accurate reporting also requires a level playing field for the various actors influencing the media. The actors recorded were scientists (in 52% of articles), firms (40%), NGOs (20%) and government (16%). However, interviews highlighted that these actors play very different roles in influencing media messages. Journalists and editors were suspicious of the motives of large GMO firms, and tended to view their engagement with the media as self-serving 'infiltration' to further agendas that are often at odds with those of public health or environmental sustainability. Academics, however, viewed the behaviour of these firms more neutrally, perceiving them to be self-serving but also as essential engines of technical progress and resource allocation.

Scientists were perceived by journalists to be

contestation is between big firms and NGOs. Some journalists were suspicious of large firms, and suggested that government policy should rein in the power of firms to 'infiltrate' the media, but were unclear as to how such policy regulations could be designed. Other journalists considered NGOs to be the actors that require restraint, as they often enter debates without sufficient scientific evidence, and are guilty of promoting 'pseudoscience'. Both the media analysis and interview findings indicate that policy in this area should focus on fostering engagement that is based on science rather than rhetoric.

Government actors appeared in a minority of articles analysed, and likewise, all of the interview participants reported that government currently plays no role in the construction of articles about biotechnology in the media. As is the case with universities, participants reported that there are no formal relationships between journalists and government, although some journalists have

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*Developing specific recommendations to meet these objectives will require larger scale research into understanding the interplay between biotechnology, public attitudes and the media*

the most neutral and objective actors and sources of information. They were also perceived to be suspicious of journalists and inaccessible. Scientists, on the other hand, feared that inadequately trained journalists would misrepresent their research, or they felt that engagement with the media should not fall within the ambit of their work. This communication gap is partially a result of fundamentally differing cultures, with academic activities structured by the patient collection of scientific evidence, and journalists' activities structured by tight deadlines and immediate results. Moreover, no formal networks exist between journalists and scientists. Rather, journalists appear to relate to individual scientists through informal networks built over time through personal relationships. Fostering a closer and more productive relationship between journalists and scientists is thus a key policy objective in terms of enhancing both access to information and neutrality in the reporting of biotechnology.

In terms of the other actors, the key area of

cultivated informal relationships and networks within government. All the journalist participants reported that government departments and parastatal agencies perform poorly in terms of providing access to information - for example phone calls and emails are not returned. Thus another key policy objective is to implement measures to enhance the public sector's willingness and ability to provide such information. Clear implications for policy-makers in South Africa emerge from the analysis. Firstly, it would be beneficial to expand the scale of biotechnology reporting in the media, and expand access to this reporting to a greater proportion of South Africans. Secondly, policies should foster objective, balanced, and scientifically accurate reporting. The third objective is to foster a closer and more productive relationship between journalists and scientists. Finally, it is important to enhance the public sector's willingness and ability to provide access to public information. Developing specific recommendations to meet these objectives will require larger scale research into understanding the interplay

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