UNIVERSITEIT STELLENBOSCH UNIVERSITY

DEVELOPMENT OF INDICATORS FOR THE MEASUREMENT OF THE SOUTH AFRICAN PUBLIC UNDERSTANDING OF SCIENCE

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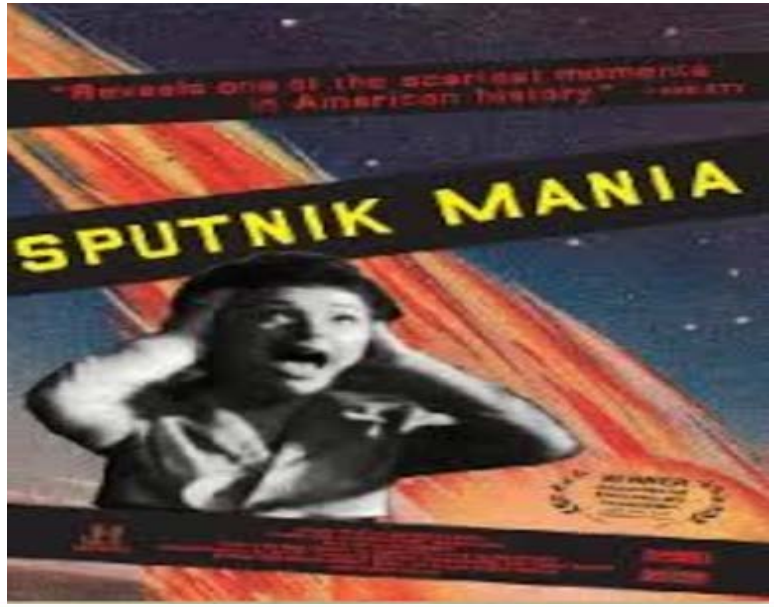
CREST - SCISTIP – SCICOM

Scientific literacy & the public understanding of science

- **A public suitably skilled and competent in the acquisition, application and transmission of information (across fields) - a valuable national asset.**
- **The Public - Science intersection has been studied since before the 17th century.**
- **Formal science measurement is more recent, and gathered increasing momentum following the 1960's, particularly in the USA and Europe.**



Evolution of the discourse…

Period and Research Paradigm	Attribution Deficit	Research Areas
Science Literacy **1960's onward**	Public deficit of knowledge	Measures of literacy, Educational policy
Public Understanding of Science **1985**	Public deficit of attitudes, Education	Knowledge and Attitudes Attitude formation and change
Science and Society **2000 onward**	Trust deficit, Expert deficit, Public confidence	Public participation, Mediators of science, Evaluations of impact

Adapted from Bauer, Allum, & Miller; 2007 page 80

The South African Public

Employment Status

Culture

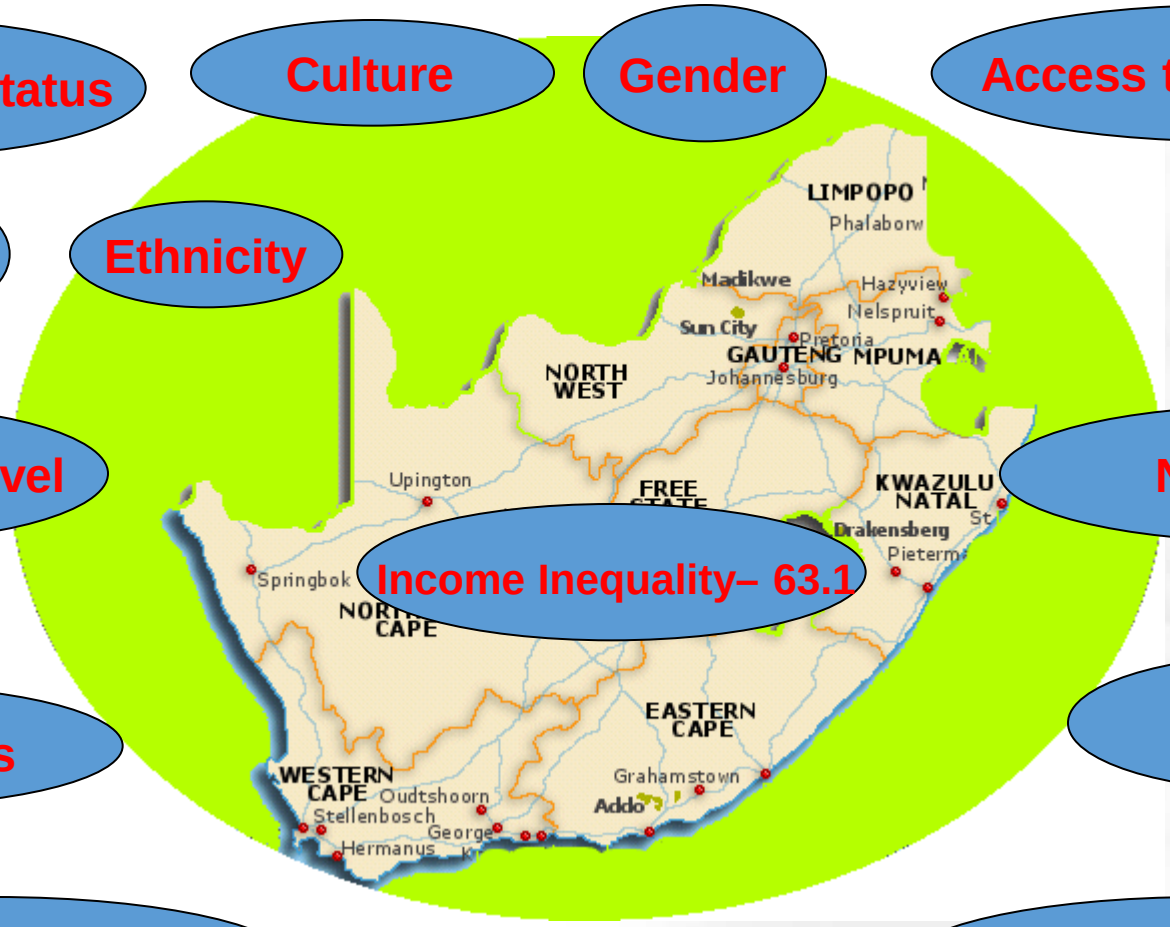
Gender

Access to information

Race

Ethnicity

Age



Educational Level

Nationality

Income Inequality– 63.1

Social Class

Religion

Access to government

HIV Status

Political Affiliation

Public Understanding of Science: the importance for South Africa

- Scarce HR skills and an experienced workforce – national asset
- Massive disparity in social development further impacts challenges
- Key to achieving sustainable growth will be an educated & literate public
- Science is both the means and the end in this regard:
    - **Accelerating development – service delivery & improved quality of life**
        - Building learning resources, economic growth, health, food security, education
    - **Increasing economic performance – new methods of production, efficiency**
        - Green-power, accessible communications, mobility, crop science
    - **Improving democracy – more informed public = informed electorate**
        - Access to information, productive and informed citizens, responsible governance
- By using S&T to accelerate these goals, South Africa will move toward addressing the gaps in the workforce and engage within a more realistic and recognized knowledge economy.

Author	Title	Year
Pouris	Public understanding and appreciation of science among the public in South Africa	1991
Pouris	Public understanding and Appreciation of Science among South African Teenagers	1993
HSRC	Omnibus Survey	1995
IEA	Trends in International Mathematics and Science Study (TIMSS)	1995
FRD-HSRC	SA Science and Technology Indicators - Public Understanding of Science chapter	1995
Laugksch	Test for Scientific Literacy and its application in assessing scientific literacy of matriculants entering universities and technikons	1996
HSRC	EPOP	1999
IEA	Trends in International Mathematics and Science Study (TIMSS)	1999
Pouris	Interests, Public Attitudes and Sources of Scientific information in South Africa	2001
Blankley and Arnold (FRD)	Public Understand of Science in South Africa – aiming for better intervention strategies	2001
Goolam	The scientific and technological literacy of first year physics students: the effects of a traditional school curriculum	2001
HSRC	SASAS: Biotechnology survey	2004
IEA	Trends in International Mathematics and Science Study (TIMSS)	2003
Pouris	Assessing Public Support for biotechnology in South Africa	2004
Conradie	The role of key role players in science communication at South African higher education institutions: an exploratory study	2004
HSRC	SASAS: climate change	2007
Reddy et al	Public understanding of science in South Africa	2010
HSRC	The Public Understanding of Biotechnology in the Media	2010
HSRC	Trends in International Mathematics and Science Study (TIMSS)	2011
HSRC	SASAS module: Public attitudes toward nuclear technology and energy in South Africa	2011

South African Indicators

- Previous research in South Africa has adopted international measurement techniques and yielded valuable insight.
- However, no indicators have been developed specifically within the South African context.
- This study set out to develop a set of measurement indicators and adopted the following *six elements* to constitute the South African public understanding of science:

    - ***Knowledge* of science**
    - ***Attitudes* to science**
    - ***Interest* and *Informedness* about science**
    - **Science *information sources***
    - **Attendance at *science engagement activities***

Data Collection

- **The main objectives of the study were:**
    - 1) To determine the level of South African PUS
    - 2) To understand the patterns of PUS in relation to demographic variables
    - 3) To develop indicators for each of the PUS elements
    - 4) To determine the key predictors of performance on each of the new indicators developed.
- The research employed a nationally representative survey, in both urban and rural settings, yielding a total sample of **3 486** respondents.
- Data outputs were compare to the results of the **National Census** as well as the **SAARF - *All Media and Products Survey*** data to ensure representivity

Headline Results

Science Knowledge – **41%** provided scientifically correct response

Attitudes to Science – Generally **positive** attitude to science

Interest in Science – **56%** report a moderate to high level of interest

Informedness – **46%** report mid to high level of informedness

Science information sources – ***Radio*** (86%); ***Newspapers*** (83%); ***Terrestrial Television*** (83%) and ***Other People*** (79%)

Science engagement activities – **11.5% attended** (at least) 1 science engagement activity; **88.5% did not** attend any engagement activity

INDICATOR DEVELOPMENT & VALIDATION

- Babbie (2007) notes the following steps involved in index construction: ***item selection; examination of empirical relationships, devising a scoring method*** and ***index validation***

- Following comprehensive literature reviews and comparisons of questions, items were adopted, adapted or developed toward producing the questionnaire.

- Within each question-set, all items carry a high degree of *face validity* within their respective domains.

- An assessment of *dimensionality* was undertaken to ensure that items within each question set share a common latent variable

- Assessments of *Item difficulty*, *item discrimination*, *reliability*, *face*, *content* and *criterion* validity as well as *construct* validity were conducted and were all found to be at an acceptable level.

Science Knowledge Index

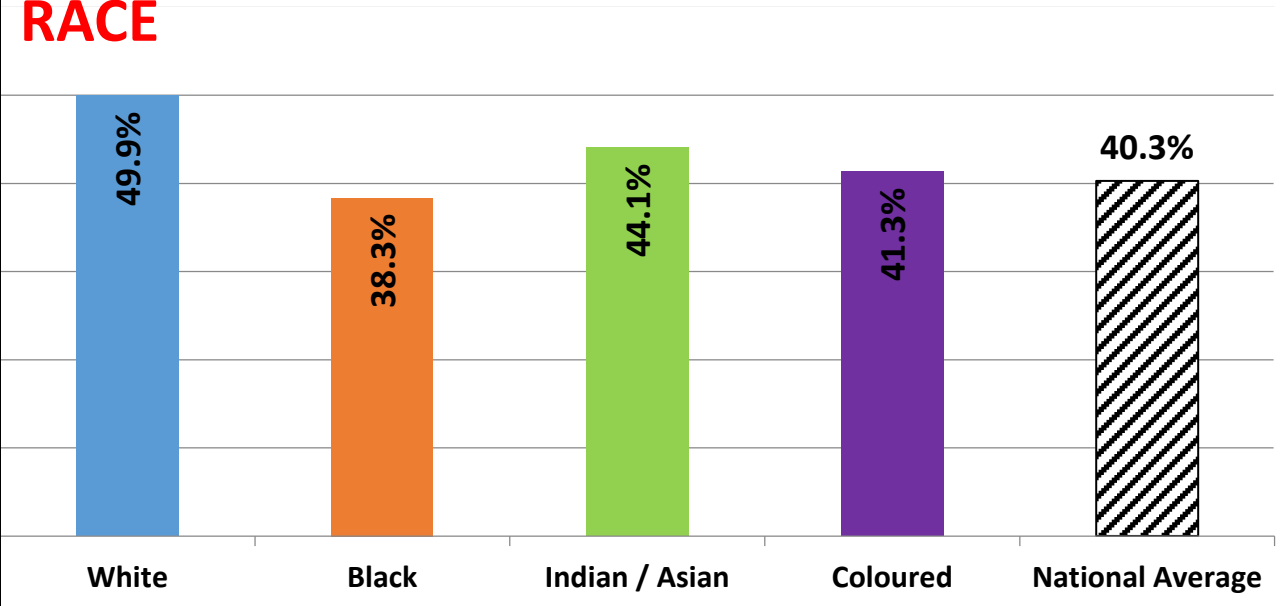
- The *Science Knowledge Index* was developed from within the 9-item science knowledge assessment questions (*True, False* or *D/K*)

KNOWLEDGE ITEM	Correct	Incorrect	D/K
In the majority of cases, HIV causes AIDS in humans	67.4%	18.7%	13.9%
Lightning never strikes the same place twice	32.7%	45.2%	22.1%
South Africa was the first nation in the world to voluntarily dismantle its nuclear weapons	39.5%	27.3%	33.2%
The continents which we live on are continually moving due to forces deep within the Earth	46.2%	24.9%	28.9%
The price of petrol in South Africa is NOT influenced by the price of crude oil	35.5%	40.8%	23.7%
Schizophrenia is the same as Multiple Personality disorder	24.4%	42.0%	33.6%
The father carries the genetic material that will determine if a baby is a boy or a girl	46.6%	33.2%	20.3%
The earth's climate has NOT changed over millions of years	41.7%	33.8%	24.5%
The main purpose of the Square Kilometre Array (SKA) radio telescopes is to search for extra-terrestrial life	28.4%	34.3%	37.3%

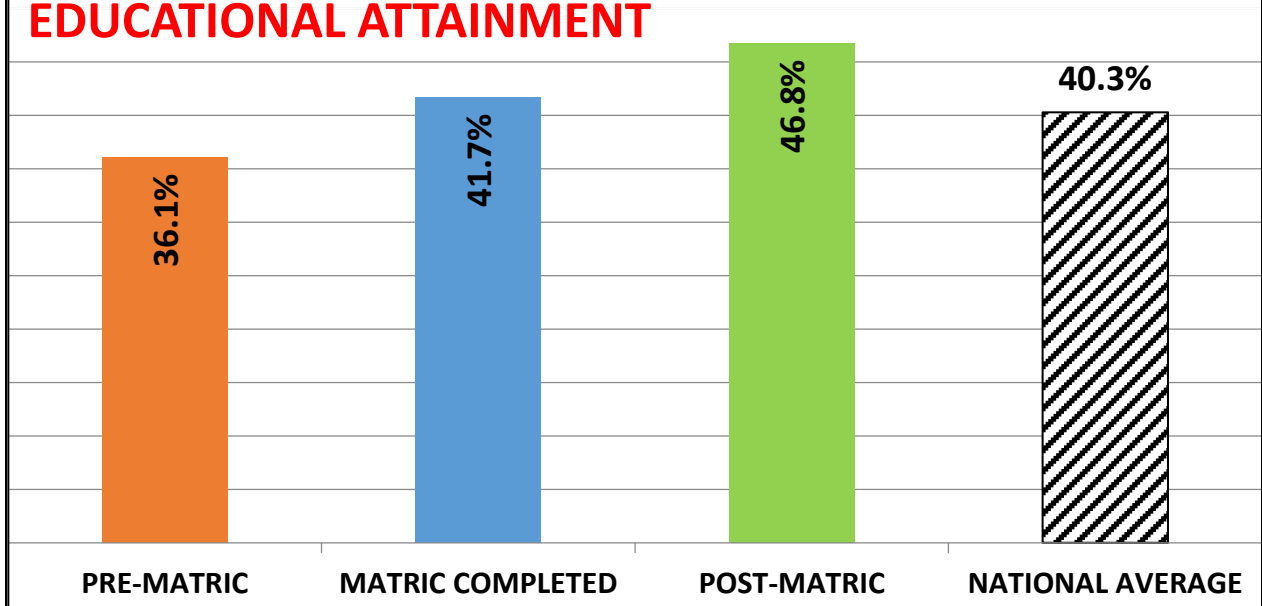
- Response varied By subject area across the 9 items
- Variations in response were also observed by demographic classification

Average Scientifically Correct Response

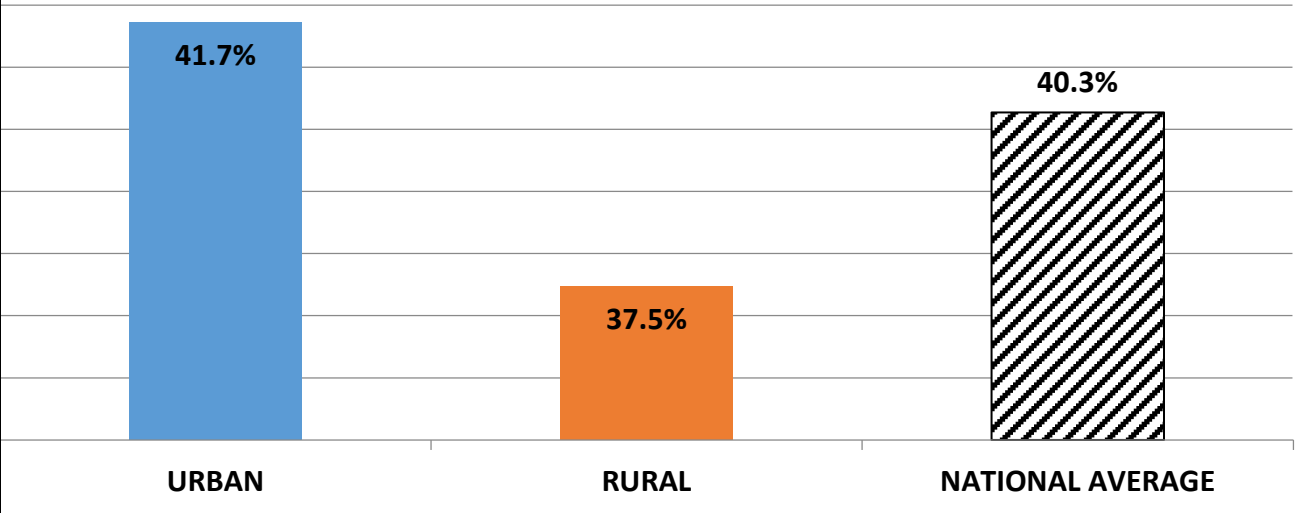
RACE



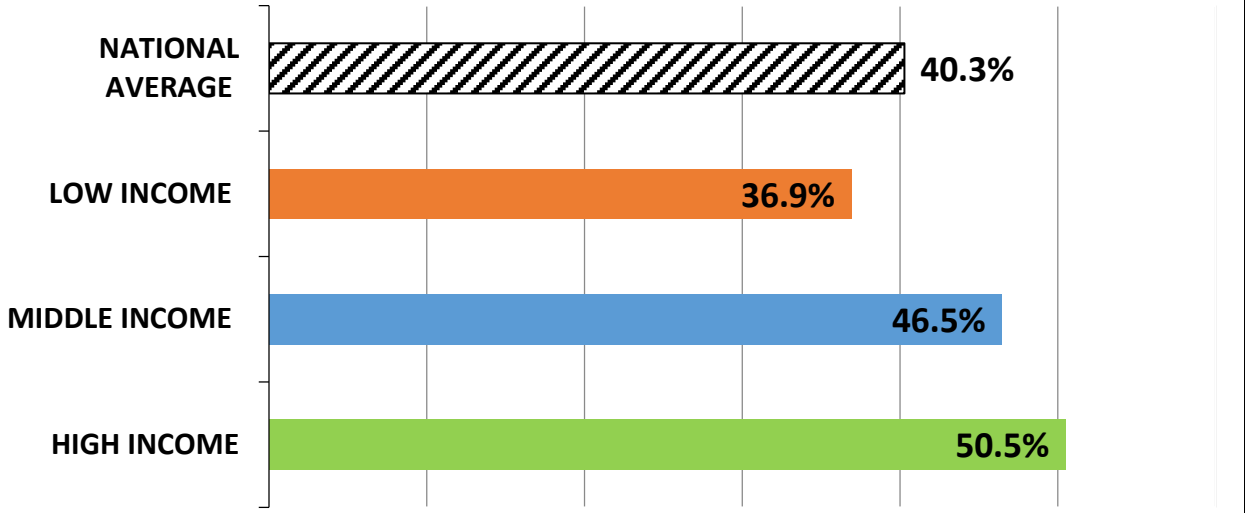
EDUCATIONAL ATTAINMENT



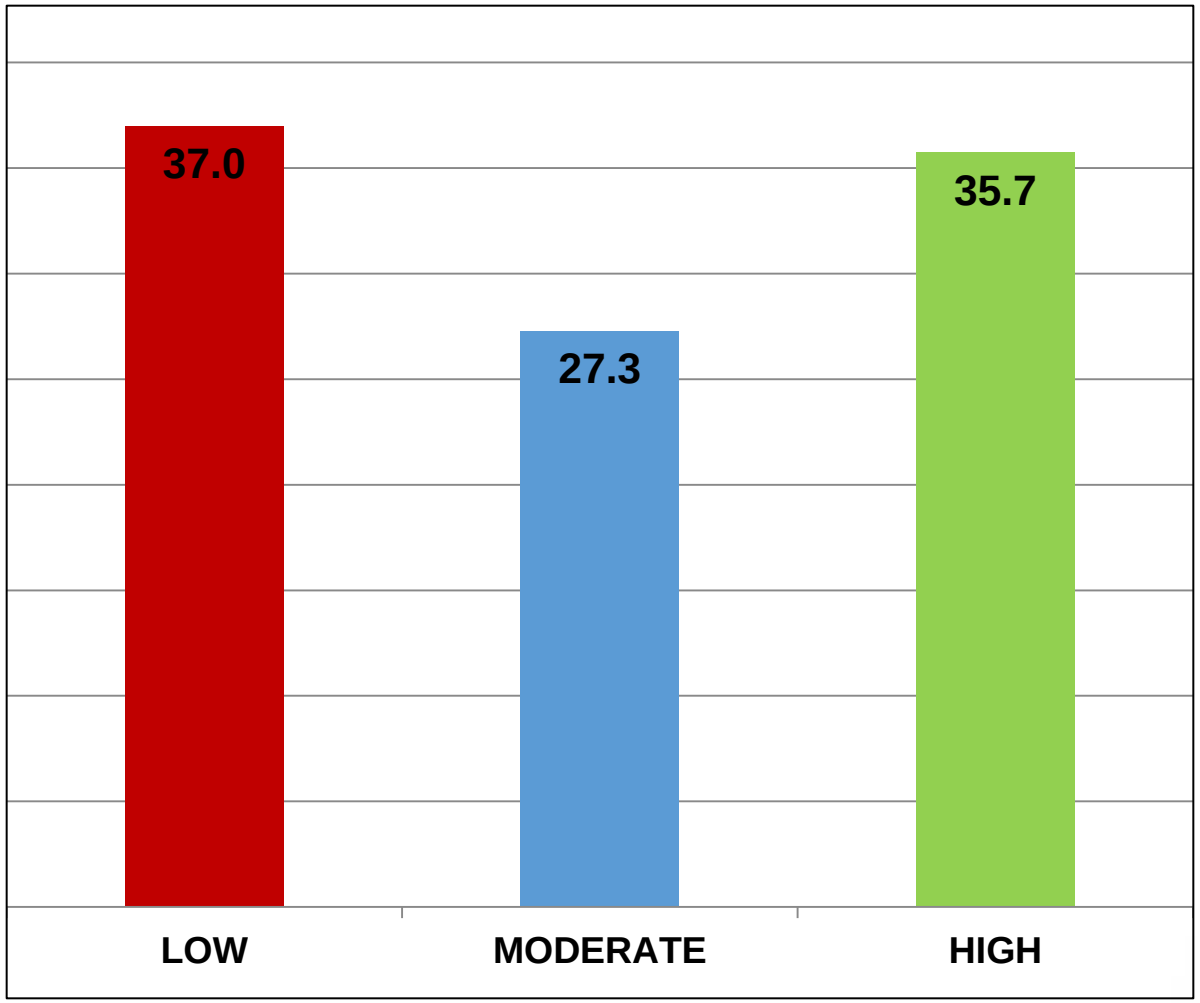
GEOGRAPHIC LOCATION



HOUSEHOLD INCOME

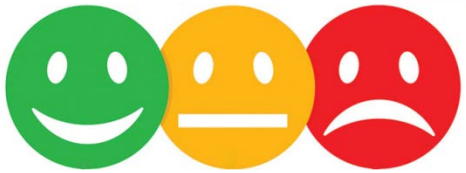


Science Knowledge Index



- 37% of South Africans were classified in the *low Science Knowledge Index classification*
- More White respondents (49%) were in the *high knowledge classification*, compared to Black respondents (33%)
- Gender did not show significant variation on this index
- More rural respondents were classified in the *low knowledge classification* (41%), compared to urban respondents (35%)
- 47% of those with Post-matric education appeared in the *high knowledge group* compared to those with Pre-matric education (32%)

Index of Attitudes to Science

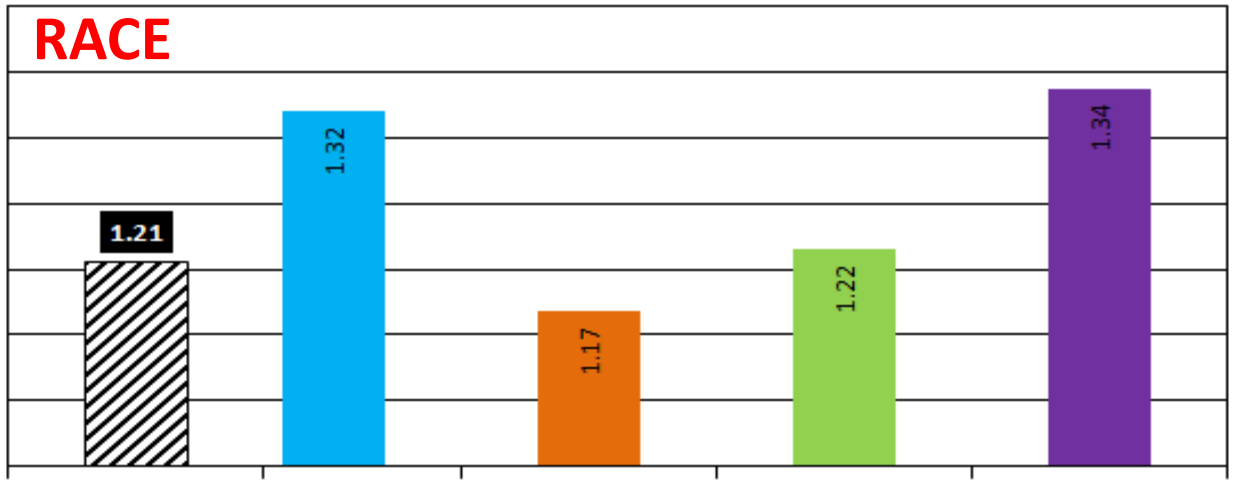


- The *index of attitudes to science* was developed based on the response to the 4 attitudinal items within the questionnaire.
- Items 1 & 3 adopt a *supportive* or *promise* position, while items 2 & 4 convey a more *critical* or *reservation* position regarding science.

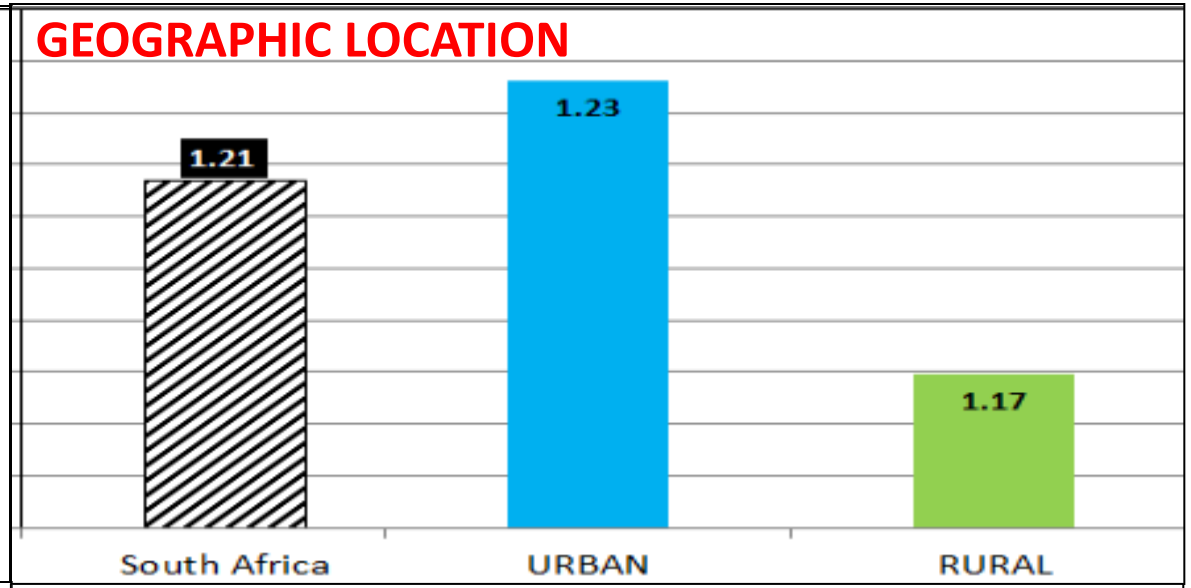
	#	Attitudinal Statement	AGREE / NEUTRAL / DISAGREE
P	1	Science and technology are making our lives healthier, easier and more comfortable	68.7% / 20.5% / 10.8%
R	2	It is not important for me to know about science in my daily life	47.5% / 22.3% / 30.2%
P	3	Thanks to science and technology, there will be more opportunities for the future generation	71.9% / 18.3% / 9.8%
R	4	The application of science and new technology makes our way of life change too fast	68.8% / 19.5% / 11.7%

South Africans are positive about science, BUT…

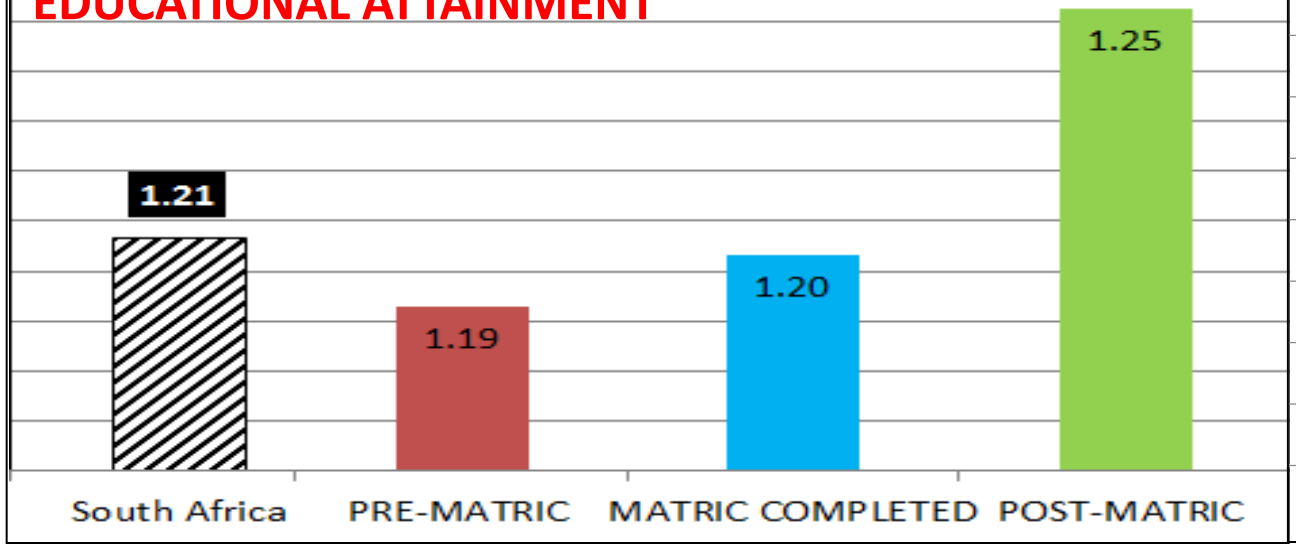
RACE



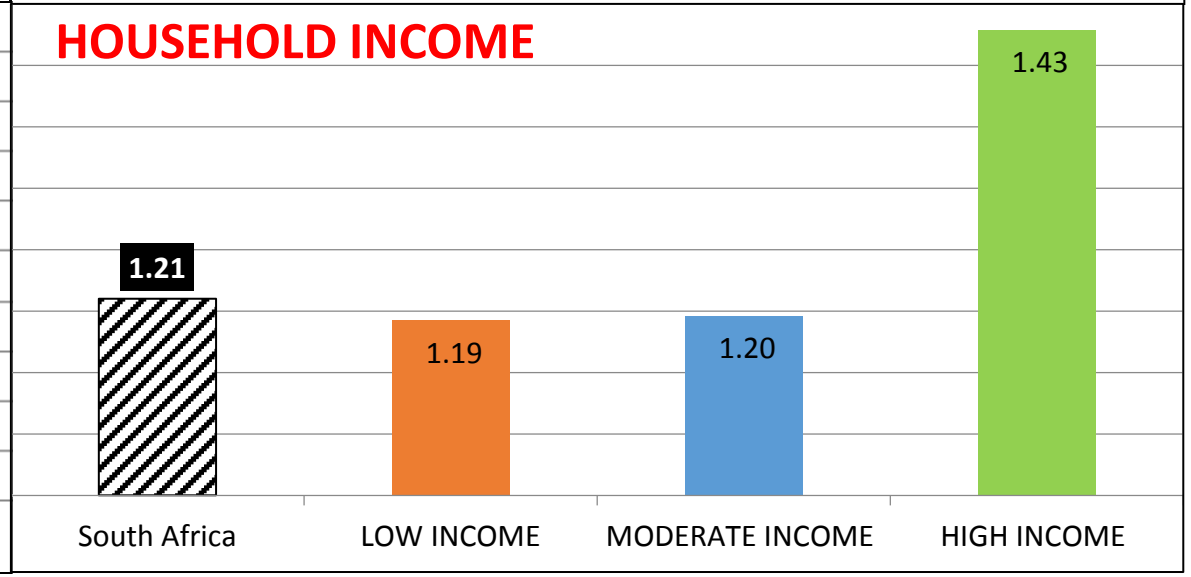
GEOGRAPHIC LOCATION



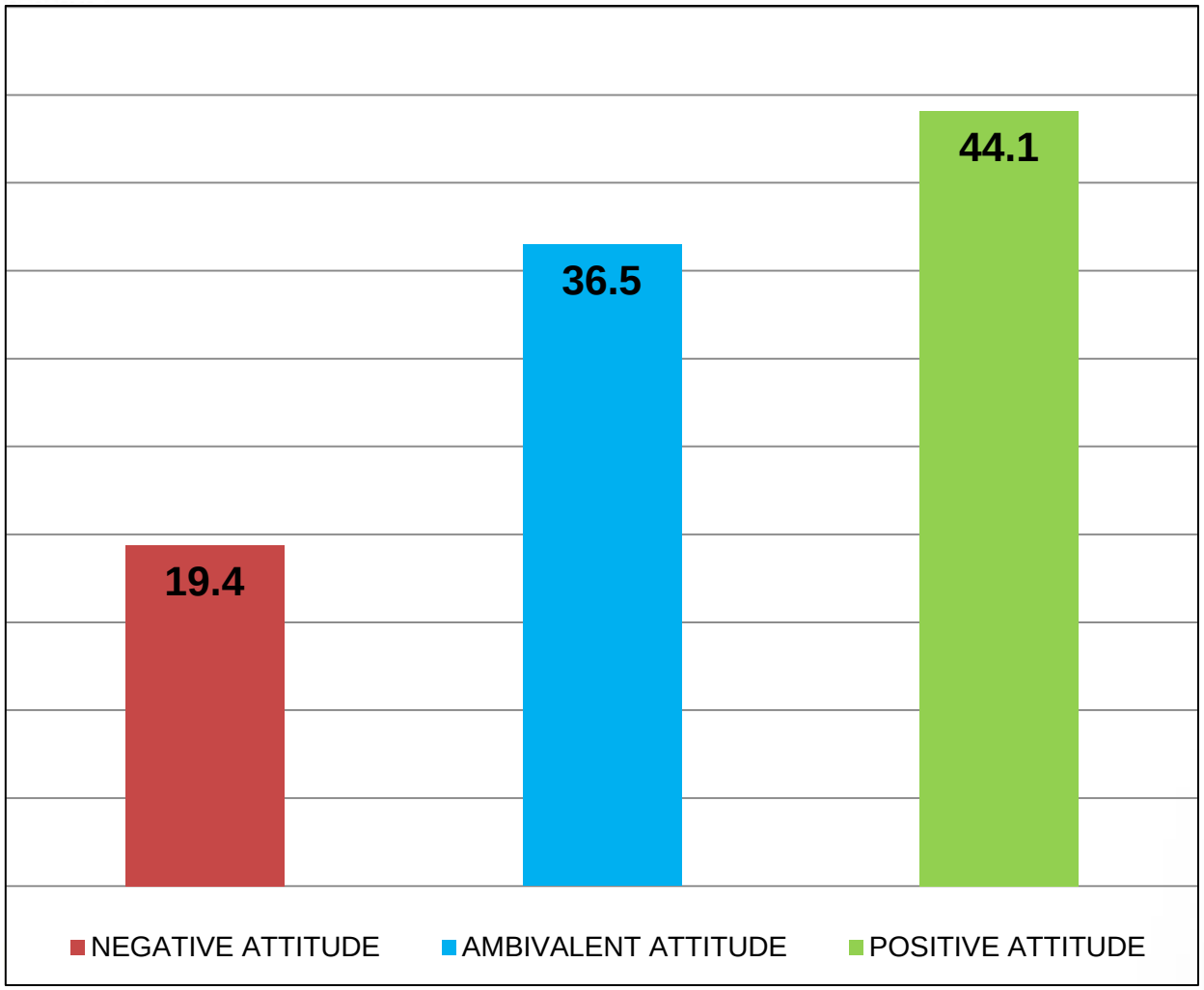
EDUCATIONAL ATTAINMENT



HOUSEHOLD INCOME



Index of Attitudes to Science



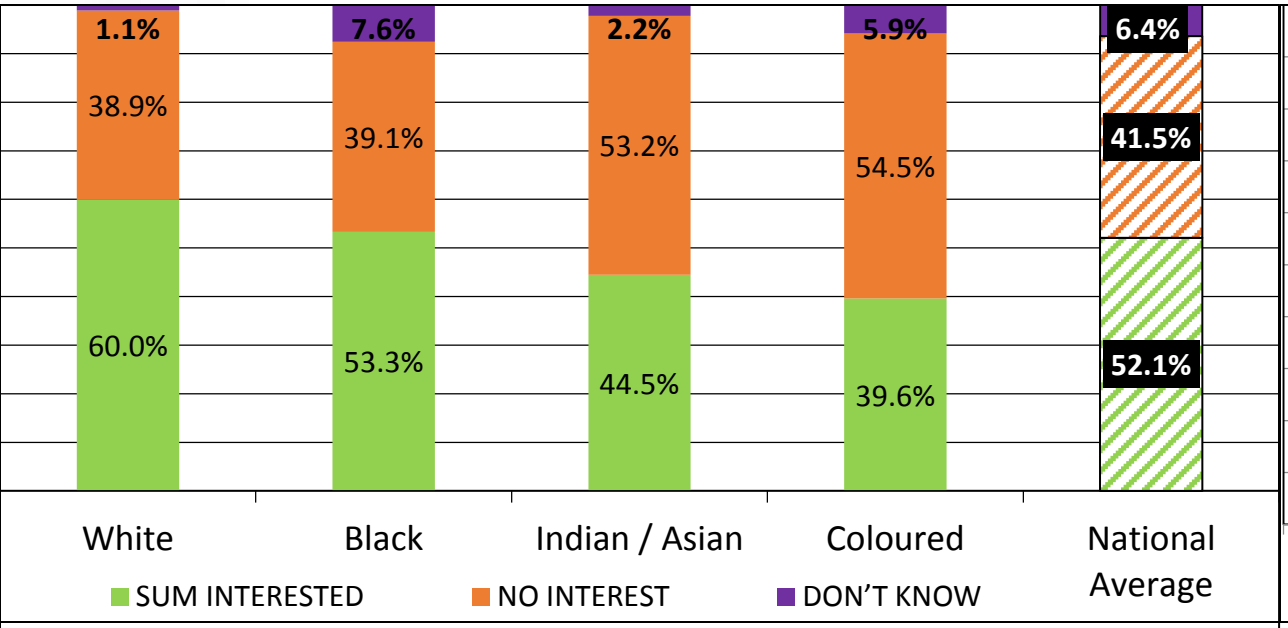
- 44% of South Africans reported positive attitudes to science
- However, a large proportion recorded *Ambivalent Attitudes* to science – of concern
- More Coloured respondents (52%) were in the high *knowledge classification*, compared to White (48%); Indian (46%) and Black (42%) respondents
- Urban respondents were more likely to be in the *positive attitudes classification* than rural respondents
- *Increased educational attainment* appears to correlate with *increased positive attitudes* to science
- Gender did not show significant variation on this index

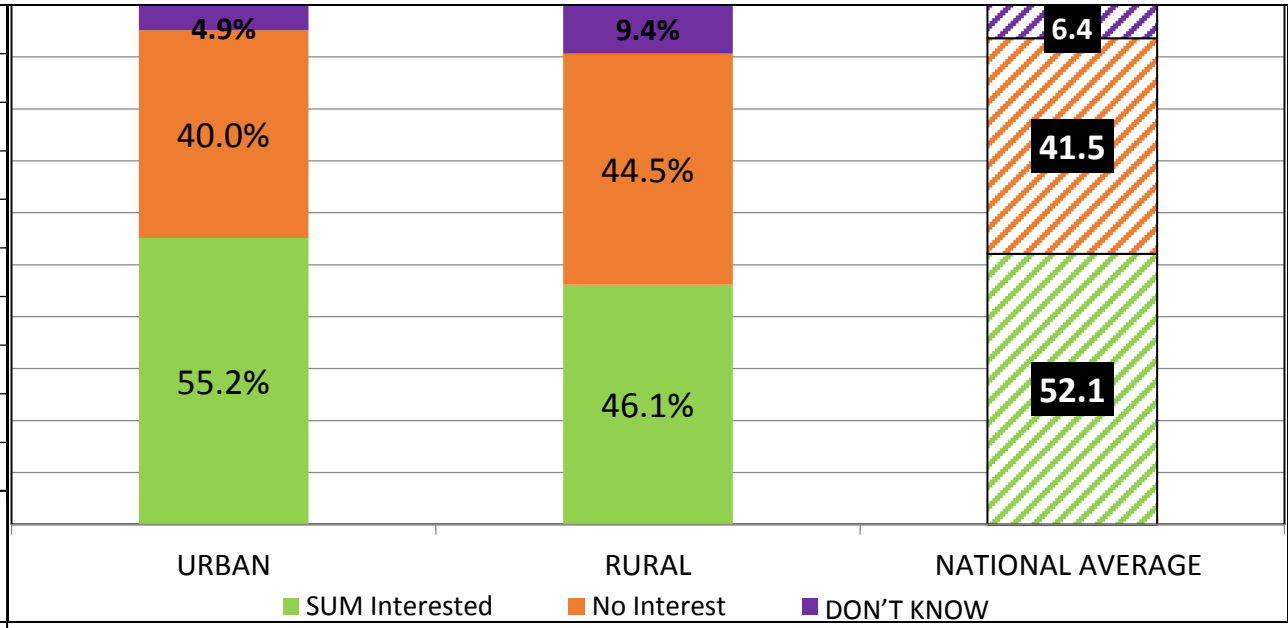
Index of Interest in Science

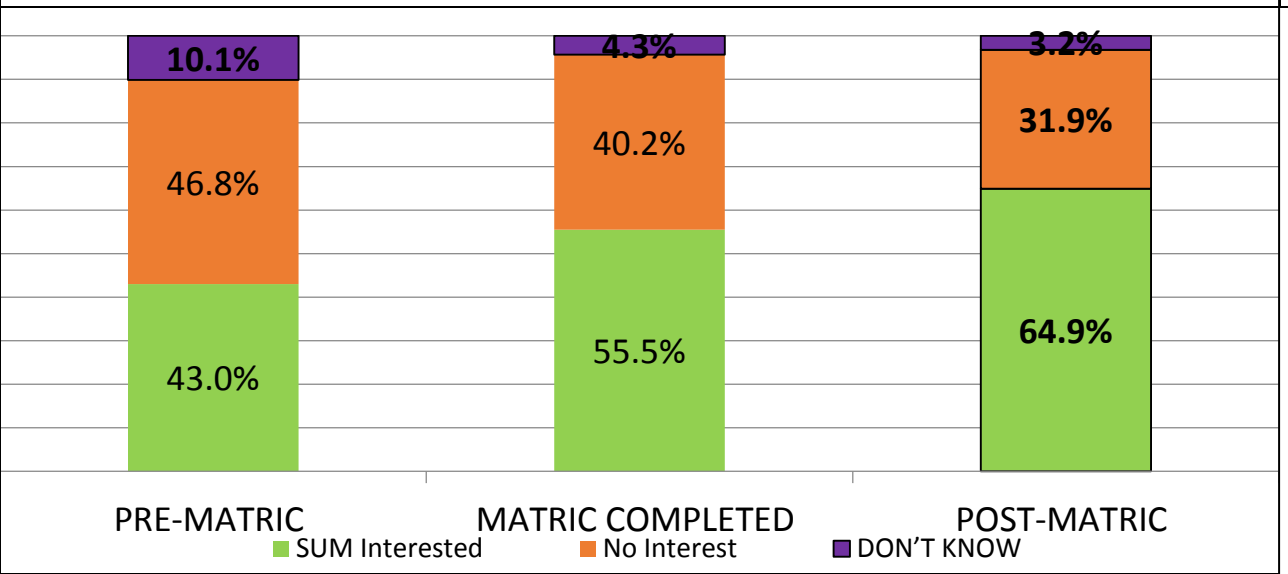
- The *Interest in science Index* was developed from the 7-item question

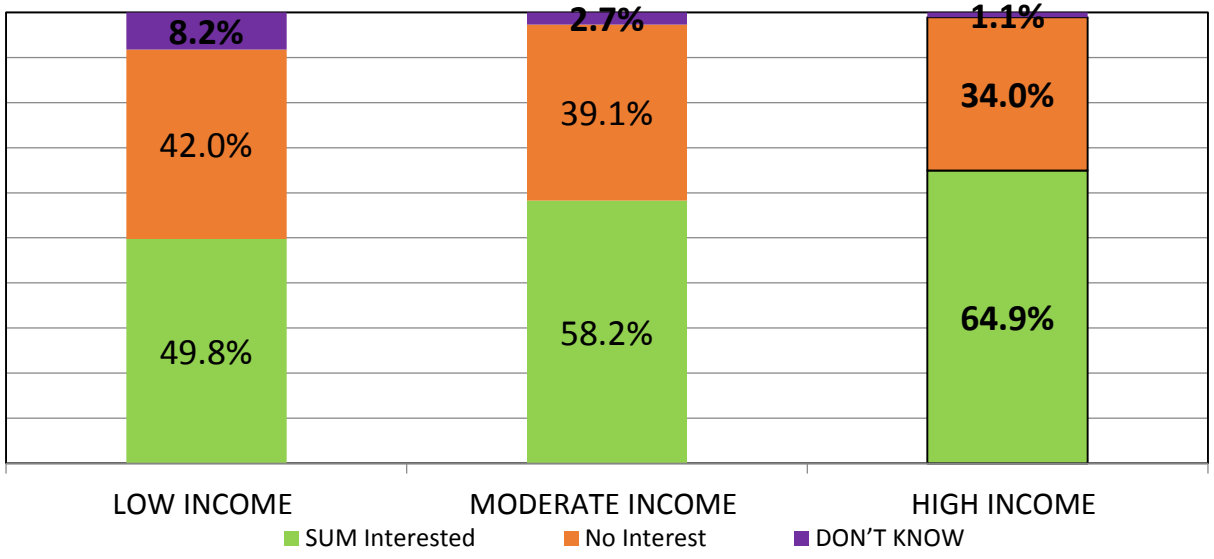
INTEREST AREA	VERY interested	MODERATELY interested	NO interest	D/K
Medical Science	23.1%	29.7%	40.8%	6.4%
Climate Change	22.4%	33.6%	37.6%	6.4%
Technology and the Internet	29.5%	31.4%	33.5%	5.5%
Politics	16.9%	32.8%	45.9%	4.4%
Economics	22.9%	33.1%	38.5%	5.5%
Astronomy	11.9%	24.3%	54.1%	9.7%
Energy	21.4%	31.4%	40.1%	7.0%

South Africans show high interest in science…

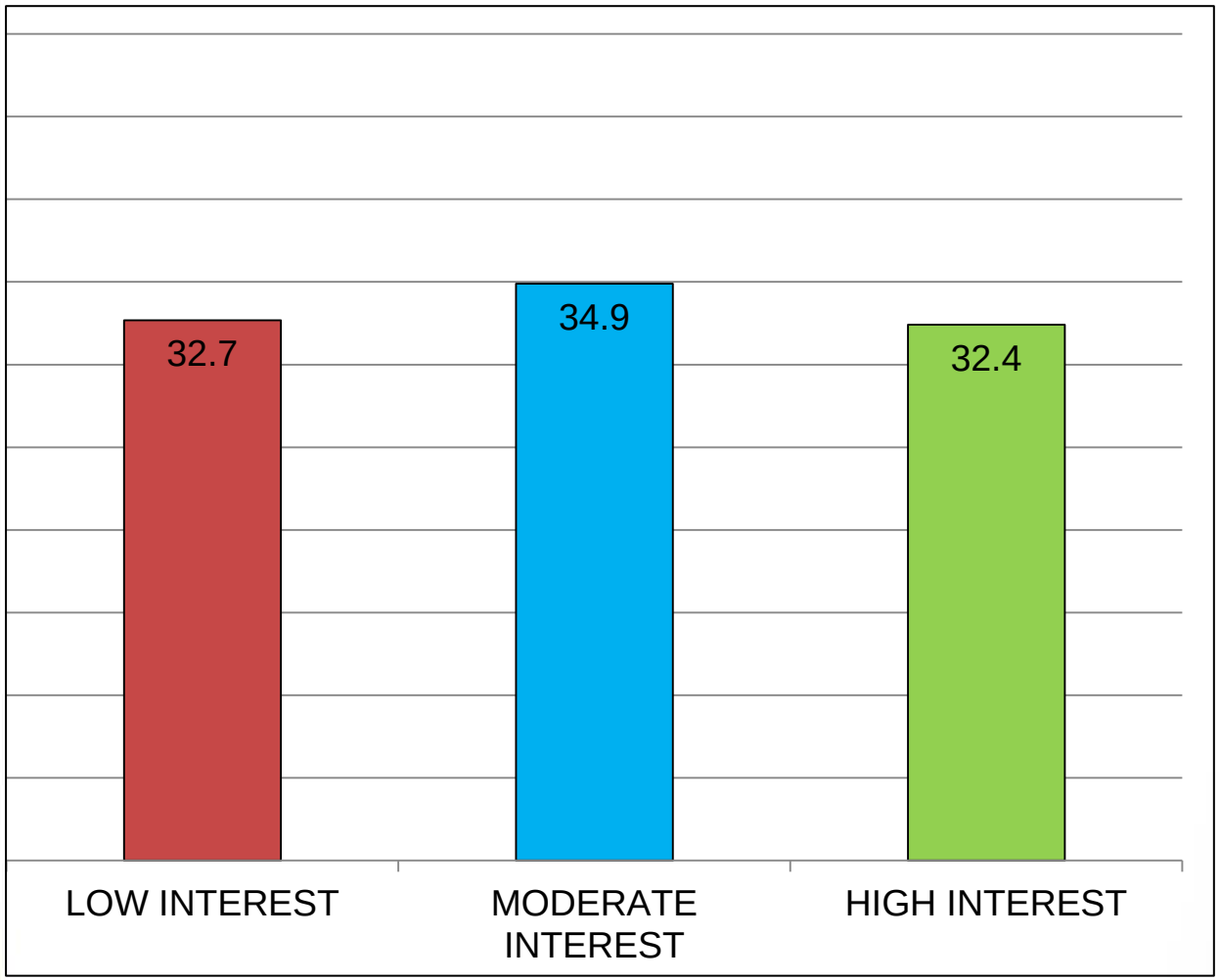








Index of Interest in Science



- 32% of South Africans report a *high interest* in science
- 24% of the total sample reported *no interest* in any of the areas of science included
- Coloured respondents reported the lowest level of interest in science (49%)
- Urban respondents were more interested in science (35%) compared to rural respondents (26%)
- 45% of those with post-matric education were in the *high interest classification*

Index of Science Informedness

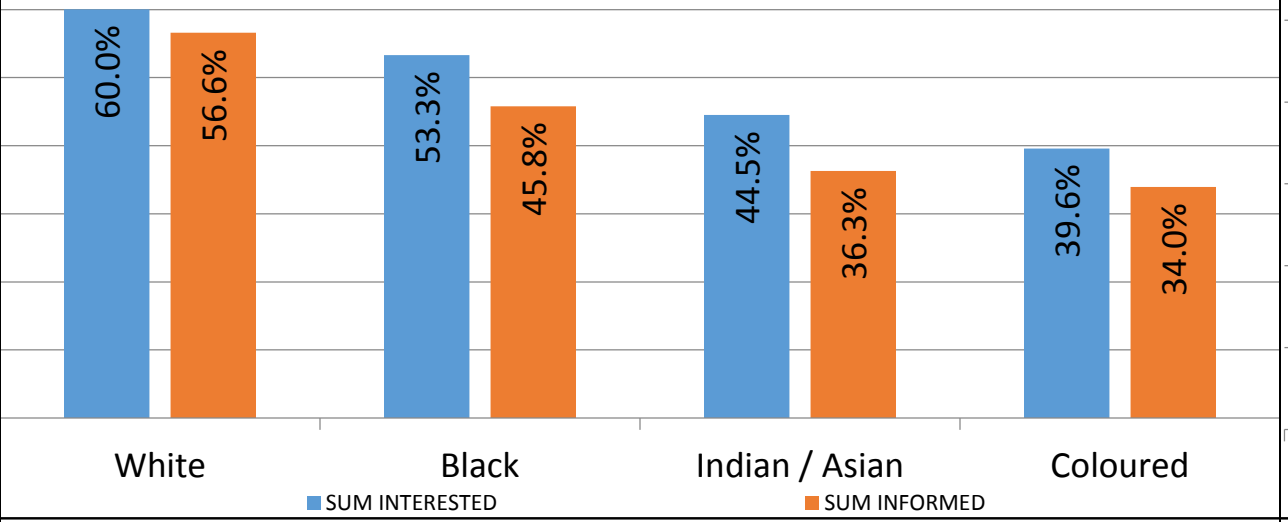
- The *Index of science informedness* adopted the same questionnaire items as the *index of Interest* in science

INFORMEDNESS AREA	VERY well informed	MODERATELY well informed	NOT well informed	D/K
Medical Science	13.5%	26.4%	52.8%	7.4%
Climate Change	12.8%	30.8%	49.6%	6.8%
Technology and the Internet	18.8%	31.1%	43.3%	6.8%
Politics	14.2%	34.6%	45.0%	6.3%
Economics	14.8%	29.2%	48.9%	7.1%
Astronomy	8.5%	19.1%	61.7%	10.7%
Energy	13.4%	26.3%	52.3%	8.1%

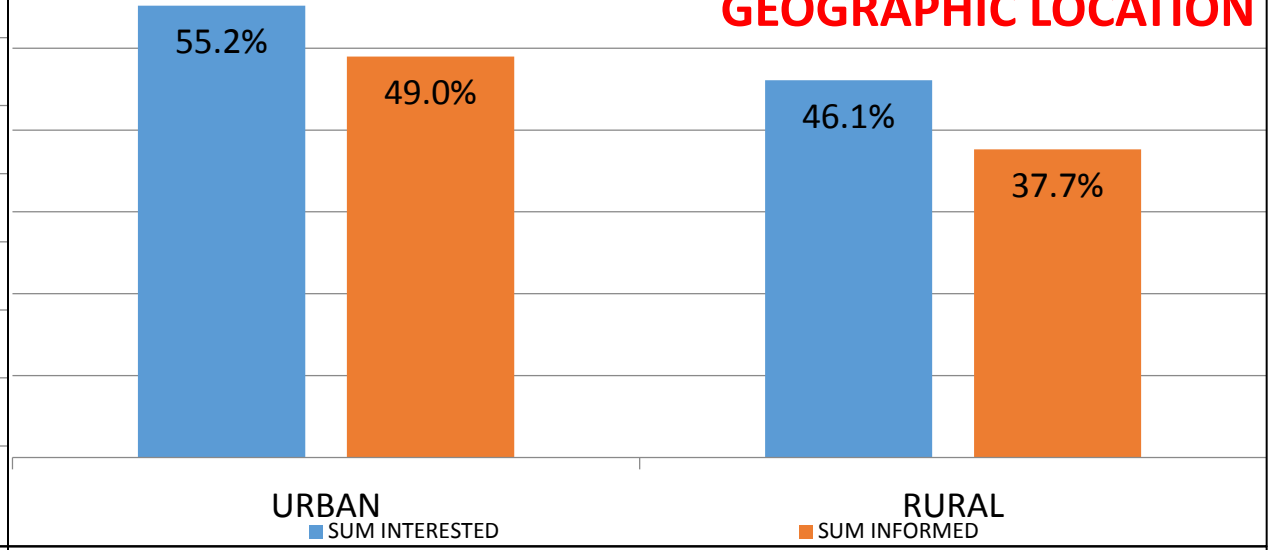
South Africans are less well-informed about science…

RACE

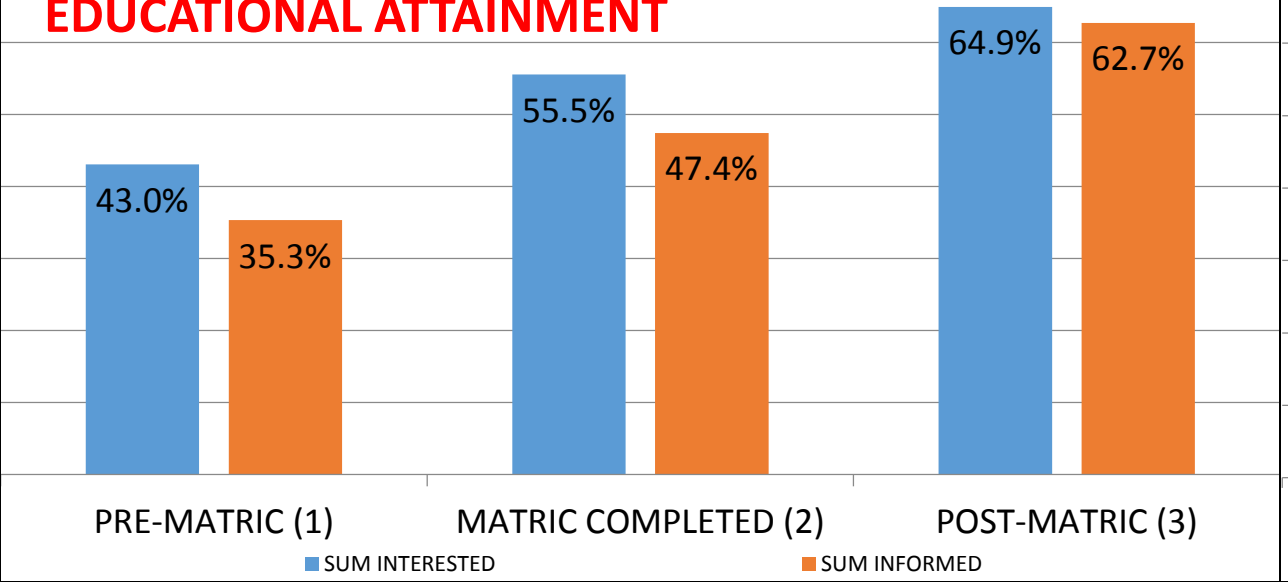
N= 3 346



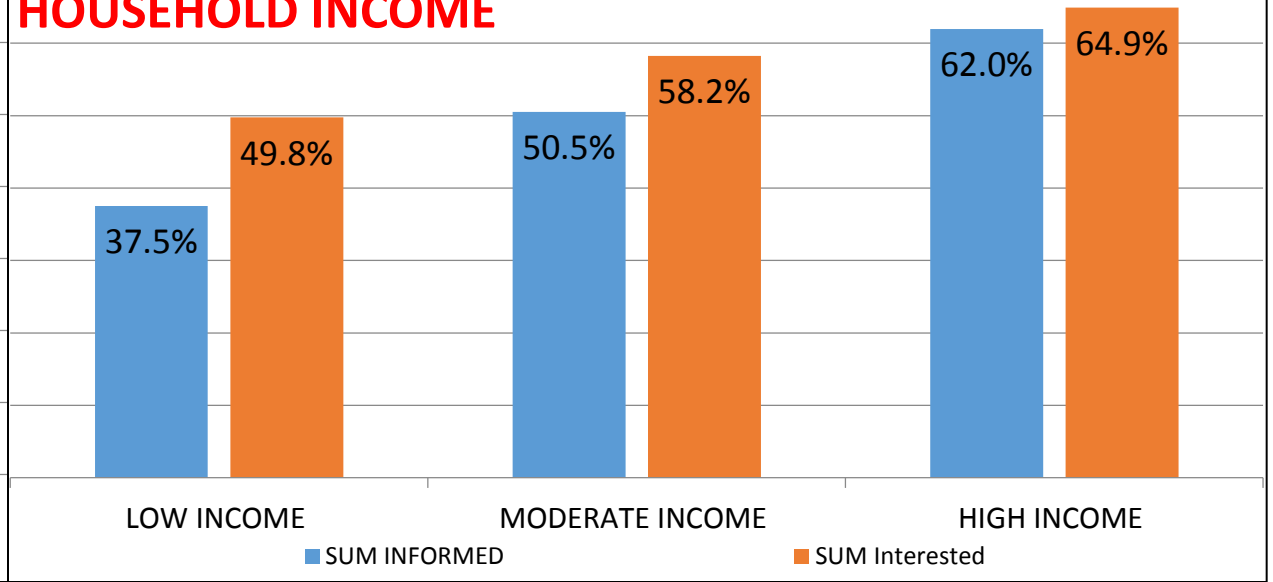
GEOGRAPHIC LOCATION



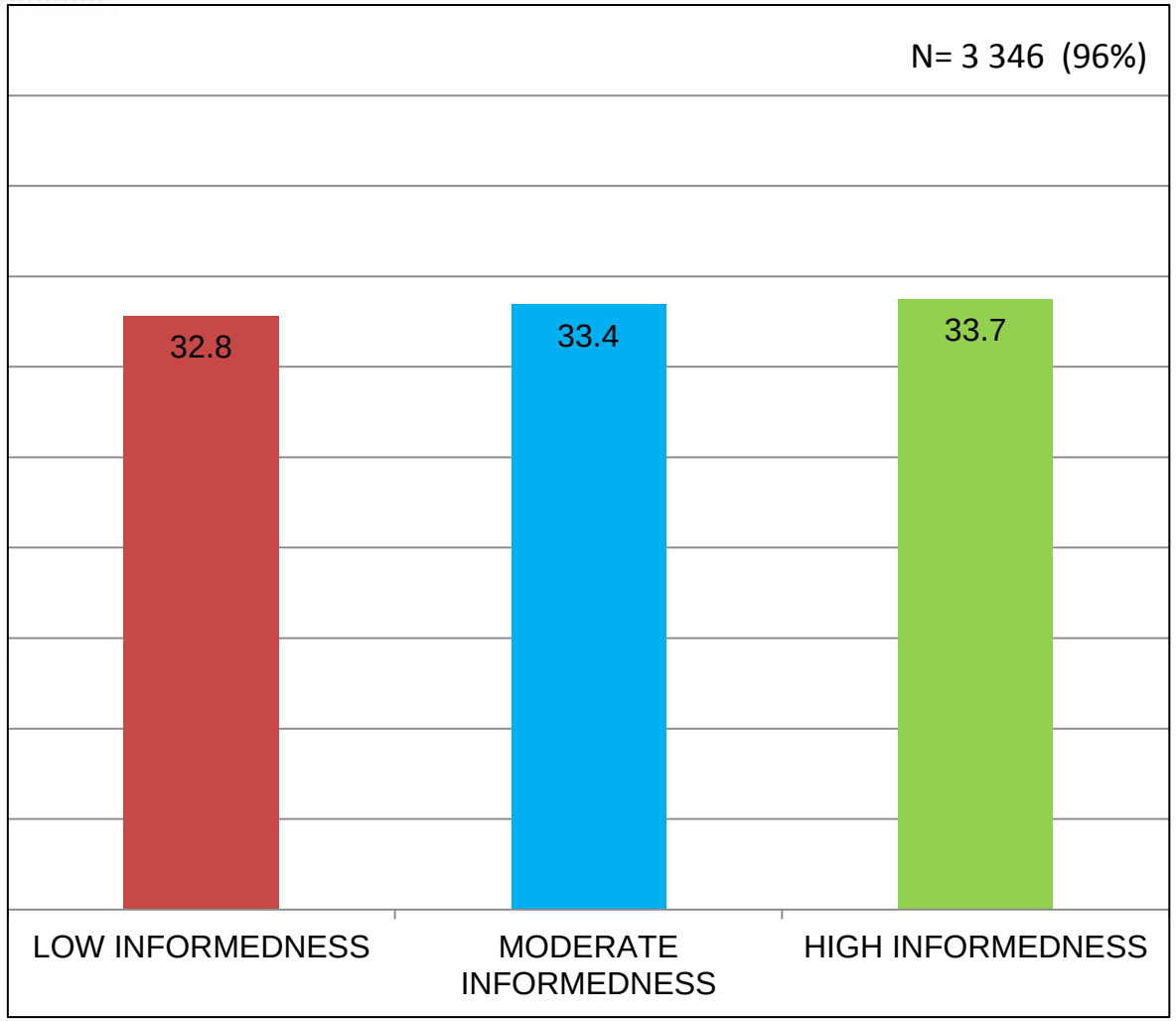
EDUCATIONAL ATTAINMENT



HOUSEHOLD INCOME

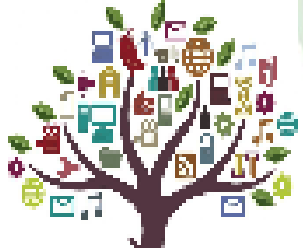


Index of Science Informedness



- The *Index of science informdness* reveals relatively equal proportions
- Indian / Asian respondents most frequently appear in the *low informedness classification* (44%)
- Respondents with increased education similarly appeared more frequently in the *high informedness classification* (55%), compared to those with pre-matric education (24%)
- Rural respondents report the highest proportions in the *low informedness classification* (43%)
- Older respondents (60 years +) appear more frequently in the *low informedness classification* (46%), than younger respondents

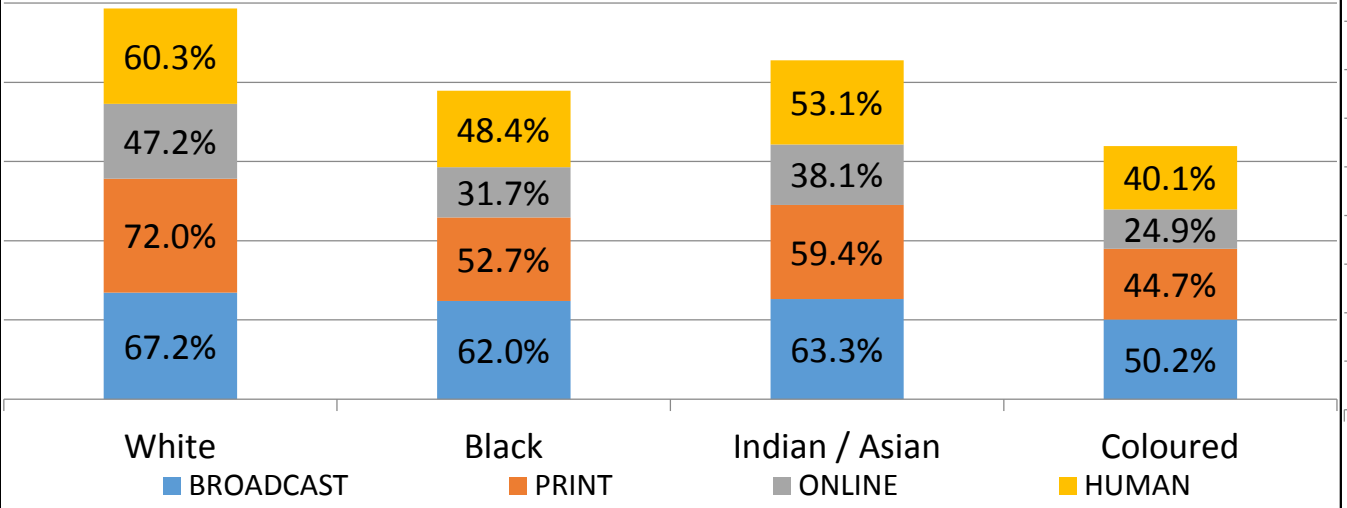
Information Immersion Index



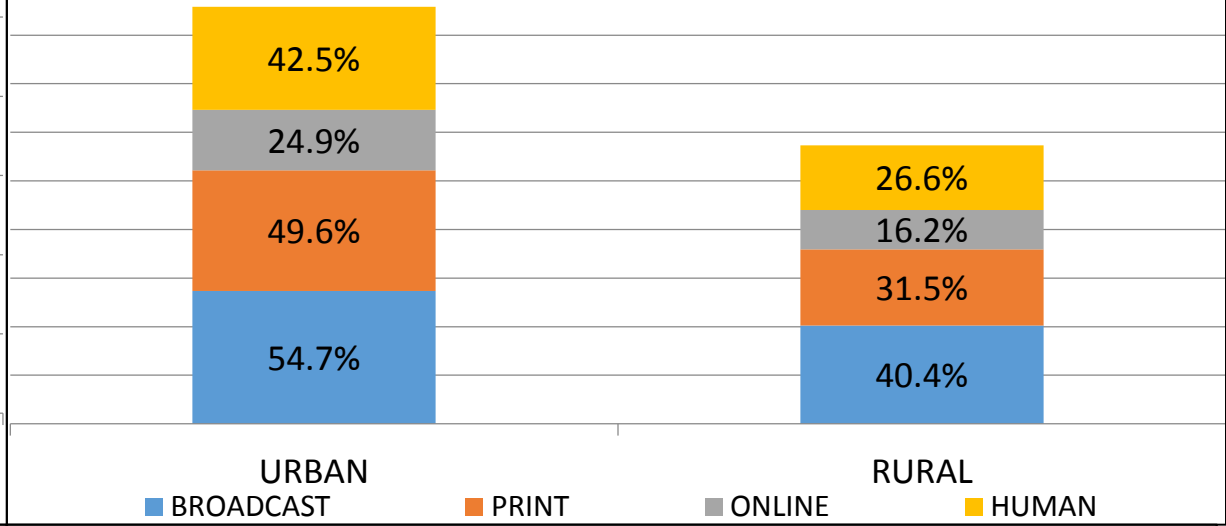
SCIENCE INFORMATION SOURCE	Most Frequently	Frequently	Least Frequently
Radio	34.10%	25.80%	26.40%
Free-to-Air Television (SABC / E-Tv)	31.10%	22.50%	28.90%
Other people (Family, Friends, Colleagues)	23.20%	24.10%	31.50%
Newspapers	22.90%	27.00%	33.00%
Satellite Pay Television (DSTV, TopTv)	18.90%	17.00%	35.70%
Books / Magazines	13.00%	24.00%	38.20%
Social media (Facebook, Twitter)	12.90%	16.60%	38.70%
Government Announcements	8.10%	18.80%	43.00%
News Websites	7.30%	14.30%	43.90%
Institutional Websites (University / Research Lab)	6.30%	12.30%	45.70%
Blogs	5.20%	12.70%	45.60%

Patterns of *Information Immersion* show variation by demographic classification

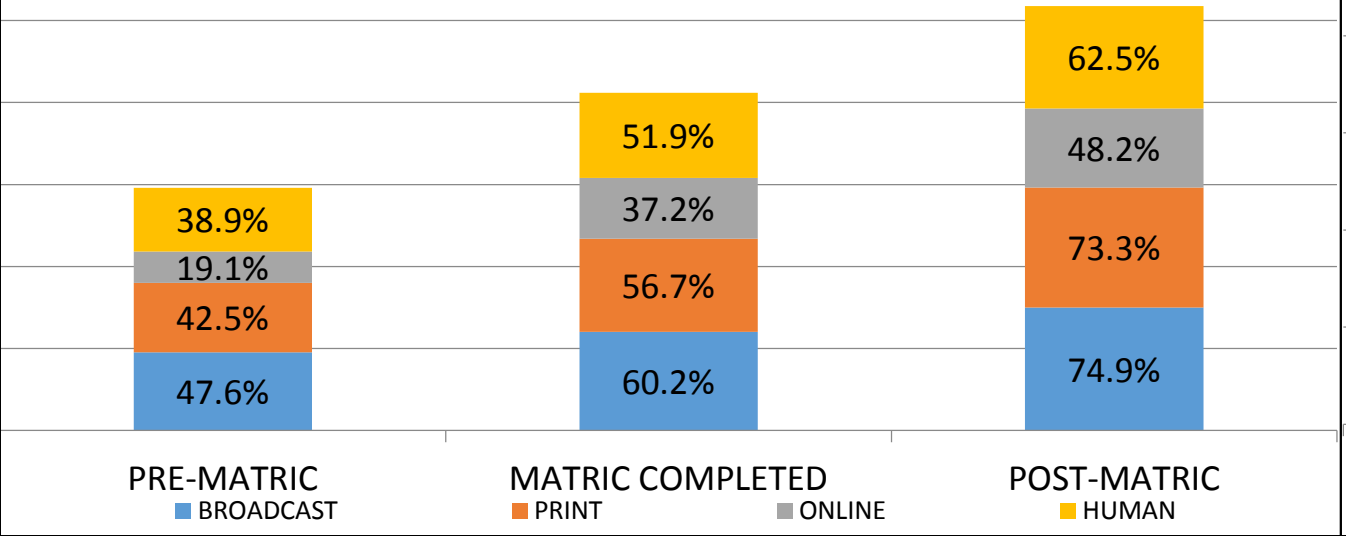
RACE



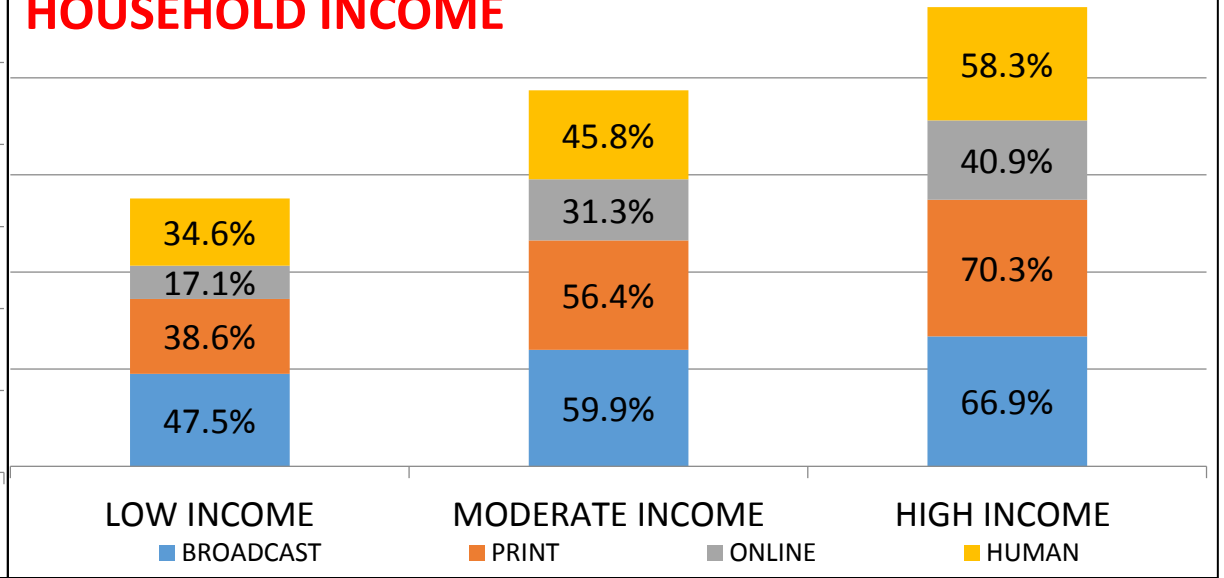
GEOGRAPHIC LOCATION



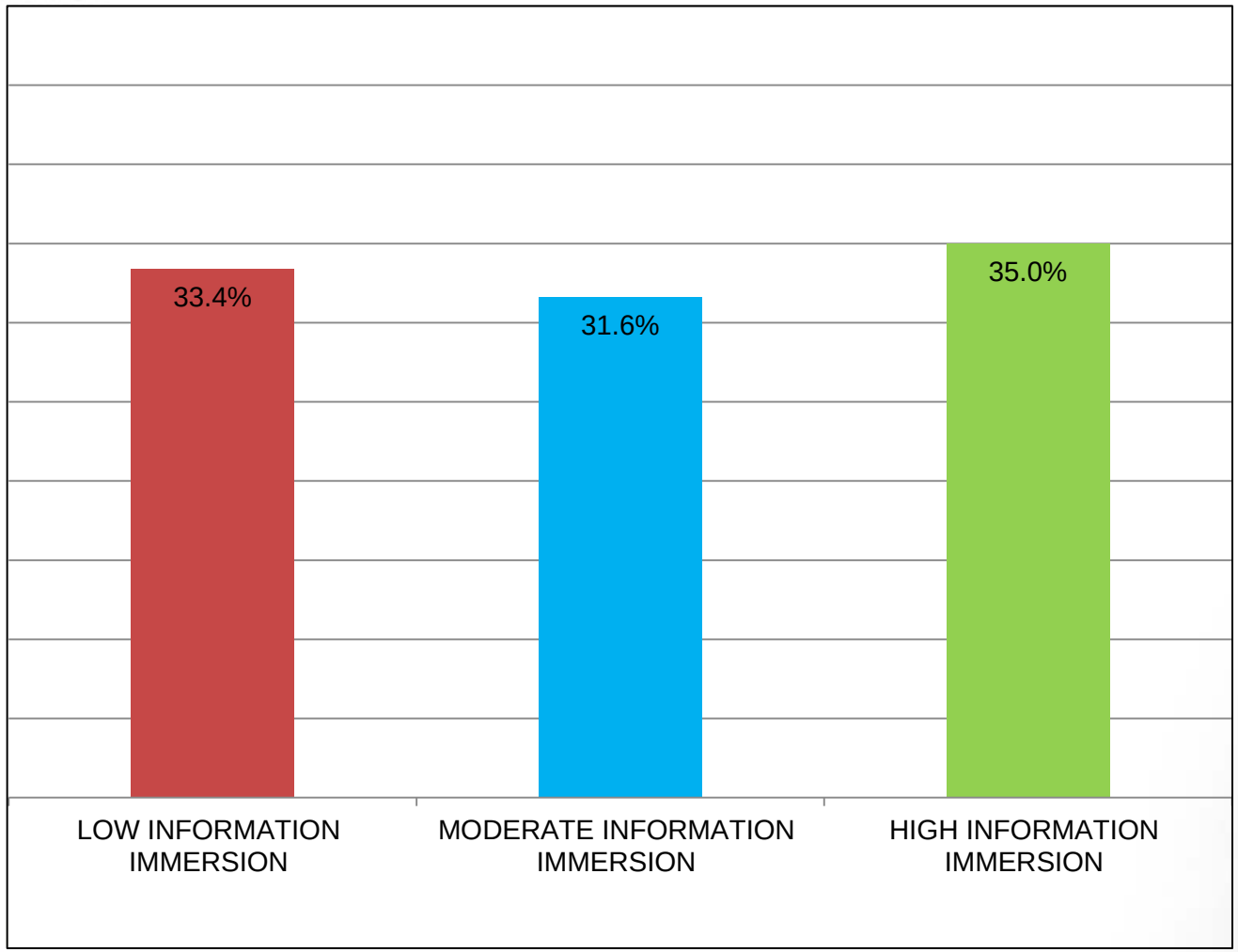
EDUCATIONAL ATTAINMENT



HOUSEHOLD INCOME

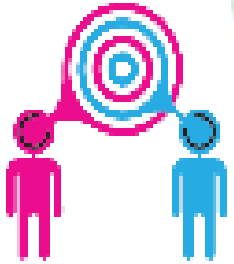


Information Immersion Index



- Count and frequency of encountering science information across information sources vary greatly
- *Broadcast* is the most frequently accessed science information medium in South Africa (TV and Radio)
- More White (54%) and Indian / Asian (46%) respondents appear in the *high information immersion* group
- Fewer urban respondents (29%) appear in the *low information immersion* group compared to rural respondents (42%)
- Respondents with post-matric education (58%) appear more frequently in the *high information immersion* group

Index of Science Engagement

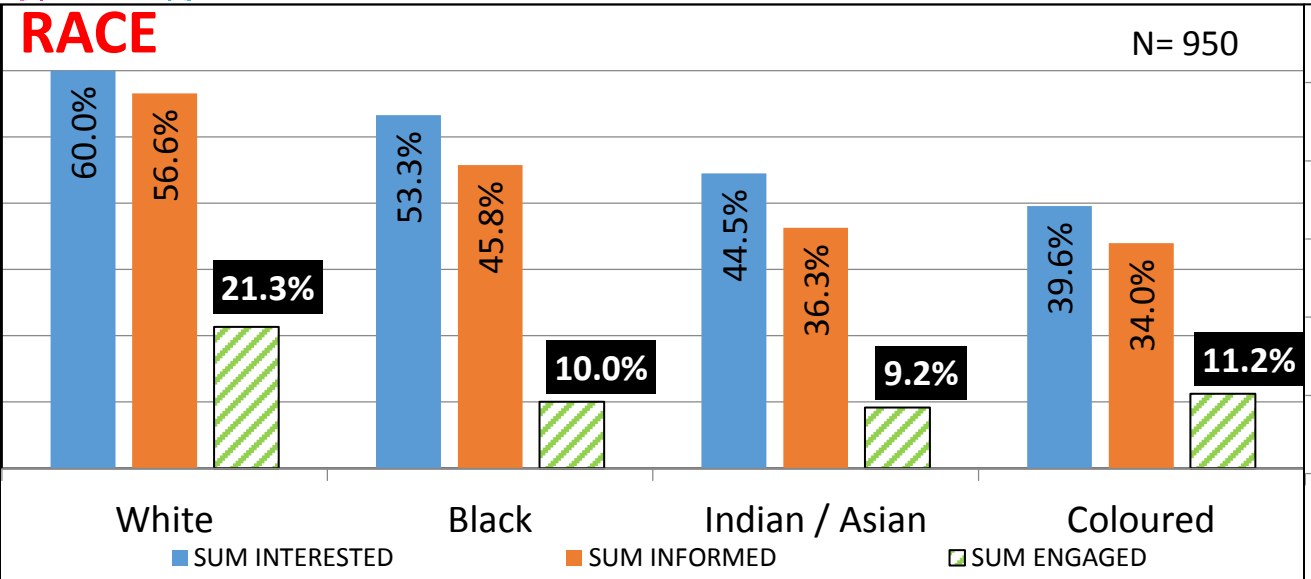


- The *Science Engagement Index* was developed from the 5-item science engagement assessment question

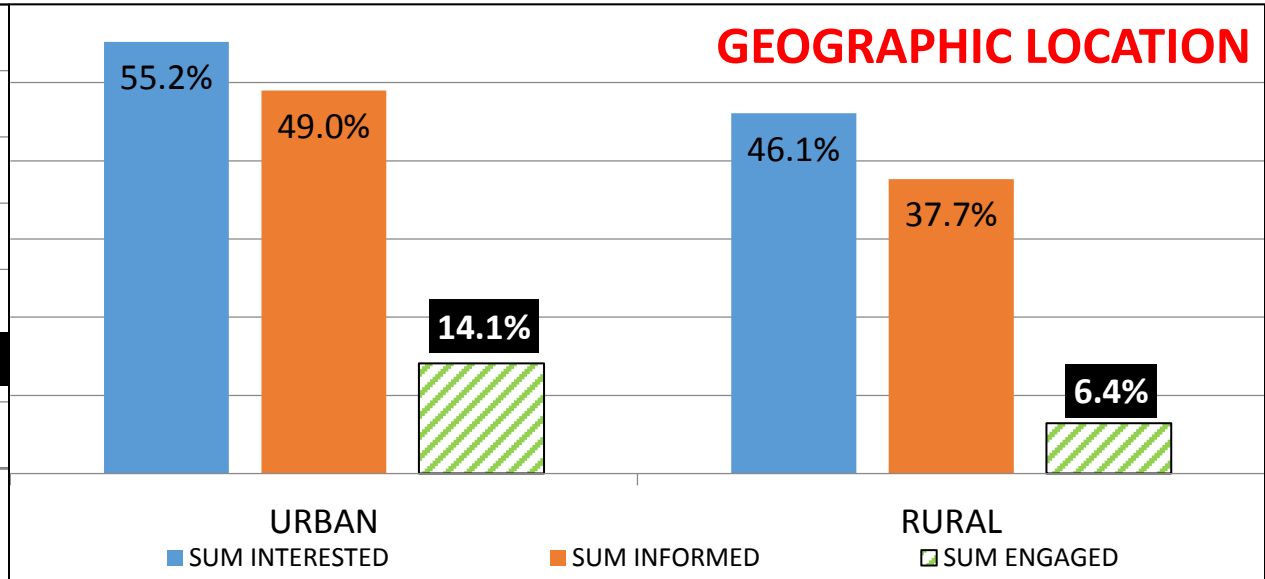
SCIENCE ENGAGEMENT ACTIVITIES	YES	NO
Public Library	19.8%	80.2%
Zoo or Aquarium	13.1%	86.9%
Museum (any)	10.5%	89.5%
Science Centre, Technology exhibition	7.2%	92.8%
Science Fair, Festival or similar Public Event	6.9%	93.1%

Among 3 486 respondents, only 950 reported attendance at a *science engagement* activity…

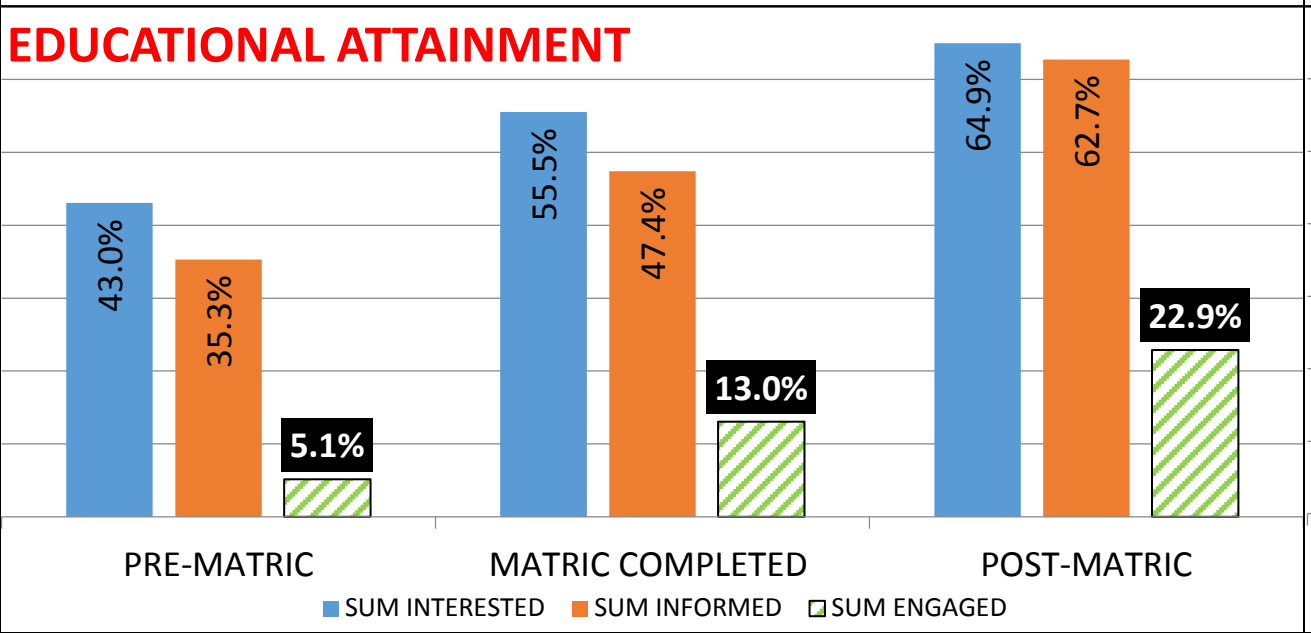
RACE



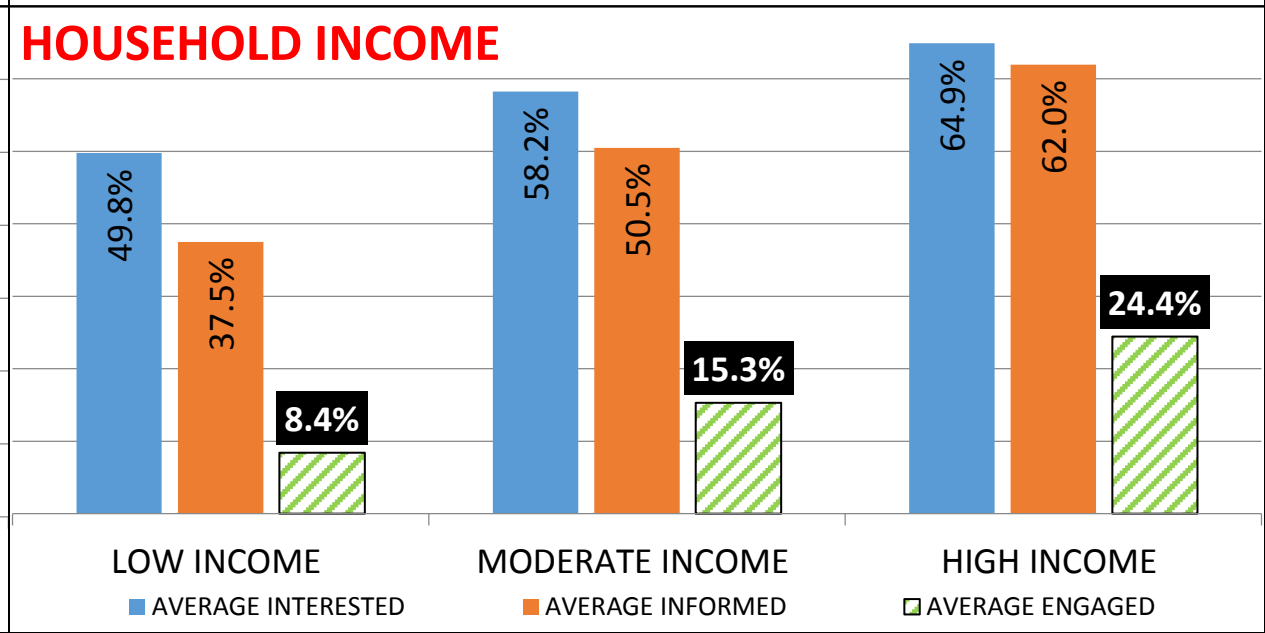
GEOGRAPHIC LOCATION



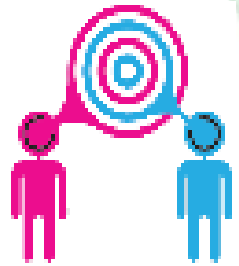
EDUCATIONAL ATTAINMENT

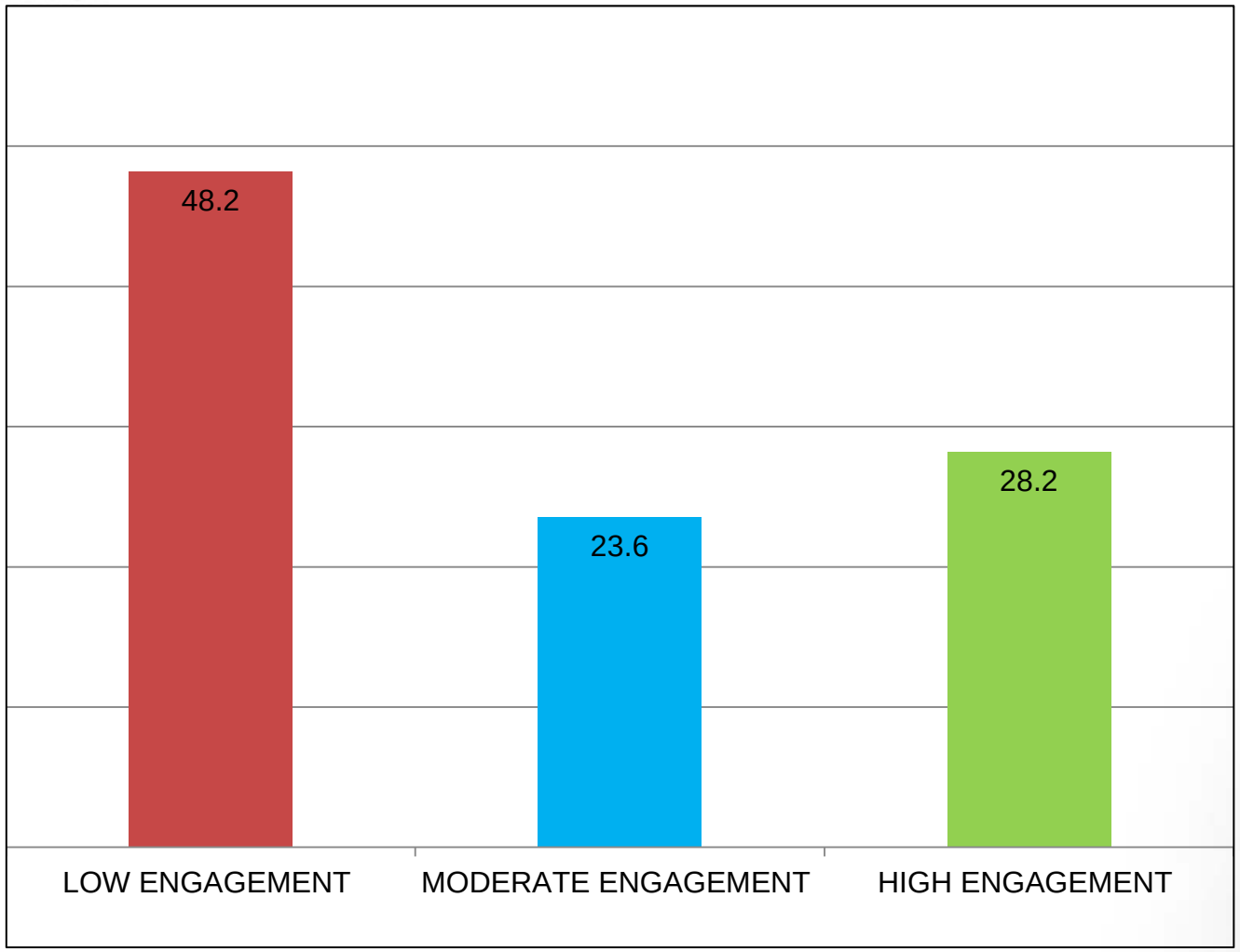


HOUSEHOLD INCOME



Index of Science Engagement





- Among those reporting attendance, 48.2% attended only 1 science engagement activity during the reference period
- 52% of Black and Coloured respondents attended only 1 science engagement activity, while more than 30% of Indian and White respondents attended more than 3 engagement activities
- Males (32%) were more frequently represented in the *high engagement classification* than females (24%)
- Urban respondents (32%) and those with post-matric education (44%) were more often classified in the *high engagement classification*

Relationships between Indicators

	KNOWLEDGE INDEX	ATTITUDE INDEX	INTEREST INDEX	INFORMEDNESS INDEX	INFO SOURCE INDEX	ENGAGEMENT INDEX
KNOWLEDGE INDEX	1.00	0.009	.120**	.122**	.147**	.081*
ATTITUDE INDEX	0.009	1.00	-0.030	.045*	0.000	-0.005
INTEREST INDEX	.120**	-0.030	1.00	.537**	.352**	.172**
INFORMEDNESS INDEX	.122**	.045*	.537**	1.00	.479**	.196**
INFO SOURCE INDEX	.147**	0.000	.352**	.479**	1.00	.203**
ENGAGEMENT INDEX	.081*	-0.005	.172**	.196**	.203**	1.00

** Correlation is significant at the 0.01 level (2-tailed)* Significant at the 0.05 level (2-tailed).(Info-Source = information immersion index)

Predictors of outcomes

INDICATOR (Outcome variable)	Valid N	Cronbach's Alpha	Mean	Standard Deviation
Science knowledge index	3188	0.911	1.99	0.85
Attitudes to science index	3311	0.939	0.25	0.76
Interest in science index	2640	0.936	2.00	0.81
Informedness in science index	3346	0.949	2.01	0.82
Information immersion index	3229	0.946	2.02	0.83
Science Engagement index	950	0.943	1.80	0.85

- ***Multinomial logistic regression*** was identified as the most suitable analytic tool to explore predictors of outcomes on each indicator
- Each indicator was considered the ***dependant*** variable, while each of the 12 demographic predictors were considered the ***independent*** variable

Sociodemographic Predictors	Valid N	Mean	Standard Deviation
RELIGION	3486	4.70	4.27
MARITAL STATUS	3486	1.77	0.99
PERSONAL INCOME	3486	24.82	10.08
RACE	3486	2.17	0.79
PROVINCE	3486	5.24	2.50
RURAL URBAN	3486	1.34	0.47
GENDER	3486	1.50	0.50
AGE	3472	3.21	1.34
LANGUAGE	3486	6.40	3.87
EDUCATION	3486	1.76	0.70
EMPLOYMENT	3486	1.74	0.75
HOUSEHOLD INCOME	2271	1.35	0.60

Predictors of outcomes

Predictor	Science Knowledge Index	Attitudes to Science Index	Interest in Science Index	Informedness in Science Index	Information Immersion Science Index	Science Engagement Index
Race group	✓	✓	✓	✓	✓	
Educational attainment	✓		✓	✓	✓	✓
Household Income	✓		✓	✓		
Geographic location (rural / urban)				✓	✓	✓
Age group				✓	✓	
Employment status				✓		

- ***Race*** and ***Educational attainment*** were the most significant predictor on 5 of the 6 indices.
- ***Household income; geographic location; age*** and ***employment status***, while significant predictors of outcomes on various indices, did not feature on all indicators.
- It remains important to note that these variables likely do not exert an *independent* influence on each indicator, and would be as a result of complex *interactions* between the *predictors*

Key findings & conclusion

- Demographic variables play a significant role in public understanding of science assessment outcomes among South Africans.
- The notion of *the many public**S*** becomes more useful, than a homogenous general public
- South Africans record lower, rather than higher scores on **knowledge** assessments – however some variation across differing subject areas
    - **Race; Household Income** & **Educational Attainment.**
- **Attitudes** to science are generally positive, however some concern as to the impact of science on daily life is noted. South Africans further report a degree of ***attitudinal ambivalence*** with regards to science
    - **Race** appears to be a key factor in outcomes on attitudinal measures.
- South Africans report moderate ***interest*** in science, However lower levels of ***informedness***.
    - **Race; Geographic Location ; Educational Attainment; Age; Employment & Household Income**
- Results indicate that South Africans more frequently use *old technologies* (Radio, Tv, Print) as science **information sources**, compared to *new technologies.* Differences were noted here based on demographic classifications: **Race**; **Location**; **Education** and **Age**
- Despite higher levels of *interest* and *informedness,* South Africans report low levels of attendance at **science engagement** activities (**Race**; **Gender**; **Location** & **Education**)

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THANK YOU

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