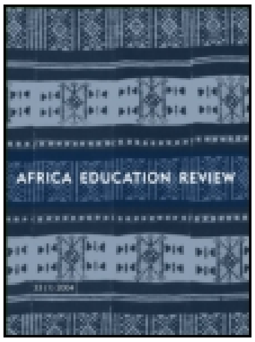

Africa Education Review

ISSN: 1814-6627 (Print) 1753-5921 (Online) Journal homepage: https://www.tandfonline.com/loi/raer20

Assessing second phase high school learners' attitudes towards technology in addressing the technological skills shortage in the South African context

H. Muller, M.T. Gumbo, J.A.T. Tholo & S.M. Sedupane

To cite this article: H. Muller, M.T. Gumbo, J.A.T. Tholo & S.M. Sedupane (2014) Assessing second phase high school learners' attitudes towards technology in addressing the technological skills shortage in the South African context, Africa Education Review, 11:1, 33-58, DOI: 10.1080/18146627.2013.853566

To link to this article: https://doi.org/10.1080/18146627.2013.853566

Published online: 16 Jan 2014.

Assessing second phase high school learners' attitudes towards technology in addressing the technological skills shortage in the South African context

H. Muller
College of Graduate Studies,
School of Interdisciplinary Research,
University of South Africa, P.O.Box 392,
UNISA, 0003, Pretoria, South Africa
Email: mulleh@unisa.ac.za

M.T. Gumbo
College of Education,
Department of Science and Technology
Education, University of South Africa, P.O.
Box 392, UNISA, 0003, Pretoria, South Africa
Email: gumbomt@unisa.ac.za

J.A.T. Tholo
North West Department of Education, P.O.
Box 5051, Mmabatho, 2735, South Africa
Email: jtholo@nwpg.gov.za

S.M. Sedupane
Department of Statistics (Mafikeng Campus),
North West University, Private Bag x 2046,
Mmabatho, 2735, South Africa
Email: silas.sedupane@nwu.ac.za

Abstract

This article argues the case that the decline in the numbers of school leavers entering science, technology, engineering and mathematics study courses worldwide and in

ISSN 1814-6627 (print) 1753-5921 (online)
DOI: 10.1080/18146627.2013.853566
University of South Africa Press

Africa Education Review 11 (1)
pp. 33 – 58

South Africa in particular, is linked to negative attitudes towards Technology. The issue is regarded as critical since a negative trend in new entrants into the technology sector contributes to the technological skills shortage experienced locally and abroad. The purpose of the research was to determine learners' perception of the concept of technology in general; their current attitude-status on seven dimensions of attitude towards technology; and factors that affect attitude. To this effect the article reports on the results of a technology perceptions-and-attitudes survey (derived from the PATT-US attitude-questionnaire) conducted on 95 Grade 10-to-12 learners during the 2009 National Science Week initiative held in the Northwest Province of South Africa. The initiative was hosted to promote science and technology awareness amongst the school going youth of the Northwest Province. The Grade 10-to-12 group included in the research represented future school leavers in the Northwest Province who would possibly consider entering into a technological career. The results of the study indicated that age, gender and grade-level of learners presented as factors that statistically significantly affected attitudes towards and perceptions of technology. The findings of the study raised the question whether the various dimensions of attitudes measured in the study influence learners' choice of a career in technology in different ways.

Keywords: attitudes, career choice, influential factors, school leavers, skills shortage, technology

Introduction

In everyday life people are surrounded by technology, exposed to it and experience its impact in different ways – whether positive or negative. How people experience technology is linked to their need of, and interest in the specific form of technology; their age or peer group; their environment; profession; geographic location and many more.

According to Volk, Yip and Lu (2003), attitudes evolve from learning experiences. It stands to reason that people's general perception of technology and attitudes towards technology will vary. For example, young people's perception of technology is constantly influenced by the advancement in technology (Khunyakari, Mehrotra, Chunawala and Natarajan, 2009): be it communication media such as cell-phone technology (iPhones), Facebook, Twitter, Skype; or electronic applications; or media in the form of television, animated movies and YouTube; or access to information via internet and search engines (such as Google) or electronic devices (iPods, iPads, GPS), to name but a few.

Patterns of thinking, emotions and actions are influenced by attitudinal constructs and these attitudes are formed early in life (Volk et al., 2003). Research has overwhelmingly indicated that primary and early secondary school years (which include the age category 12–16) are formative years when it comes to attitudes, and, once formed attitudes tend to remain constant (Bennett and Hogarth, 2009). Applied to the technology sphere, these findings are of the essence if actions, planning and decisions regarding careers and career promotion in technology are considered. If the *attitude-influences-action* deduction by Volk et al. is considered against the backdrop of the worldwide skills shortage in technology (Gupta and Houtz, 2002) and particularly in the South African context, (Bremer, 2012; MacGregor, 2010), then the ripple effect of positive attitudes towards technology on school leavers' decision to follow technological careers and in this way address the skills shortage in South Africa, calls for further investigation.

Based on this argument, the authors of this article propose that if learners' attitudes towards the general concept of technology and attitude towards technology can be swayed (if found to be negative), their pattern of thinking, actions and career choices will be influenced accordingly, creating a technological awareness which will inspire school leavers to enter technological courses and careers.

The *attitude-influences-action* deduction (Fishbein and Ajzen, 1975; Volk et al., 2003) formed the conceptual framework of the study. However, set against this framework, the argument has to be taken further that technological awareness initiatives cannot be initiated and effectively implemented if the current technological awareness status of the target population remains an unknown.

The article is structured to review national and international research findings on learner attitudes towards technology. The article reports on a technology-attitude study conducted on Grade 10-to-12 learners in South Africa. This group was selected since they represent students and job seekers of the near future. A literature study indicated that limited research has been done on this age group (Grade 12 learners) both in South Africa and internationally. A number of referenced studies attest to this statement, for example, studies by Ankiewicz, Van Rensburg and Myburgh (2001) were conducted on Grade 9-to-10 learners; Van Rensburg, Ankiewicz and Myburgh (1999) researched 12-to-16-year olds – which represents Grades 6-to-10 learners; and the ongoing international ROSE (Relevance of Science Education) project investigates 15-year olds (Grades 9-to-10) in 40 participating countries. This project is lead by Sjoberg and Schreiner (2008).

The findings of the study are presented once the research methodology and analysis strategy, which underlie the quantitative analysis, have been explained. The focus of the strategy was to address the research questions, namely, to assess the status of Grade 10-to-12 learners' *perception* of the concept of technology in general; determine the status of learners' *attitude* towards seven attitude-dimensions of technology and assess the effect of biographical factors on learners' perception of and attitudes towards technology.

The article summarizes the assessed status of learners' technology *attitudes*, the factors that affect attitudes and learners' *perception* of the concept of technology. An interpretation of results and suggestions on how informed actions (based on research results) can raise technology awareness, motivate technology career choices and address the technical skills shortage in South Africa in the long run concludes the article.

Literature review

The concepts of technology, STEM and attitudes

Research approaches on attitudes towards technology are shaped according to researchers' interpretation of the concept of technology. Literature indicates that researchers either view technology as a general innovative and ever changing skills application area, or as a discipline-specific area (Ankiewicz, 1995:36; Brake and Bellamy, 2007).

The definition of the general concept of technology, as referred to in the education policy for Technology Education in South Africa (cited by Ankiewicz, 1995:36) states that,

> [Technology is] humankinds' purposeful mastery and creative use of knowledge and skills regarding products, processes and approaches in order to improve the management of the environment. It also emphasises the use and production of artefacts and processes by means of which labour, productivity and entrepreneurial empowerment can be accomplished [and improved].

Brake and Bellamy (2007) on the other hand, define technology in terms of disciplines that include science, engineering, physics, engineering technology and mathematics. Brake and Bellamy's interpretation reflects the meaning attached to acronyms such as STEM (science, technology, engineering, mathematics), STE (science, technology, engineering) and STEME (science, technology, engineering, mathematics, engineering education). According to the STEM careers website, STEM includes those academic and professional disciplines that fall under the umbrella areas represented in the acronym (STEM Careers, n.d.).

These fields jointly explain the general concept of technology and are regarded as cornerstones of an advanced society. The strength of the STEM workforce of a country is viewed as an indicator of a nation's ability to maintain itself, therefore the level of technological awareness and advancement receives prominent attention worldwide (Boser, Palmer and Daugherty, 1998). Examples of STEM awareness initiatives abroad include the STEM Education Coalition in the United States (The STEME Coalition, n.d.) and, in South Africa for example, the SA Agency for Science and Technology Advancement (SAASTA) who, in conjunction with the Department of Science and Technology, implement STEM strategies in schools. STEM initiatives in South Africa also include the introduction of technology education in 2005 as a compulsory discipline in government schooling and the opening of STEM government schools. (A STEM-specific government school, the third such school was for example opened in Tokai, Western Cape, September 2010). Technological skills shortages are experienced in all STEM disciplines (Bremer, 2012; Naido, 2007; Sjoberg and Schreiner, 2005) and in the current research it was therefore argued that attitudes towards technology should not be limited to a single technological discipline but should be investigated over all STEM disciplines – therefore the references in this article to learner perceptions regarding the *concept of technology in general*.

A technology profile, a measure of technology awareness, defined by Ankiewicz, Van Rensburg and Myburgh (2001) thus formed part of the conceptual framework of the study. Mentioned researchers define the technology profile of a learner as technology insight and knowledge, awareness and capability, and, how these attributes are incorporated into the personality, beliefs, perceptions and behaviour system of the learner (Ankiewicz et al., 2001:93).

Equally relevant to the study is Volk et al.'s (2003:49) description of attitudes in terms of determinants and consequences of learning experiences. Volk et al. state that attitudes can be considered both the determinants or consequences of learning experiences, and, despite those experiences being positive or negative, attitudes develop from these experiences which stimulate or inhibit further learning opportunities. Volk et al.'s view agrees with the definition given by White (1988:101) who states:

> 'An attitude towards a concept such as science (or technology) is the person's collection of beliefs about it, and episodes that are associated with it that are linked with emotional reactions. The stimulation of these reactions affects decisions to engage in behaviour, such as choosing to take a science course, to read about scientific matters, or to adopt a science related hobby.'

The definition underlines the traditional view of an attitude as an integration of a cognitive, affective and behavioural component (Van Rensburg et al., 1999:142). The affective component – which refers to a person's emotions regarding an attitudinal object (such as technology) and which determine behaviour and choices – is important to the study. In the context of the study, learners' primary affective associations with technology will be assessed. These associations are described by Ankiewicz et al. (2001:98) as *attitudes towards technology.*

Technological skills shortage and research findings on attitude towards technology

The skills shortage dilemma and the declining interest in technological courses and careers receive prominent attention in the media and literature (Bremer, 2012, for example). Gupta and Houtz (2000) report on the phenomenon in the USA; Lyons (2003:592) on skills shortages in Australia; Bennett and Hogarth (2009) on shortages in the UK and Wales; The European Commission (2004) and Sjoberg and Schreiner (2005) on Europe; Osborn (2003:1049) on technological skills shortages in the UK; and MacGregor (2010) and Naido (2007) on skills shortages in South Africa. In 2006 Gibbons (2006) for example reported that South African women were still alarmingly under-represented in science, maths, engineering and technology careers, which mirror international trends (Tomas and O'Grady, 2009:11–13).

The reported studies on skills shortages in the technology sector invariably turn attention to school leavers as the most probable source of new entrants to the technology sector. However, a comparative matriculation performance trend in South Africa on 2006 (Kuenzi, 2008), 2010 and 2011 figures (SouthAfrican.info newsletter, 2012) paint a bleak picture. The figures indicate that in 2006 only 16% (84,564) of 528,525 candidates passed with grades required for university entry. In 2010 and 2011 these figures were respectively 23.5% (126,322 of 537,543) and 24.3% (120,549 of 496,090). In 2006 only 4.8% (25,633) passed higher-grade mathematics, and only 5.7% (30 174) passed higher-grade science (Simkins, Rule and Bernstein, 2006). The 2010 and 2011 figures are not directly comparable with 2006 higher-grade mathematics and science figures since the distinction between higher and lower grades has since been abolished. The 2010 and 2011 mathematics pass rate – on a 30% pass criterion – was 47.4% and 46.3% respectively. These corresponding figures for science came to 44.9% and 53.4%. In addition a very worrying decline in the number of Grade12 science learners was reported (SouthAfrica.info Newsletter, 2012). These results echo

Kuenzi's (2008) concerns on learner performance and the numerous learners who fail to reach proficiency in mathematics and science.

Key elements of findings by independent researchers on attitudes towards technology in general and STEM disciplines in particular are relevant to this study. In their research Fishbein and Ajzen (1975) deduced that attitude towards technology, determines, to a large extent, a learner's future behaviour and choices: if technology awareness is kindled and attitudes and perception positively influenced choices for technology career will increase. Other critical findings include research by De Klerk Wolters (1989) who indicated that attitudes towards technology are formed early in life and that certain factors, such as familiarity with technology, culture, society, environment, country and school most probably affect attitudes towards technology. Knulst also reported on the effect of familiarity with technology on attitudes (cited in De Klerk Wolters, 1989:2). Equally informative are the findings by Weinburgh (1995) that positive or negative experiences with technology affect a learner's attitude towards technology. Weinberg furthermore reported that attitudes towards different aspects of technology differ statistically significantly. For example learners' attitudes were often reported as positive towards the dimension of the *consequences of technology* yet, negative towards the dimension of *technology as a career choice*. According to Weinberg these attitudes, once formed, tend to remain constant. Volk et al. (2003) studied learner performance and indicated that academic achievement in technology courses is related to learners' attitude towards technology. Akpinar, Yildiz, Tatar and Ergin (2009), amongst others, identified gender differences in attitudes towards technology and Akpinar et al. (2009) grade differences (and by implication age). He indicated that younger learners (11-year-olds) tend to be more positive than older (16-year-old) learners. In the same year Khunyakari et al. (2009) reported that positive attitudes towards certain aspects of technology tend to predominate – although the degree of optimism may not always be very high. Tomas and O'Grady (2009) found culture, parental influence, peers, gender, knowledge and understanding of technology and role models to affect attitudes towards technology.

A literature study indicated that a vast amount of research has been conducted on learners in the 11-to-16-year-old age category and that extensive cross-country studies (Sjoberg and Schreiner, 2005, 2008) on 15-year-olds were undertaken. However, limited research has been undertaken on 16-to-18-plus-year old learners.

The literature discussion served to motivate the reasoning followed in this research, namely, that actions (career and course decisions) flow from attitudes developed by learners (the attitude-influence-action deduction by Fishbein and Ajzen (1975)) and that various factors – such as age, grade-level, gender and technology education differentiation level – may shape attitude towards technology (De Klerk Wolters, 1989; Tomas and O'Grady, 2009; Weinberg, 1995). By determining the status quo of learners *attitudes* towards attitudinal dimensions of technology, learners' *perceptions* of the construct of technology in general, and factors that affect technology *attitudes* and *perception*, educators and the educational community will be better informed to stimulate technology awareness effectively and work towards the cultivation of positive technology attitudes. The argument is concluded with Fishbein and Ajzen's deduction that positive attitudes prompt future behaviour, where future behaviour refers to technology career decisions.

The research methodology discussed in the next section relates how the status of *perceptions* and *attitudes* towards technology were assessed and formative factors identified.

Research methodology

Research questions of the investigation

The aim of the investigation was to evaluate senior phase (Grades 10 and 11) and school leavers' (Grade 12) *attitudes* towards dimensions of technology and *perceptions* of the general concept of technology. The possible significant effect of gender, age, grade and technology education differentiation levels on attitudes was also investigated. The aims were formulated in three research questions, namely

1. What is the status of sampled Northwest learners' attitude towards attitudinal dimensions of technology?
2. What are the perceptions of sampled Northwest learners' regarding the concept of technology in general?
3. Which biographical factors affect sampled Northwest learners' attitudes towards attitudinal dimensions of technology statistically significantly?

The research design, measuring instrument, sampling and data collection

The research was conducted as a quantitative survey design on 6 randomly selected, urban, public secondary schools in region seven of the Northwest

Province of South Africa. A questionnaire was considered an appropriate measuring instrument of learners' *attitudes* and *perceptions* of technology. Ninety-five Grade 10-to-12 learners were randomly selected from the identified schools and a questionnaire administered. Questionnaire administration was conducted during the 2009 Northwest National Science Week (NSW) activities which was open to all learners. The NSW was hosted by the Department of Science and Technology to foster STEM and general technology awareness in learners. Grade 10-to-12 learners formed the target population because these learners represent the job seekers and probable entrants to the technology sector in the near future. Technology education was included in the curriculum of all these learners. These learners chose between three differentiation fields in technology education, namely, mechanical, civil and electrical technology.

Since the assessment of *attitudes* and *perceptions* resort under the affective component of an attitude as defined by Van Rensburg et al. (1999:142) the PATT-USA (Pupils' Attitude towards Technology) questionnaire (Bame, Dugger, De Vries and McBee, 1993; Raat and De Vries, 1985), was used to develop a questionnaire that would suitably measure *attitudes* and *perceptions* in the South African environment and culture of the Northwest Province. The decision to use the PATT questionnaire was based on research reported by De Klerk Wolters (1989), Van Rensburg et al. (1999), Ankiewicz and Van Rensburg (2001), Volk et al. (2003), Becker and Maunsaiyat (2002) and Boser et al. (1998), Yurdugul and Askar (2008).

The South African adapted questionnaire consisted of 83 questions similar to the items of the PATT-USA questionnaire. The questionnaire was prepared in English, which is the medium of tuition in the sampled schools. (The questionnaire is in the Appendix). The first five questions of the questionnaire probed learners' biographical information (age, gender, grade-level and Technology education differentiation level). The following 58 of the 78 Likert agreement rating scale questions addressed six dimensions of *attitude* towards technology (Raat and De Vries, 1985), namely,

- the *interest* dimension (13 items, namely questions 9, 12, 22, 24, 37, 39, 43, 51-52, 59, 61, 63 and 81) which evaluated the extent to which learners engage in technology activities at school;
- the *role pattern* dimension (10 items, namely questions 11, 32, 56, 71, 76, 19, 26, 48, 62 and 40), which questioned learners' opinion of technology as a gender-independent career option;

- the *consequence* dimension (8 items, namely questions 6, 7, 14, 33, 38, 46, 53 and 57) which evaluated learners' personal perception of the impact of technology on their lives and society;
- the *technology is difficult* dimension as a career option (9 items; questions 35, 47, 74, 18, 28, 65, 79, 83 and 80);
- the *curriculum* dimension (11 items, namely questions 23, 30, 36, 41, 50, 53, 55, 69, 72, 73 and 75) which evaluated the perceived standing of technology in the curriculum; and
- the *career* dimension (4 items, namely questions 49, 58, 78 and 34) which assessed the likelihood of learners choosing a technological career.

The remaining 20 of the 78 Likert rating scale questions probed learners' *perceptions* of the *concept of technology* (questions 8, 109, 11, 15-17, 21, 25, 27, 31, 42, 44-45, 60, 64, 67,-68, 70, 77).

Respondents indicated their level of agreement with each statement according to the rating levels, '1', indicating 'strong agreement', '2' indicating 'agreement', up to '4' indicating 'strong disagreement'. All in all learners *attitudes* on six attitudinal dimensions towards technology, and their *perception* of the *concept of technology in general* were assessed.

Questionnaires were administered during school hours in the schools during the NSW. Learners were informed that completion of the questionnaire was confidential and voluntarily. Prior consent was obtained from the Department of Education (2009; Northwest Province Region) and principals of schools. Teachers administered the survey in their classrooms and were briefed via an accompanying circular to ensure uniform administration conditions.

Data analysis strategy

The analysis strategy developed for the study focused on the status of learners' *attitudes* towards technology (evaluated on 6 dimensions), their *perceptions* regarding the *concept of technology* and the nature of the effect of biographical factors on *attitudes* and *perception*.

Frequency distributions of the biographical attributes of learners would describe the backdrop against which findings were interpreted. Scale reliability testing furthermore verified that the subsets of questionnaire items designed to describe the six *attitude*-dimensions and *perception* concept of technology, presented as reliable measures. Once the internal consistency reliability of the *attitudes* (6) and *perception* measures of technology had been verified, the mean value of each technology *attitude dimension* (6) and *perception measure* for each respondent were calculated. These mean values (referred to as scores) reflect learners' attitude towards the six technology *attitude dimension* and *perception* of the concept of technology (thus answering to the first two research questions). Parametric analyses of variance were furthermore conducted on each of the six sets of technology *attitude dimension* scores and technology *perception* scores to identify biographical factors (age, gender, grade, technology education differentiation level) that statistically significantly affected particular *attitude dimensions* and/ or *perception* of technology. Bonferroni multiple comparisons of means tests were lastly conducted on relevant *attitude* and *perception* score means to describe the nature of the effect of significant factors on the various *attitude* dimensions regarding technology and *perception* of the construct of technology (Answering to the third research question).

Analysis results and findings

Context of the study

The exploratory frequency results (Table 1) indicate that almost 70% of the respondents were female. The majority (65%) of the learners fell in the 16-to-18-year age bracket and 35% were older than 18 years. Grade-distribution categories indicated that respondents were fairly well represented in each category with 34%, 22% and 44% in Grade 10, 11 and 12, respectively. Technology education differentiation indicated that the mechanical field was best represented with 44% indicating this field, followed by the electronic (33%) and the civil (23%) fields.

Table 1: Frequency distribution of biographical factors

Category	Frequency	Percent	Cumulative Freq.	Cumulative Percentage
Age				
<17	16	16.84	16	16.84
17	22	23.16	38	40.00
18	24	25.26	62	65.26
19	18	18.95	80	84.21
20+	15	15.79	95	100.00
Gender				
Female	66	69.47	66	69.47
Male	29	30.53	95	100.00
Grades				
10	32	33.68	32	33.68
11	21	22.11	53	55.79
12	42	44.21	95	100.00
Technology Education differentiation level				
Mechanical	42	44.21	42	44.21
Civil	22	23.16	64	67.37
Electrical	31	32.63	95	100.00

Scale reliability testing and general attitude towards technology

The results of scale reliability tests performed on the rating responses of learners on the six *attitude* dimensions towards technology and *perception* of the concept of technology listed in Table 2, indicated that the attitude dimensions of, *interest in technology; consequences of technology; technology in the curriculum; role pattern in technology; and technology careers;* complied with internal consistency reliability. Cronbach alpha coefficients in the region of 0.6 were indicated. According to Hair, Anderson, Tatham and Black (1998:118), Cronbach's alpha value may be decreased to 0.6 in exploratory research to indicate consistency reliability. The Cronbach alpha coefficient for the *concept of technology* was calculated at 0.84, which also indicated a high degree of internal consistency reliability. Except for the *attitude* dimension of *technology is difficult (alpha = 0.46),* all *attitude* dimension and *perception* measures could be regarded as reliable measures of learners' *attitudes* and *perception* of technology.

Table 2: Scale reliability tests on technology attitude dimension (6) ratings and perception of technology ratings on the adjusted PATT questionnaire

Attitude dimensions	Subset of questionnaire items		Cronbach alpha coefficient	Mean score	Std. dev.
	Included	Omitted			
1. Interest in technology	q9, 12, 22, 24, 37, 39, 43, 51–52, 59, 61, 63, 81	-	0.88	1.92	0.53
2. Consequences of technology	q6, 7, 14, 33, 38, 46, 53, 57	-	0.74	1.95	0.54
3. Technology in curricula	q23, 30, 36, 41, 50, 53, 55, 69, 72, 73, 75.	-	0.84	1.96	0.48
4. Role pattern	q11, 32, 56, 71, 76, 19, 26, 48, 62	Q40	0.67	2.09	0.49
5. Career in technology	q49, 58, 78	Q34	0.60	1.97	0.64
6. Technology is difficult	q35n, 47, 74, 18, 28n, 65n, 79, 83	Q80,	0.46	-	-
***Perception* of concept of technology**					
***Perception* of technology**	q8, 109, 11, 15–17, 21, 25, 27, 31, 42, 44–45, 60, 64, 67,68, 70, 77	-	0.84	1.96	0.42
Note: Cronbach alpha coefficients in the region of 0.60 or greater, act as indicators of internal consistency reliability (Hair, Anderson et al., 1998).					

Once internal consistency reliability had been established, five sets of technology *attitude* dimension scores and a set of *technology-perception* scores were calculated for each respondent. The individual scores were calculated as the mean rating response of responses to the subset of questionnaire items that describe a specific *attitude* dimension or *perception* of the concept of technology. These scores reflect each respondent's *attitudes* and *perception* towards the five reliable measured *attitude* dimensions and *perception* of the concept of technology. Because these scores were derived from rating values, the values of the scores are interpreted similar to the Likert agreement ratings of the questionnaire. Mean scores are indicated in the last column of Table 2 and reflect the status of learners' *attitudes* towards and *perceptions* of technology.

The mean *attitude* dimension scores and the mean *perception of* the concept of technology score are all approximately 2, indicating a generally positive attitude-status ('agreement') on the five *attitude* dimensions and a positive *perception* of the concept of technology. Learners' *attitude* towards *interest in technology* seemed marginally higher (mean score of 1.92) than the *consequences of technology; technology in the curriculum;* a *career in technology;* and *gender roles in technology* (mean scores respectively 1.95; 1.96; 2.09 and 1.97).

These *attitude* and *perception* scores were entered as the dependent variable in analyses of variance which is described in the next section.

Analysis of variance and nature of biographical effects on technology attitude and concept

The status of learners, general *perception* of the concept of technology and their *attitudes* towards technology, evaluated against the five reliable *attitude* dimensions, are indicated in Table 2 as mean scores. The statistical significance of biographical factors on *perceptions* of and *attitudes* towards technology were next investigated by means of three factor analyses of variance. Separate analysis of variance, conducted on each of the five sets of *attitude*-dimension scores and the *perception* of technology scores, are reported in Table 3. The biographical attributes of age, grade, gender and technology education differentiation-level were entered as exploratory variables into each anova model. (Statistical significance was not indicated for technology differentiation level in any model and the effect was added to the error term in the models presented in Table 3). Each row of the table presents the results of an analysis.

Results in Table 3 indicate that general significance was established for each of the anova models on at least the 10% level of significance (Hogg and Graig Statistical Tables, 1970). The *career attitude* dimension is not included in Table 3 since the particular model was not statistically significant. The statistical significance levels of age, grade and gender on the various technology *attitude* dimensions and *perception* of technology are presented in columns 4-to-6 of Table 3. Bonferroni multiple comparisons of means test results are reported in columns 4-to-6 of Table 3.

Table 3: Three factor analyses of variance and Bonferroni comparisons of means tests

Results of five analyses on *attitude* dimension scores and *perception* of concept technology scores. Grade level, age, gender entered as explanatory variables in each anova model (5)

***Attitude* dimensions**	**F-prob. & significance**	**Error df**	**Score means & Significance of biographical effects (indicated in parenthesis)**		
			Grade	**Gender**	**Age**
1. General interest	0.08 ~	91	(0.05*) 10: 2.02 ab 11: 2.05 a 12: 1.78 b	(0.26) female: 1.96 a male : 1.84 a	-
2. Role patterns	0.03*	91	(0.04*) 10: 2.12 ab 11: 2.27 a 12: 1.97 b	(0.05*) female: 2.15 a male: 1.96 b	-
3. Technology in curricula	0.02*	91	(0.09?) 10: 2.07 a 11: 2.01 ab 12: 1.85 b	(0.02*) female: 2.03a male: 1.79b	-
4. Consequences of technology	0.10~	88	(0.05*) 10: 2.09 a 11: 1.90 ab 12: 1.87 b		(0.14) 10: 2.09 a 11: 1.90 a 12: 1.87 a
***Perception* of concept of technology**					
5. *Perception* of technology	0.03*	91	(0.04*) 10: 2.10 a 11: 1.96 ab 12: 1.84 b	(0.13) female: 2.00 a male: 1.86 a	-
Significance legend: ~ : 10% level of significance * : 5% level of significance	** : 1% level of significance (Statistical tables *** : 0.1% level of significance Hogg & Graig 1970)				
Bonferroni Multiple Comparisons of Means Tests: means in the same cell suffixed with different small letters indicate that means differ statistically significantly.					

Table 4: Pearson's product moment correlations (and associated significance) between perception of technology scores and technology attitude dimension scores (5)

	Dimensions of attitude towards technology				
	General interest	**Role patterns**	**Technology in curriculum**	**Consequences of technology**	**Career in technology**
Concept of technology	0.8256 (<0.0001***)	0.6490 (<0.0001***)	0.8149 (<0.0001***)	0.7486 (<0.0001***)	0.6545 (<0.0001***)

Results of Table 3 indicate that:

- *Gender* and *grade* had a statistically significant effect on *attitudes* of the *role pattern* and *technology in the curriculum* dimensions. For both dimensions the *attitudes* of Grade 12 learners were statistically significantly more positive than Grade 11 (role patterns) or Grade 10 learners' (technology in the curriculum) attitudes, and, for both dimensions boys' *attitudes* were significantly more positive than that of girls.
- The effect of *grade* was statistically significant on the *attitude* dimensions of *interest in technology* and *consequences of technology*. The attitudes of Grade 12 learners were statistically significantly more positive than that of Grade 11 learners on the *interest* dimension, and that of Grade 10 learners on the *consequences of technology* dimension.
- The effect of *grade* on learners' *perception* of the *concept of technology* was statistically significant. Grade 12 learners' *perception* was statistically significantly more positive than that of Grade 10 learners.

Conclusions

Generally positive perceptions of technology and attitudes towards the dimensions of interest in technology; consequence of technology; technology in the curriculum; and role patterns in technology were reported. Findings furthermore indicated that the older learners (Grade 12) exhibited the most positive attitudes and that boys were more positive than girls towards the attitude dimensions of role pattern and technology in the curriculum. The positive relationship between grade level and positive technology attitudes and perception can be ascribed to the fact that Grade 12 learners were more familiar with technology since technology education had been a compulsory part of their curriculum for a longer period than the other grade levels. According to De Klerk Wolters (1989) being familiar with an attitude object results in a more positive attitude towards the object. Technology awareness levels of Grade 12 learners might also be elevated due to the fact that school leavers begin to consider career options. Although results of independent studies, as mentioned, pertain to younger learners, the findings of this research are generally in agreement with local and international studies (Ankiewicz and Van Rensburg, 2001; Khunyakari et al., 2009; Sjoberg and Schreiner, 2005:16).

Noteworthy is the fact that although positive, the *perception* of technology and *attitudes* towards dimensions of technology were not exceptionally high. Mean *attitude* and *perception* scores varied between 1.78 and 2.27. Score-means in the region of one would indicate enthusiasm. Khunyakari et al. (2009) reported the same tendency. This somewhat guarded general *attitude* towards technology when evaluated against Fishbein and Ajzens' (1975) finding that *attitude* towards technology determines future behaviour and choices, suggests that although learners are aware of technology (their *perception* of the *concept of technology),* their level of enthusiasm does not match the enthusiasm level which would motivate aspirant students and job seekers to follow a technology career path. Thus not the desired *perception* and *attitude* status that would promote technology career entry.

This deduction is strengthened by the fact that statistically significant correlations were indicated between learners' *perception* of *the concept of technology* and their *attitudes* towards the dimensions of *interest in technology* (r = 0.83), *technology in the curriculum* (r = 0.82), *gender roles in technology* (r = 0.65) and *consequences of technology* (r = 0.75) (Table 4 and 0.1% significance level). These dependencies suggest that learners – aware of technology – are interested in how technology affects and improves their lives, where it fits into the school curriculum and the idea of technology gender roles, but, not necessarily interested in technology as a career choice. Anova results could not identify biographical factors influencing the attitude dimension of *technology as a career*. This deduction of the study regarding the link between an agreeable technology perception and agreeable attitudes towards technology is validated by the findings of Knulst as cited in De Klerk Wolters (1989) stating that familiarity ('interest') with technology, or a positive concept of technology, leads to positive attitudes towards technology.

In summary the findings suggest technology awareness, but not to the level that motivate school leavers to pursue a career in technology.

The fact that the Northwest results generally agree with research findings from other studies, implies that the affective component of the PATT-USA questionnaire, as adapted for the cultural and societal environment of the Northwest Province, can be used to assess *attitudes* towards and *perceptions* of technology in the Northwest Province. South Africa is home to a heterogeneous population and findings from one region of South Africa – with attributes unique to that region – cannot be generalised as such to the entire country. This posed to be a limitation to the study. The researchers recommend *attitude* and *perception* status assessment nationally, and, on a regular basis to evaluate the impact of the introduced compulsory technology education on technology awareness of learners, implementing change – if necessary – based on up to date knowledge of the technology *perception* and *attitude* status of the South African learner.

The practical value of the study lies in the fact that concerned parties should note that even though positive attitudes towards technology have been reported, the type of attitudes assessed and the level of optimism attached to these attitudes (*agreement*) might signify that learner are interested in technology in as far as it affects and impacts their lives, but that the current status does not necessarily signify learners enthusiasm to pursue careers in technology. The results seem to suggest that a technology attitude scale (questionnaire) should distinguish between dimensions of attitude that measure awareness of the impact of technology on society and dimensions of attitudes that signify eagerness to engage in a technological career.

The question might well be asked whether current technology awareness initiatives promote general awareness of the impact of technology on society or technology awareness that stimulates interest in technology career choices.

References

Akpinar, E., Yildiz, E., Tatar, N., and Ergin, O. 2009. Students' attitudes towards science and technology: An investigation of gender, grade level, and academic achievement. *Procedia Social and Behavioral Sciences* 1: 2804–2808.

Ankiewicz, P., Van Rensburg, S., and Myburgh, C. 2001. Assessing the attitudinal technology profile of South African learners: A pilot study. *International Journal of Technology and Design Education* 11: 93–109.

Ankiewicz, P. 1995.The planning of technology education for South African schools. *International Journal of Technology and Design Education* 5: 245–254.

Bame, E., Dugger, W., De Vries, M., and McBee, J. 1993. Pupils' attitudes toward technology: PATT-USA. *Journal of Technology Studies* 19(1): 40–48.

Becker K.H., and Maunsaiyat, S. 2002. Thai students' attitudes and concepts of technology. *Journal of Technology Education* 13(2): 6-20. [Online] Available at: http://scholar.lib.vt.edu/ejournals/JTE/v13n2/pdf/becker.pdf (accessed on 22 October 2013).

Bennett, J., and Hogarth, S. 2009. Would you want to talk to a scientist at a party? High school students' attitudes to school science and to science. *International Journal of Science Education* 31(14): 1975–1998.

Boser, R.A., Palmer, J.D., and Daugherty, M.K. 1998. Students' attitudes towards technology in selected technology education programmes. *Journal of Technology Education* 10(1): 4-19. [Online] Available at: http//scolar.lib.vt.edu/ejournals/JTE/v10n1/boser.html (accessed on 15 May 2010).

Brake, M., and Bellamy, A. 2007. Choice of technology majors among high school students. *Advancing Woman in Research Journal* 23(1): 1–8.

Bremer, M. 2012. Critical skills shortages result in lost opportunities. *The skills Porta, American Public University Chartered Accountant Weekly.* [Online] Available at: http://www.skillsportal.co.za/page/features/1199140-Critical-skills-shortages-result-in-lost-opportunities (accessed on 2 October 2012).

Department of Education. 2009. *Southern and Eastern African Consortium for Monitoring Education Quality (SACMEC 3).* Pretoria: Government Printers.

De Klerk Wolters, F. 1989. A PATT study among 10 to 12 year old students in the Netherlands. *Journal of Technology Education* 1(1). http://scholar.lib.vt.edu/ejournals/JTE/v1n1/falco.pdf (accessed on 22 October 2013).

European Commission. 2004. *Europe needs more scientists: Increasing human resources for science and technology in Europe.* Luxembourg: Office for Official Publications of the European Communities.

Fishbein, M., and Ajzen, I. 1975. *Belief, attitude, intention and behaviour: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Gibbons, M. 2006. On the rise. *Prism, American Society of Engineering Educators* 15(9): 32–36.

Gupta, U.G., and Houtz, L.E. 2000. High school students' perceptions of information technology skills and careers. *Journal of Industrial Technology* 16(4): 2–8.

Hair, J.F., Anderson, R.E., Tatham, R.L., and Black, W.C. 1998. *Multivariate data analysis*. Upper Saddle River, NJ: Prentice Hall.

Hogg, R.V., and Graig, T.C. 1970. *Introduction to mathematical statistics* (3rd ed.). Toronto: Collier-MacMillan.

Khunyakari, R., Mehrotra, S., Chunawala, S., and Natarajan, C. 2009. Studying Indian middle school students' attitudes towards technology. In *Proceedings epiSTEME-3: An International Conference to Review Research in Science, Technology and Mathematics Education*, eds. K. Subramaniam and A. Mazumdar (pp. 81–87). Delhi: Macmillan.

Kuenzi, J.J. 2008. Science, Technology, Engineering, and Mathematics (STEM) Education: Background, federal policy, and legislative action. (CRS Report for Congress) Congressional Research Service. [Online] Available at: www.fas.org/sgp/crs/misc/RL33434.pdf (accessed on 17 November 2010).

Lyons, T. 2006. Different countries, same science classes: Students' experiences of school science in their own words. *International Journal of Science Education* 28(6): 591–613.

MacGregor, C. 2010, August 26. South Africa: Jobless amid skills shortage. *University World News.* [Online] Available at: http://www.universityworldnews.com (accessed on 17 November 2010).

Naido, B. 2007. Below par mathematics and science performance placing economic strain on SA. *Engineering News.* 17 November 2007. [Online] Available at: www.engineeringnews.co.za (accessed on 17 November 2010).

Osborn, J. 2003. Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education* 25(9): 1049–1079.

Raat, J.H., and De Vries, M. 1985. *What do 13-year olds think of technology? The conception of and attitude towards technology of 13-year old boys and girls*. Dissertation. Eindhoven University of Technology. The Netherlands (ERIC Document Reproduction Service No. ED 262-998).

Simkins, C., Rule, S., and Bernstein, A. 2006. *Doubling for growth – addressing the maths and science challenge in South Africa's schools* (Centre for Development and Enterprise Research Report no 15). [Online] Available at: http://www.cde.org.za/article.php?a_id=264 (accessed on 20 January 2010).

Sjoberg, S., and Schreiner, C. 2005. How do learners in different cultures relate to science and technology? *Asia-Pacific Forum on Science Learning and Teaching* 6(2): 4–19.

Sjoberg, S., and Schreiner, C. 2008. *Young people, science and technology, attitudes, values, interests and possible recruitment. Selected Results from Recent Research*. [Online] Available at: http://folk.uio.no/sveinsj/Sjoberg-ERT-background-Brussels2Oct08.pdf (accessed on 22 October 2013).

SA Agency for Science and Technology Advancement (SAASTA). (n.d.). [Online] Available at: http://www.saasta.ac.za/scienceawareness/index.shtml (accessed on 13 September 2010).

SouthAfrica.info. 2012. Newsletter of BrandSouthAfrica. [Online] Available at: http://www.southafrica.info/about/education/matric-050112.htm (accessed on 9 October 2012).

STEM Careers: STEMCareer.com. (n.d.). [Online] Available at: www.stemcareer.com (accessed on 21 August 2010).

The STEME Coalition. (n.d.). [Online] Available at: www.stemedcalition.org/

(accessed on 4 September 2010).

Tomas, S., and O'Grady J. 2009. Right for me? A study of factors that shape the attitudes of young women towards Mathematics and Science and towards careers in Engineering and Technology. *Engineering and Labour Market Study.* Toronto: Engineers Canada.

Van Rensburg, S., Ankiewicz, P., and Myburgh, C. 1999. Assessing South African learners' attitudes towards Technology using the PATT (Pupils' Attitude Towards Technology) questionnaire. *International Journal of Technology and Design Education* 9: 137–151.

Volk, K., Yip, W.M., and Lo, K.T. 2003. Hong Kong pupils' attitudes towards Technology: The impact of design and Technology programs. *Journal of Technology Education* 15(1): 48–63.

Weinburgh, M. 1995. Gender differences in student attitudes towards science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching* 32(4): 387–398.

White, R.T. 1988. *Learning science.* New York: Basil Blackwell.

Yurdugul, H., and Askar, P. 2008. An investigation of the factorial structure of Pupils' Attitude towards Technology (PATT): A Turkish sample. *Elementary Education Online* 7(2): 288–309.

Appendix

QUESTIONNAIRE: LEARNERS' CONCEPTS AND ATTITUDES TOWARDS TECHNOLOGY

This survey is designed to discover what learners think about technology. All you have to do is read the statement and then circle the number, which best describes how you feel. There is no right or wrong answer; it is just how you feel. Your first reaction is probably the best one, so don't think about the statement too much. Please answer all questions.

SECTION A

You don't have to put your name on the survey, just your age, school, location, region, grade gender and Technology Education differentiation level.

Your age (in years):
Location of school: Urban Rural
School number: Urban Rural
Region no:
Grade: 10 11 12
Gender: Boy Girl

Technology Education differentiation level: Mechanical Civil Electrical

SECTION B

Please read each statement and circle the number which indicates how you feel about the statement. Circle only one number in each statement.

Key
1 = Strongly agree 2 = Agree 3 = Disagree 4 = Strongly disagree

	1	2	3	4
6. Technology is very important in life.				
7. Technology makes everything go better than before				
8. Technology is only concerned with computers.				
9. When something new is discovered, I want to know more about it immediately				
10. Working in technology is very creative				
11. Girls can do technology				
12. I positively want to have a job in technology				
13. Developed countries can do much for developing countries using technology				
14. Technology is good for the economy				
15. All jobs have something to do with technology				
16. In everyday life you have much to do with technology				
17. In technology you have many opportunities to use your imagination				
18. Technology is too difficult for me				
19. A girl can have a technological profession just as well as a boy				
20. All jobs have something to do with technology				
21. In technology you have to design things by yourself				

22. For learners of my age technology is interesting				
23. I know pretty well how an electric kettle works				
24. In the newspapers you often read about technology				
25. Without technology there would be more problems in the world				
26. Boys are able to repair things better than girls				
27. You have to be creative in technology				
28. To understand something of technology you have to take a difficult training course				
29. A hundred years ago there was no technology				
30. I would like to learn more about technology at school				
31. Developing countries should develop their own technology				
32. It is a good thing when girls learn to put a plug on a cord				
33. Technology gives people more leisure				
34. It is difficult for me to say now whether I want to choose a technological profession or not				
35. There should be more TV programmes about technology				
36. To know how a bike is constructed you have to study technology				
37. Thoughts of technology are often in my mind				
38. Technology has brought more good than bad things				
39. If you know nothing about technology you are behind the times				
40. Girls prefer to go to a technical school				
41. At school I hear enough about technology to be able to make a choice about going or not going to a technical school				
42. In technology there are many inventions that are really new				
43. If there was a hobby club about technology at school, I would certainly join it				
44. Technology is good for developing countries				
45. I know what the word technology means				

46. Humans can do without technology				
47. Technology is always bad for the environment				
48. Boys know more about technology than girls				
49. I would like to have a career in technology later on				
50. Designing an appliance is part of technology				
51. I am interested in technology				
52. At school I hear much of technology				
53. With technology you learn to assemble appliances				
54. I think technology is a bit scary				
55. I know how most appliances are constructed				
56. More girls should go to a technical school				
57. Technology makes people ask for more and more comfort				
58. When I choose a profession I consider whether it is technological or not				
59. I like to read technological magazines				
60. Making a dress is a sort of technology				
61. Technology is the learning area of the future				
62. Technology is as difficult for girls as it is for boys				
63. I enjoy repairing things at home myself				
64. In technology you work with your hands				
65. You must be very clever to be able to study technology				
66. A girl can become a car mechanic				
67. Technology always has to do with electricity				
68. Modern technology should be adapted before being applied in developing countries				
69. At school you should learn more about repairing things around the home				
70. You can learn a lot of technology by yourself				
71. Mothers should be able to repair domestic appliances themselves				
72. At school I hear something about technological jobs				
73. In technology there is much opportunity to invent things by yourself				

74. It would have been better if no technological inventions had ever been made				
75. I know what most appliances are for				
76. Girls should repair their own bicycle tyres				
77. Technology makes people more creative				
78. I can list many technical jobs				
79. Technology is only for bright people				
80. Technology mostly is dangerous				
81. Sometimes I have taken things apart to see how they work				
82. Technology is nothing but applied science				
83. These sort of questions about technology are difficult for me				
6. Technology is very important in life.				
7. Technology makes everything go better than before				
8. Technology is only concerned with computers.				
9. When something new is discovered, I want to know more about it immediately				
10. Working in technology is very creative				
11. Girls can do technology				
12. I positively want to have a job in technology				
13. Developed countries can do much for developing countries using technology				
14. Technology is good for the economy				
15. All jobs have something to do with technology				
16. In everyday life you have much to do with technology				

Thank you for your cooperation