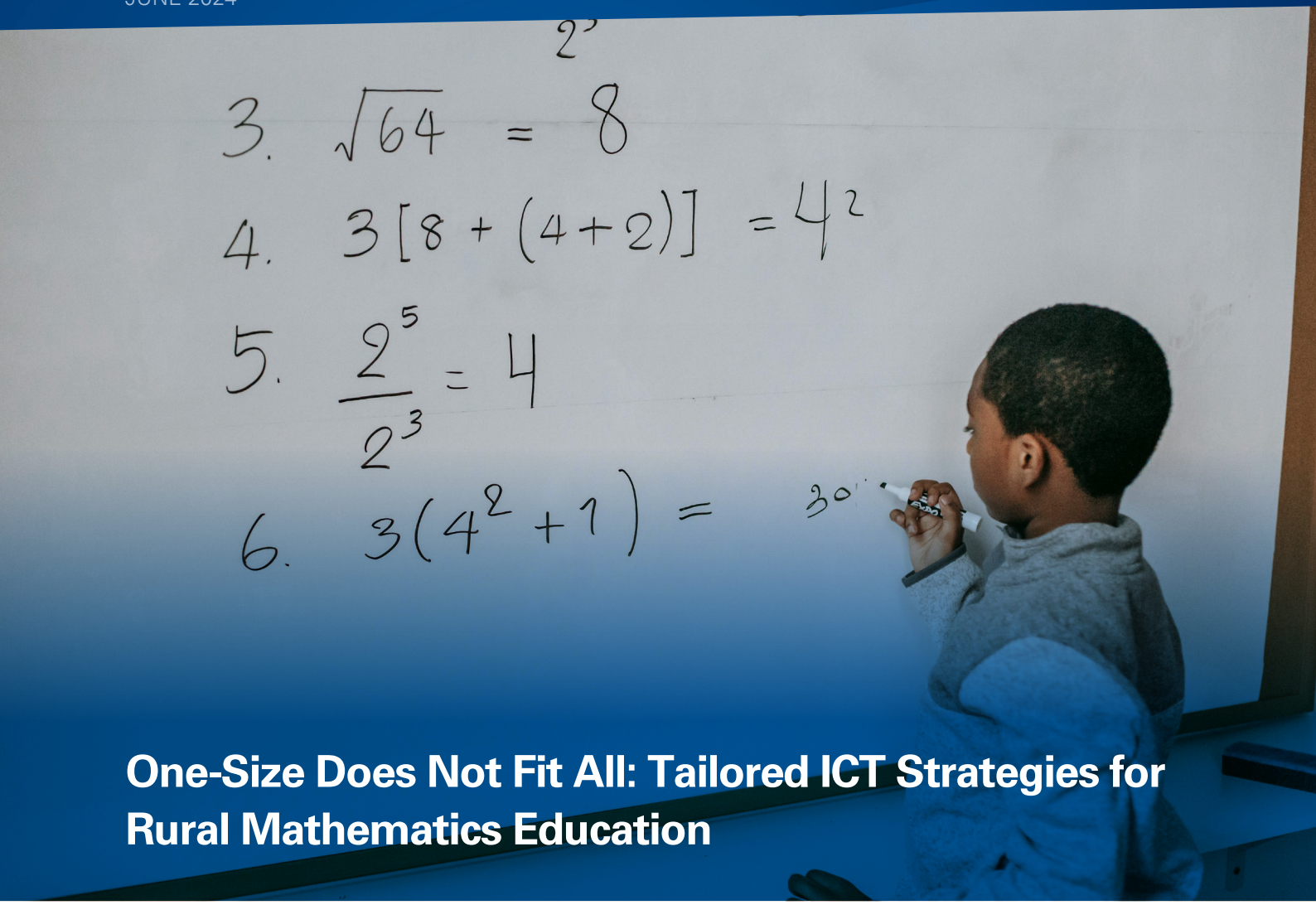
science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

HSRC
Human Sciences
Research Council

POLICY BRIEF

PETRONELLA ELIZE SAAL AND SYLVIA HANNAN

JUNE 2024




# One-Size Does Not Fit All: Tailored ICT Strategies for Rural Mathematics Education

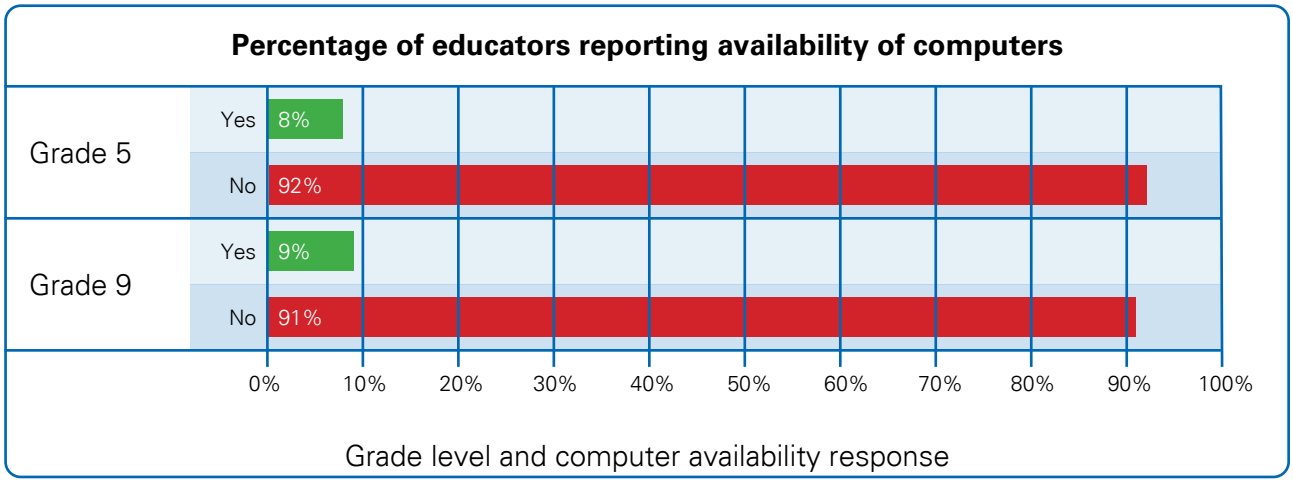
## Executive summary

This policy brief addresses the challenge of integrating Information and Communication Technology (ICT) into mathematics education within schools in South Africa's rural communities. Despite substantial government investment, many schools still lack access to ICT infrastructure, hindering effective ICT usage in teaching and learning, specifically in mathematics. The lack of ICT availability and skills contributes to low technology usage by educators, as well as limited access to ICT resources for learners. To address this issue, tailored ICT integration plans for mathematics in rural communities are recommended. A "one-size-fits-all" approach is ineffective due to rural schools' diverse needs and contexts across provinces. Key recommendations include revising the ICT infrastructure allocation system, providing qualified Information Technology (IT) technicians or training for current educators, specialised ICT training for mathematics educators and developing ICT resources in local languages, made available on an easily accessible database. By implementing these recommendations, South Africa can enhance ICT access and integration in rural schools, thereby improving the quality of mathematics education.

## Introduction

The incorporation of ICT into education plays an important role in fostering innovation, contributing to a country's long-term development goals and equipping learners with digital literacy and skills required for the future of work. However, the effective incorporation of ICT in education faces many challenges, particularly in developing country contexts[1;2] such as South Africa, especially in rural schools. The current state of ICT infrastructure in schools remains inadequate despite substantial investments by the government and the private sector. According to the latest Education Facility Management System (EFMS) from 2023, 66% of schools did not have a computer centre.[4] The lack of ICT is one of many barriers contributing to educators' low usage of technology. The lack of integration of ICT is further supported by the Trends in International Mathematics and Science Study (TIMSS), which reported that less than 10% of South African learners are taught by mathematics educators that have computers available to use during mathematics lessons.[3] Research further shows that the few educators who incorporate technology in the classroom often lack the necessary technological skills and knowledge.[5] Some studies have found that ICT availability and usage in the classroom positively impacts learners' mathematics performance.[6;7] However, the success of such integration is dependent on overcoming barriers such as limited access to ICT.

***Figure 1. Computer availability in Grades  and 9 mathematics classrooms***




### Effects of ICT integration on mathematics education

The current limitations in ICT integration within rural mathematics education have led to many adverse effects, significantly impacting educators and learners. The lack of ICT infrastructure deprives learners of interactive educational experiences, such as online tutorials and digital mathematics games, that their urban counterparts enjoy, leading to a stark disparity in the quality of education.  Educators grappling with a high educator-to-computer ratio and lacking ICT training (initial or continuing) often find their skills limited or their anxiety high, and they are, therefore, unable to leverage technology to enhance teaching. This situation is exacerbated by most available ICT resources being in English, posing a significant challenge for non-English speaking educators and learners who struggle to grasp mathematical concepts in a second language. Educators having to translate mathematics software creates additional complexity and reduces the software's effectiveness. This demotivates and disengages learners, leaving them ill-prepared for higher education and modern job markets. The underutilisation of computers due to educators' lack of technical skills highlights inefficiency and resource wastage in these settings. Collectively, these challenges contribute to a cycle of educational and socio-economic disadvantages, limiting opportunities and maintaining poverty in these rural communities.

### A critical review of policy context

Both the South African *National Development Plan* (NDP) and the 2019 *White Paper on Science, Technology and Innovation* (STI) emphasise the importance of literacy, numeracy/mathematics and science outcomes for the country.[8] However, the White Paper highlights that the South African schooling system is not yet delivering the required outputs. Emphasis is placed on initiatives to improve these areas and to support digital literacy. The White Paper further highlights the role of ICT in transforming the education system, with more changes expected in terms of "new models for open-access, mobile, lifelong and ubiquitous learning beyond the traditional classroom".[9]

The NDP further states that all schools require resources such as computer and media centres and that high-speed broadband should be available to enable greater technology use in education, with the exploration of mobile devices for distributing learning content. However, as noted, the extent and use of ICT remain limited in many schools.

The 2004 *White Paper on e-Education* in South Africa established an objective for educators to integrate ICT into teaching and learning by 2013, aiming to enhance educational outcomes, which has not been met[10]. Neither did it provide specific guidelines for applying ICT in mathematics education, particularly in rural areas.

The importance of addressing the limited integration of ICT into education in rural communities stems from several factors. Firstly, ICT can greatly improve achievement scores by providing users access to a broader range of educational resources. Secondly, incorporating ICT into education can foster innovation, align with long-term development goals, and equip learners with digital literacy and skills for the future workforce. Thirdly, the lack of ICT integration in rural schools not only restricts education access but also hinders the growth and competitiveness of these areas. Therefore, addressing the limited integration of ICT into mathematics education in rural communities is important to ensure equitable access to quality education and to prepare South African learners for the demands of the 21st century.

Consequently, this policy brief addresses these gaps by providing recommendations for effectively integrating ICT into mathematics education in rural areas.

## Our latest research

This policy brief draws on the findings of multiple exploratory case studies conducted as part of a needs analysis for digital learning games in mathematics undertaken by the Human Sciences Research Council in the Nama Khoi Municipality in the Northern Cape province. Data were collected from thirty mathematics educators and nine principals from six primary and four secondary schools. These participants[1] reported a desire to shift from a more traditional teaching approach to a learner-centred or constructivist approach. However, they faced challenges due to limited ICT infrastructure, among other things.

### Identified barriers to ICT integration into mathematics education

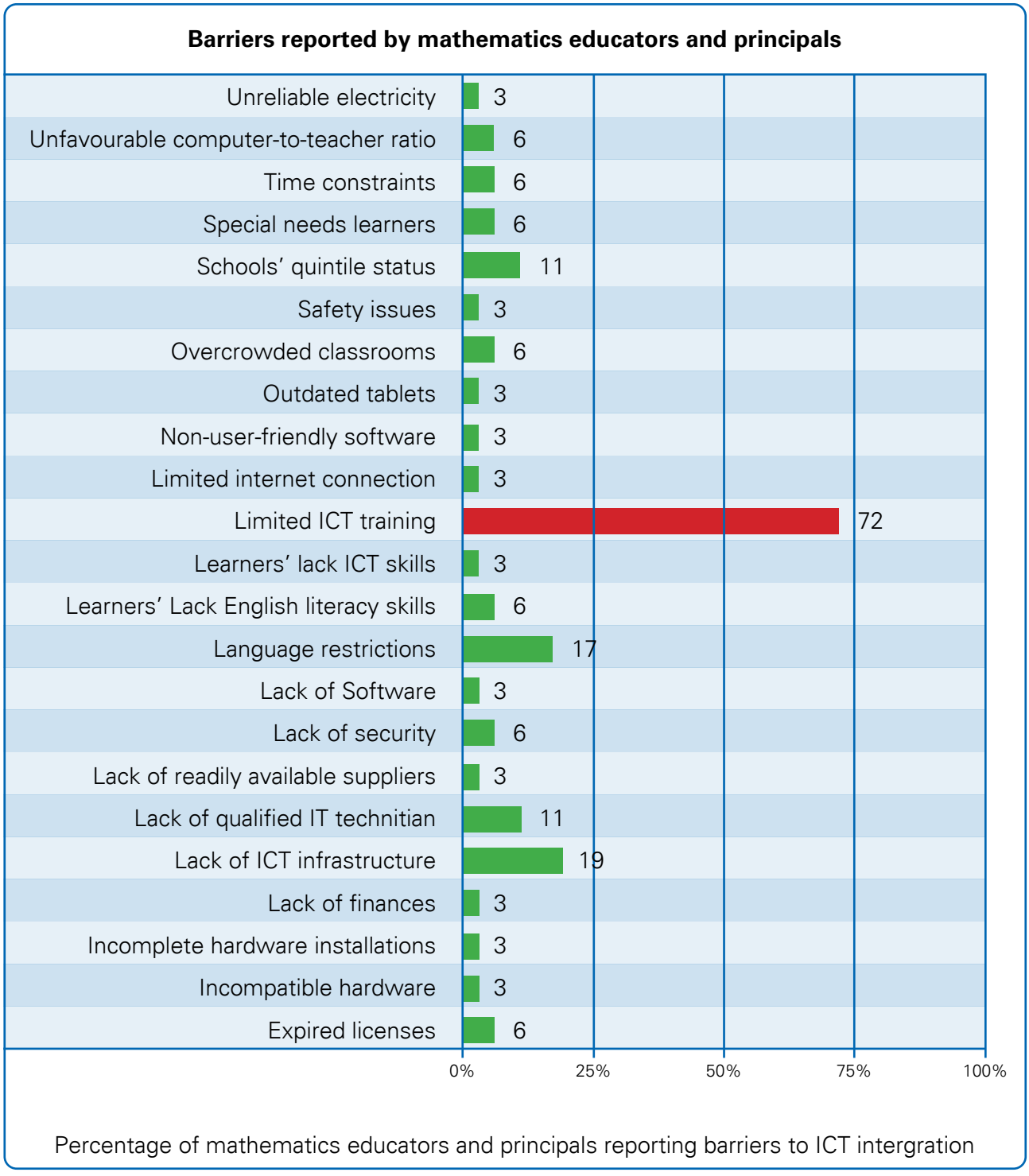
The current limitations in ICT in rural mathematics education stem from a confluence of complex factors (Figure 2). Only key evidence on which the policy brief is based is discussed.

1. The participants were Afrikaans home language speakers, predominantly females, with 78% having over ten years of teaching experience. The majority had advanced qualifications, with 67% specialising in mathematics.

**Limited specialised training and infrastructure hinder effective ICT use**

A primary issue is the limited specialised training for educators: almost three-quarters of the educators had not received sufficient pre-service training in using ICT for mathematics education nor had access to relevant continuous professional development opportunities. This situation is compounded by a general lack of specialised training in mathematics, which is critical for effectively integrating ICT into the subject. Another significant issue is the lack of ICT infrastructure, with some schools facing limited electricity, computers/tablets and internet facilities, which are foundational for any ICT initiative. Additionally, the absence of qualified IT technicians in schools exacerbates the problem, as inadequate support for maintaining and troubleshooting ICT resources exists.

***Figure 2. Challenges to the integration of ICT into mathematics education***



### Quintile ranking system constrains resource allocation for schools

The quintile ranking system also poses a challenge as it limits resource allocation for Quintiles 4 and 5 schools. Some participants reported that their schools were previously Model C schools and had, therefore, received a Quintile 4 or 5 ranking. However, the surrounding communities had changed, over time and most learners were social grant recipients, and their parents could not pay school fees. These schools could also not raise funds in the community because many parents were unemployed.

### Low ICT and English literacy levels pose challenges

Another barrier is the learners' low ICT and English literacy levels, which require additional support. Educators reported that most mathematics software is in English, and they must translate the worksheets for the learners. It is also difficult for learners to understand some areas of mathematics because the English concepts are different from those in Afrikaans. Similar constraints would be encountered in other schools where English is not learners' home language. Educators also did not see the need to continuously use the software because the learners are assessed in Afrikaans, not English.

These complex challenges collectively impede the effective use of ICT in mathematics education in rural schools, thus necessitating a comprehensive and tailored approach to address them.

## Policy implications/recommendations

Based on the findings of the needs analysis study, we offer four key recommendations for the effective integration of ICT into mathematics education in rural schools:

1. **Review the standards for distributing ICT infrastructure to schools:** This will ensure that schools in rural areas are not under-resourced due to classifications that may not reflect the surrounding communities. The revised system should consider the socio-economic status of the local community and the level of infrastructure available. Doing so will enable more equitable resource allocation, allowing for targeted support where it is most needed. This revision should be done regularly to adapt to changing demographics and economic conditions within communities.
2. **Provision of qualified IT technicians or training for current staff:** Implement a programme to recruit and place IT technicians in rural schools or provide comprehensive training for existing staff with IT competencies to handle ICT infrastructure.
3. **Specialised ICT Training for mathematics education:** Address the gap in ICT training for mathematics educators by providing both pre-service and in-service training specifically tailored to the needs of mathematics education. This training should include targeted modules focusing on using ICT tools and digital resources specifically for teaching mathematics. These modules should provide practical guidance on integrating specific software, apps, and games into mathematics lessons to enhance learner understanding and engagement.
4. **Resource development:** Develop and provide access to mathematics resources and software that is culturally relevant and available in the official South African languages. It is also important to create and maintain an easily accessible database of ICT tools, including a description of each tool, how it aligns with the curriculum and how it can be integrated into mathematics teaching and learning.

## Acknowledgements

This study was funded by the Human Sciences Research Council (Project number: LWACAA).

## References

1. Alcantara, E.C., Veriña, R.U. & Niem, M.M. (2020). Teaching and learning with technology: Ramification of ICT Integration in mathematics education. Southeast Asia Mathematics Education Journal, 10(1): 27-40.
2. Sawyer, A. & Agyei, D.D. (2022). Mathematics teachers' use of ICT in classroom instruction: Exploring the will-skill-tool-pedagogy model in the Ghanaian context. Education and Information Technologies, 28: 9397-9416.
3. Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Boston College, TIMSS & PIRLS International Study Center website. Available at https://timssandpirls.bc.edu/timss2019/international-results/
4. Department of Education (DOE) (2023). Education Facility Management System (EFMS). Available at https://www.education.gov.za/Portals/0/Documents/Reports/2023/EFMS%202023.pd f?ver=2023-09-04-115953-093
5. Umugiraneza, O., Bansilal, S., & North, D. (2017). Exploring teachers' practices in teaching mathematics and statistics in KwaZulu-Natal schools. South African Journal of Education, 37(2). Available at http://dx.doi.org/10.15700/saje.v37n2a1306.
6. Freitas, G., & Spangenberg, E. (2019). Mathematics teachers' levels of technological pedagogical content knowledge and information and communication technology integration barriers. Pythagoras. Available at https://doi.org/10.4102/pythagoras.v40i1.431
7. Saal, P., Ryneveld, L., & Graham, M. (2021). Comparing the relationship between using educational technology in mathematics and student achievement in South Africa and Germany. Journal of Research on Technology in Education, 54, 581-598. Available at https://doi.org/10.1080/15391523.2021.1904062.
8. National Planning Commission (NPC) (2012). National Development Plan: Our future – make it work. Available at https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf.
9. Department of Science and Technology (DST) (2019). White Paper on Science, Technology and Innovation. Available at https://www.dst.gov.za/images/2019/White_paper_web_copyv1.pdf.
10. Department of Education (DoE) (2004). White Paper on e-Education: Transforming learning and teaching through Information and Communication Technologies (ICTs). Available at https://www.gov.za/documents/white-papers/white-paper-e-education-transforming-learning-and-teaching-through.

## Authors

Petronella Elize Saal, PhD; Research Specialist, Human Sciences Research Council, South Africa.

Sylvia Hannan: Chief Researcher, Human Sciences Research Council, South Africa.

Enquiries to: Dr Petronella Saal: PSaal@hsrc.ac.za