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Assessment of secondary school students' awareness, knowledge and attitudes to environmental pollution issues in the mining regions of South Africa: implications for instruction and learning

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In this paper, we compared the levels of awareness, knowledge and attitudes (AKA) about environmental pollution of secondary school students from two South African provinces. The purpose was to determine the levels of AKA between students living under different environmental conditions. These two groups were students from a coal-mining province (Mpumalanga) and those from a non-coal-mining province (Gauteng). Participants were 753 purposively selected students from Grades 8 to 12 from the two the provinces thus: 423 from Mpumalanga province and 330 from Gauteng province. Their ages ranged from 13 to 23 years ($M = 16.1$; SD = 1.75). They responded to a 36-item awareness, knowledge and attitude questionnaire ($r = 0.77$) on issues relating to environmental pollution. Data were analysed through computing descriptive statistics followed by unpaired t-tests. Statistically significant differences were established between students from the two provinces with regards to all the environmental variables tested, where students from Mpumalanga province had higher mean scores than their counterparts from Gauteng. Students from both provinces identified newspapers as the most important source of information on environmental pollution.

Keywords: environmental attitudes; environmental awareness; environmental pollution; environmental knowledge; sources of environmental information

Introduction

Over the past few decades, environmental pollution has become a serious issue in South Africa as in many parts of the world, owing to increased industrialisation (Matooane et al. 2004). The concern is about the damage pollution can cause if it is left unchecked. It is clear that human actions and behaviour are largely responsible for this problem (Onur, Sahin, and Tekkaya 2012). For instance, it is averred that whenever we use fossil fuels (coal, gas and oil); we automatically contribute to the greenhouse effect (Shepardson et al. 2011). Also, acid water from mines when not monitored and dealt with, may seep into river systems and waterways causing untold harm to humans and to aquatic and land animals (DeNicola and Stapleton 2002). In fact, it is argued that significant changes in climate may be expected due to the increase in the atmospheric concentration of greenhouse gases such as carbon dioxide (Houghton et al. 1996). Africa is reportedly one of the continents that is

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most vulnerable to climate change that negatively affect humans and the general ecosystem (Ogbuigwe 2009).

At the global level, various forms of environmental pollution are identified in the literature. However, the major concern is air pollution, followed by water pollution (Gambhir et al. 2012). It is estimated that more than two million premature deaths each year can be attributed to the effects of urban outdoor and indoor air pollution (WHO 2005). Research studies have indicated that exposure to air pollution may be associated with increased incidence of respiratory diseases, cardiovascular diseases and mortality (Brunekreef and Holgate 2002; Stieb, Judek, and Burnett 2002). Regarding water pollution, industrial activities such as mining are reported to be largely responsible (Amezaga et al. 2011). In South Africa, high rates of urbanisation and industrialisation are reported to have aggravated the threat to wetland resources (Coetzee 1995). The adverse effects of water pollution may be seen from the World Health Organization (WHO) (1997) report, which estimates that approximately one billion people drink unsafe water, from which about 10 million children die each year.

In many nations of the world, coal remains the main source of energy. While coal is a source of energy, it is also one of the largest sources of pollution to the environment (World Coal Institute 2009). The effects of this pollution result from the different stages of coal processing, such as coal mining, transportation and combustion for electricity generation. In essence, the exploitation of coal results in pollution that affects the air, water and soil (Kearting 2001). In South Africa, electricity generation releases 170 million tons of carbon dioxide annually, about 0.7 million tons of nitrogen oxides and about 1.5 million tons of sulphur oxides into the environment (Lloyd 2002). These emissions are responsible for high levels of atmospheric pollution, which of course further results in global warming and climate change (South Africa Department of Environmental Affairs and Tourism 2005). These global warming and climate change issues have made it necessary for leaders of major nations to take action to address them. Globally, the United Nations Framework Convention on Climate Change (UNFCCC) has hosted a number of conferences aimed at addressing these issues. For instance, in December 2011, the United Nations Climate Change Conference was held in Durban, South Africa. This high-profile conference on pollution and other environmental matters was the main motivation for this study. With world leaders and interested parties having visited South Africa, we felt it was opportune to establish South African students' level of awareness, attitudes and knowledge about environmental pollution.

This study falls within the tradition of studies that have investigated issues relating to environmental education in South Africa. For instance, similar studies have looked at concept formulation for environmental literacy (Loubser, Swanepoel, and Chacko 2001) and the environmental literacy of teachers (Swanepoel, Loubser, and Chacko 2002). In addition, Adams (2003) examined the effect of environmental education programmes on students' attitude towards the environment. Rosenberg (2009) has developed a teacher workbook for environmental education. However, to the best of our knowledge, no studies have compared students' awareness, knowledge and attitudes to environmental pollution from a South African perspective. Therefore, this study should add to the body of knowledge on environmental education.

This study is based on the objectives of Environmental Education from the UNESCO–UNEP Tbilisi intergovernmental conference (UNESCO 1978). Here, five

primary categories of environmental education objectives were recommended: (a) awareness, (b) knowledge, (c) attitude, (d) skills and (e) participation. A combination of these, according to Hungerford and Volk (1990) has been said to promote responsible citizenship behaviour. Several studies have investigated only one of these objectives or variables at a time (Alli, Ganapathy, and Muthumanickam 2011; Ekpoh and Ekpoh 2011; Kang and Chawla 2011), while some have considered a combination of only two (Abd El-Salam, El-Naggar, and Hussein 2009; Alp et al. 2006; Aminrad et al. 2010) or three variables at a time (Hausbeck, Milbrath, and Enright 1992; Lasso de la Vega 2006; Olufemi 2012). For the purposes of this study, the first three of the five components were considered, while the others may be considered in future studies. The three were: awareness, knowledge and attitude (AKA).

The definitions of AKA in this study are in accordance with those in the Tbilisi Declaration, which are as follows: a*wareness* is to help social groups and individuals acquire an awareness of and sensitivity to the total environment and its allied problems. *Knowledge* is to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems. *Attitude* is to help social groups and individuals acquire a set of values and feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection (UNESCO-UNEP 1978).

Various research studies have reported a lack, or low level, of awareness and knowledge and a negative attitude regarding environmental issues among students, teachers and other groups of society (Hausbeck, Milbrath, and Enright 1992; Loubser, Swanepoel, and Chacko 2001; Mansaray, Ajiboye, and Audu 1998; Toili 2007). For instance, a study conducted among school children in Kenya reported that 'students rarely ventured into the community surrounding the school to assist in protecting and improving the quality of the environment' (Toili 2007, 64). On the other hand, a low level of environmental knowledge among Nigerian teachers was reported, which affected their attitude towards the environment (Mansaray, Ajiboye, and Audu 1998). The contention is that for people to display positive attitudes towards the environment, it is necessary for them to be aware of and be knowledgeable about their environment. When people have positive attitudes towards or concern for the quality of the biophysical environment, they are able to participate in solving environmental problems (Disinger 1983).

Literature that has addressed variables such as *awareness*s, *knowledge* and *attitude* has also explored these from the demographic perspective of students (Harun, Hock, and Othman 2011; Lasso de la Vega 2006; Makki, Abd-El-Khalick, and Boujaoude 2003; Tuncer et al. 2005). For instance, a study was conducted in Southwest Florida on awareness, knowledge, and attitude about environmental education. The respondents in this study were secondary school students, environmental specialists, school instructors and parents. This study differed from ours, in that it was looking at four different groups of people, while our study focused only on students. Moreover, the Florida study was not a comparative study, while ours was a comparative study, looking at students from two provinces living under two different ecological locations. The findings in the Florida study regarding the students reported that there were statistically significant differences among these three variables: AKA. The researcher reported that of these three variables, students' mean scores were lower in the *knowledge* category than *awareness* and *attitude*. Lasso de la Vega (2006) further investigated some factors, such as gender and socio-economic status, which could affect students' environmental AKA. However, with respect to

gender, no statistically significant differences between male and female students were reported.

Comparative studies of students (using different environmental variables such as awareness, attitude, knowledge and behaviour, depending on the researchers' choices) have been conducted in different countries and have reported different results. Most of the studies in the literature have compared students in two countries; to the best of our knowledge, we have not seen any studies that were conducted specifically comparing respondents in two provinces. The only exception which was similar to ours was a comparative study conducted in China between two regions in China (Tiefenbacher et al. 2011). Globally, far more single studies than comparative studies have been conducted (e.g. Lasso de la Vega 2006). Some of these comparative studies were looking at elementary students, some at secondary school students and others at university students. In view of the scope of our study, we had intended to limit our references to comparative studies on secondary schools students. Nonetheless, these were so scarce in the literature that we decided to refer to studies other than those conducted among secondary school students.

Huang and Yore (2003) examined Canadian and Taiwanese Grade-5 students' environmental knowledge, attitude, behaviour, concern and emotional disposition. The authors considered these five environmental variables with respect to some biographical variables such as gender and experience of nature. They wanted to determine the effect of such biographical variables on the five environmental variables, using a series of *t*-tests to find whether significant differences existed within and between the two groups of students. Their findings indicated that with respect to gender there were significant differences among both Canadian and Taiwanese children in all the environmental variables investigated except for environmental knowledge. Female students' scores were significantly higher than for male students in both countries. For example, female students acted more responsibly and displayed more positive attitudes than males. These researchers looked at five different environmental variables, only two of which (*knowledge* and *attitude*) were investigated in our study, in addition to awareness. Moreover, this study focused on elementary students, while ours focused on secondary school students.

A comparative study on environmental awareness involving Iranian and Indian secondary school students was also conducted by Shobeiri, Omidvar, and Prahallada (2007). In this study, the authors focused only on the variable *awareness* (this was actually the only comparative study we found that examined secondary school students, but it compared two different countries and not provinces). The authors also determined the effects of students' biographical variables, such as gender and school type, on the variable *awareness*, employing the two-way ANOVA (analysis variance). The Iranian students demonstrated a much higher level of awareness (85.10%) than the Indian students (56.00%). Significant differences with respect to school type were also established; hence, the authors concluded that the type of school has an influence on students' environmental awareness. However, no significant differences between the two groups of students were established as regards gender and awareness (Shobeiri, Omidvar, and Prahallada 2007).

Benton and Funkhouser (1994) investigated environmental attitude and knowledge of university business students from Loyola University Chicago, United States (US) and the National University of Singapore. These authors hypothesised in their study that the American students would outscore Singaporean students with respect to knowledge and awareness about environmental issues. This hypothesis was based

on the fact that the US had a history of many years of industrialisation and was reported to be one of the world's leading polluting nations; moreover, the country was also known to be more environmentally aware due to several years of extensive environmental education compared with Singapore (Benton and Funkhouser 1994). However, their findings did not support the hypothesis, rather it revealed statistically significant differences between the scores of students with the Singaporean students being more environmentally knowledgeable and concerned (attitude) than the US students. Moreover, they examined the effect of gender on the environmental variables *knowledge* and *attitude* and found significant differences. Male American students displayed higher levels of environmental knowledge and attitude than females did, whereas in the case of the Singaporean students, female students outscored the male students.

Tiefenbacher et al. (2011) examined to what extent environmental differences might affect students' environmental AKA in the eastern/coastal and western/inland regions of China. This was a comparative study conducted with students living in two different regions. The findings indicated that students from both regions possessed rather low levels of environmental knowledge, but had positive environmental attitudes and were willing to commit to environment-friendly behaviours. The authors added that students in the two regions had significantly different levels of general environmental awareness in terms of their mean scores, despite their shared exposure to institutionalised environmental education. The authors argued that in view of the low mean scores of students in environmental knowledge, environmental education in the country should focus mainly on improving the students' knowledge, which might later form the basis for developing pro-environmental attitudes and behaviour in students. The authors concluded their study by suggesting that in order to enhance the quality of environmental education, schools should be responsible for making students aware of the need for and ways of protecting the environment.

Other than exploring students' levels of environmental AKA with respect to their demographic variables, researchers have also investigated the sources of their environmental information. The sources of information have varied from people to the media (in both print and electronic form) and from country to country. The most prevalent source of information among studies that have been conducted in various countries has generally been television. For instance, in Malaysia students indicated that television (84%) was their main source of information. This was followed by the internet (6%), newspapers (5%), radio (4%) and textbooks (1%) (Said, Yahaya, and Ahmadun 2007). In New York, students identified their sources as electronic media (television, radio, internet) (44%), print media (newspaper and magazines) (19%), school (12%) and friends and family (8%) (Hausbeck, Milbrath, and Enright 1992).

In Iran, the majority of students (43.6%) indicated that mass media, particularly radio and television were their main sources of environmental information. This was followed by newspapers and magazines (19.3%). To a lesser extent, teachers/school (16.4%); friends (9.8%); and other sources (10.9%) were also identified as sources of information (Shobeiri and Prahallada 2007). In the UK, students indicated that their major source of information was television and other electronic sources like the internet, followed by their school and friends (Boyes and Stanisstreet 2001). In Greece too, television was the source of choice for information about environmental matters (Liarakou, Athanasiadis, and Gavrilakis 2011). In Australia, as in other countries, students described television and the internet as the most significant

sources in teaching them about environmental matters (Nagel 2004). Comparative studies have also investigated students' sources of environmental information. For example, in a comparative study of Canadian and Taiwanese children, '[T]elevision was the most popular source of environmental information for both groups of children' (Huang and Yore 2003, 419).

Research purpose

The purpose of this study therefore was threefold. Firstly, we compared the levels of AKA about environmental pollution of students living in different environmental conditions. Secondly, we compared student levels of AKA with reference to demographic variables, including gender, age, school grade level and school type. Thirdly, we determined the most important sources of environmental information for the students. We felt that investigating these issues was significant. This is because understanding what students know or do not know about environmental pollution issues may provide some insights into and guidance for instructional planning and classroom teaching centred on those concepts. Importantly, our view was that if proper awareness, knowledge and positive attitudes regarding environmental pollution are acquired early in life by students, then these will be carried over to adulthood and be passed on to future generations. Specifically, the questions this comparative study answered were:

(1) Are there statistically significant differences in the levels of AKA about environmental pollution:
   (a) between Mpumalanga and Gauteng students?
   (b) between Mpumalanga and Gauteng students with respect to gender, age, grade level and school type?
(2) What are the most important sources of environmental information for students in both Mpumalanga and Gauteng provinces?

Methodology

Research design

This is essentially a survey research and it employed the descriptive survey research design of the ex-post facto type. The study, being a comparative study, was conducted in two locations. The first was Emalahleni, a town in the province of Mpumalanga in the coal belt of South Africa. This town is dotted with coal mines and this product is generally hauled by trucks to harbours at the coast for export internationally. Also found in this town are coal-fired electricity-generating power stations and foundries that burn coal for energy. This is because South Africa largely depends on coal to generate its electricity. The second town in the study was Soshanguve, which is located in the province of Gauteng. A distinguishing feature between the two sites is that the latter is in a non-coal-mining area. The fact that one group of students was from Gauteng does not mean there is no pollution in their environment. What this study focused on was pollution from a mining environment perspective as compared with one where mining was not prevalent.

Participants

Participants from the coal-mining environment numbered 423, while those from the non-coal-mining environment totalled 330. The participants were from five schools in each area. From the mining area, five schools were purposively selected because they were in the vicinity of the mines and foundries. On the other hand, the five schools from the non-coal mining environment were purposively selected because they were near the authors' university in Gauteng. Before the questionnaires were administered, students were assured that they could desist from participation at any time without sanction. Also, we impressed on them the fact that their identities and those of their schools' would not be divulged under any circumstances whatsoever.

The intention was to administer 20 questionnaires to 20 students in each grade level, but unfortunately in some of the grades not all the 20 students were available to participate. Therefore, some of the questionnaires were carried over to the other grades. In each school, students in each grade were randomly selected. At each grade level, students were allocated numbers from a table of random numbers.

Instrument and procedure

Data were collected by means of a three-part 36-item questionnaire tagged awareness, knowledge and attitude questionnaire (AKAQ). The first part requested participants to provide demographic data such as gender, age and grade level. The second part was an *awareness, knowledge and attitude* scale that included 36 items on environmental pollution issues. These were measured using a 5-point Likert-type scale. The questionnaire used in this second part was adapted from three other questionnaires (Bas, Teksoz, and Ertepinar 2011; Lasso de la Vega 2006; Yilmaz, Boone, and Andersen 2004).

The first questionnaire which was adapted was a 51-item Likert-type scale which had been used to measure views of Turkish students towards environmental issues (Yilmaz, Boone, and Andersen 2004). The full version of this instrument was requested from the author. The instrument received from the author was originally in Turkish and it was kindly translated for the purposes of this study by the Turkish Embassy in Pretoria. A total of 13 items were adapted from this particular instrument, of which 10 items were modified and 4 were not. For instance, one of the original items read: *In order to protect natural resources, electric power should be used instead of fossil fuel such as wood and coal* (Yilmaz, Boone, and Andersen 2004). For the purpose of this study, the authors modified the item to read: '*To protect our environment, renewable resources should be used to generate electricity instead of fossil fuels*'. These authors reported the item reliability to be 0.99, while the alpha reliability was found to be 0.80 (Yilmaz, Boone, and Anderson 2004).

The second questionnaire was developed by Lasso de la Vega (2006) to evaluate AKA on environmental issues. The author indicated that he had adapted the instrument from others (e.g. Bogan and Kromrey 1996). For the purpose of this study, only three items were adapted from this instrument, of which only two were modified. For example, one of the adapted items read: *There is a lot I, as an individual, can do to protect the environment in my community.* This particular item was modified to read: *I am prepared to participate in the prevention of environmental pollution in my community.*

The third questionnaire used in this study was a 45-item Likert-type scale that measured environmental attitudes of elementary school students (Bas, Teksoz, and Ertepinar 2011). The reported internal consistency alpha of the scale scores was 0.87 (Bas, Teksoz, and Ertepinar 2011). In this study, a total of 15 items were adapted from their instrument, of which 10 items were modified and 5 were not. For instance, the item: *There are many plants and animal species in our country that are at the edge of extinction* was modified to read: *Many plant and animal species in our country are facing extinction as result of environmental degradation.* The remaining five items were developed by the authors.

The third part of the questionnaire was an open-ended question comprising 10 items requesting the students to indicate their sources of information with regard to environmental pollution. In this part, students were asked to write down and rate, in terms of importance to them, the sources from which they had gathered information about environmental pollution, the highest being 1 and lowest 10.

A decision was made to accept a 36-item questionnaire named AKAQ, with 12 items for each of the three components. Participants were requested to register their views on a 5-point scale anchored by 1 = Strongly Disagree and 5 = Strongly Agree. The items were selected from the three questionnaires described above. Of the 36 items in the questionnaire, 8 had negative statements. In the data file, the ratings in respect of the negative items were reversed. For example, the ratings for the item: *Industrialisation does not lead to global warming* was reversed.

Initially, face validity of the questions comprising the AKA was ascertained. As the items of the AKA were adapted from other questionnaires, it was important that the resulting questions should elicit what was desired for the study. It should be pointed out that some of the questions' content and structure was modified for ease of understanding by the targeted study sample. For instance, one initial statement was: *The climate of Turkey gradually gets warmer every passing year.* This statement was reformulated to read: *The climate of South Africa gradually gets warmer every passing year.* Following the changes, the reconstituted questionnaire was given to two experts in the faculty for face validity.

Content validity of learners' scores from the AKA variables was ascertained by performing a principal components analysis. It was argued that if principal components analysis could produce a meaningful three-factor solution that was consistent with the three AKA variables, then content validity would be acceptable. Principal components analysis produced a three-factor solution with 12 items associated with each factor; which was consistent with the number of items in each AKA variable. Furthermore, closer inspection of the items indicated that nine items associated with attitude loaded on factor 1 and nine items associated with knowledge on factor 2, while six items associated with awareness loaded on factor 3.

Administration of instrument

The questionnaires were administered to students with the help of some educators in various schools. The students in both provinces received the same questionnaires with the same items. The completed questionnaires were collected a week later. All analyses in this study were computed using IBM's SPSS © version 19.

Results

Rate of return

In the coal-mining area, 500 questionnaires were distributed to participants in three public schools and two private schools. Of the 500 questionnaires, 423 (85%) copies were completed and returned. Similarly, in the non-coal-mining area, 500 questionnaires were distributed to participants in four public schools and one private school. In this instance, 330 (66%) completed questionnaires were received. All the returned questionnaires were properly completed and therefore included in all analyses.

Biographical data

From the two study sites, there were 753 students, who were from Grades 8–12. Their ages ranged from 13 to 23 years ($M = 16.1$ years; SD = 1.75). More detailed biographical data of the respondents is outlined in Table 1.

Validity and reliability of scale scores

As we had taken the questionnaire from studies conducted and reported elsewhere, we accepted its face and content validity a priori. Further, we estimated its internal consistency by computing Cronbach's (1951) coefficient alpha. The computed alpha value was 0.77 [95% CI: $\alpha = 0.73$–0.81] (Barchard 2007; Feldt 1965).

Comparison of students' AKA scores

Here a number of *t*-tests were conducted to compare the same data-sets. In order to eliminate a greater chance of detecting what appears to be a significant finding in

Table 1. Biographical data of students from Mpumalanga ($N = 423$) and Gauteng ($N = 330$).

	Province			
	Mpumalanga		Gauteng	
Variable	*n*	%	*n*	%
Gender				
Male	189	44.7	150	45.5
Female	234	55.3	180	54.5
Age in years				
13–15	160	37.8	115	34.9
16–17	184	43.5	156	47.3
18+	79	18.7	59	17.9
Grade				
8	127	30.0	69	20.9
9	95	22.5	72	21.9
10	94	22.2	71	21.5
11	89	21.0	105	31.8
12	18	4.3	13	3.9
School type				
Public	250	59.1	243	73.6
Private	173	40.9	87	26.4

error, a Bonferroni adjustment was applied. This means that the original p value of 0.05 was not considered to be statistically significant, but an adjusted value of 0.0019 was (0.05/26 = 0.0019).

In comparing mean scores of students from the two provinces, the unpaired t-test was performed to evaluate differences in the levels of AKA for the two groups. The result showed statistically significant differences in the two provinces with respect to *knowledge* and *attitude*. For *awareness*, [$t_{\text{Awareness}}$ (751) = 3.035, $p = 0.0025$]; *knowledge* [$t_{\text{Knowledge}}$ (751) = 39.855, $p = 0.0001$]; and *attitude* [t_{Attitude} (751) = 6.2913, $p = 0.0001$]. Here, students from Mpumalanga had higher levels of *knowledge* and *attitude* than their counterparts in Gauteng (see Table 2).

Demographic variables against AKA variables

Descriptive statistics and unpaired t-tests were analysed to determine the effect of students' demographic variables on the AKA variables in the two provinces.

Effect of gender

In terms of *awareness*, there were statistically significant differences between males in the two provinces, t (337) = 4.077, $p = 0.0001$. Here, male students from Mpumalanga had significantly higher mean scores than their counterparts in Gauteng. However, no statistically significant differences were computed for females. For *knowledge*, statistically significant gender differences were computed: (males) t (337) = 17.928, $p = 0.0001$; (females) t (412) = 16.412, $p = 0.0001$. Here, students from Mpumalanga had significantly higher mean scores than those from Gauteng. With respect to *attitude,* no statistically significant differences were established for both males and females in both provinces (see Table 3).

Effect of age

With regard to *awareness*, no statistically significant differences were established for all the age groups. In terms of *knowledge*, statistically significant differences were established for all the three age groups. The differences were t (273) = 13.714, $p = 0.0001$ (13–15 years); t (338) = 16.912, $p = 0.0001$ (16–17 years); t (136) = 9.581, $p = 0.0001$

Table 2. Measures of central tendency, including the 25th and 75th percentiles and t-tests in respect of the AKA variables for students in the two provinces.

						Percentiles	
Province	Variable	*M*	*SD*	Median	Mode	25	75
Mpumalanga	Awareness	47.99	5.94	49	49	45	52
	Knowledge	41.81‡	5.83	42	43	38	46
	Attitude	47.68†	7.19	48	50	42	53
Gauteng	Awareness	46.44	8.07	48	48	43	52
	Knowledge	31.42	6.08	31	30	27	35
	Attitude	44.15	8.18	46	46	40	50

Knowledge‡ ($p < .0019$); Attitude† ($p < .0019$).

Table 3. Frequency distribution, means, standard deviation and *t*-tests of the *awareness, knowledge and attitude* by *Gender* in both provinces.

		Province					
		Mpumalanga		Gauteng			
Variable	Gender	*M*	SD	*M*	SD	*t*	df
Awareness	Male	49.12	4.9	46.29	7.8	4.077*	337
	Female	47.07	6.5	46.57	8.3	0.440	412
Knowledge	Male	43.33	5.4	31.93	6.3	17.928*	337
	Female	40.59	5.9	30.99	5.9	16.412*	412
Attitude	Male	49.21	6.8	43.43	8.0	7.187	337
	Female	46.44	7.3	44.74	8.3	2.212	412

*$p < 0.0019$.

(18 years and more). In all the groups, students from Mpumalanga had significantly higher mean scores. In the case of *attitude*, statistically significant differences were established for 16–17-year-olds, t (338) = 3.823, $p = 0.0002$. Here, students from Mpumalanga had significantly higher mean scores (see Table 4).

Effect of grade level

In terms of *Awareness*, no statistically significant differences were established between students in all the grade levels. It can be observed from Table 5 that the Mpumalanga means were higher, although not statistically significantly different. For *knowledge*, statistically significant differences were computed for all the grade levels except for Grade 11. The differences were t (194) = 9.402, $p = 0.0001$ (Grade 8); t (165) = 10.673, $p = 0.0001$ (Grade 9); t (163) = 11.306, $p = 0.0001$ (Grade 10); t (29) = 8.756, $p = 0.0001$ (Grade 12). In all these instances, Mpumalanga students had higher mean scores. In the case of *attitude*, statistically significant differences were established for Grade 8 and Grade 11. Here, the differences were t (194) = 3.180, $p = 0.0017$ (Grade 8); t (192) = 3.404, $p = 0.0008$ (Grade 11). Again, in all these instances, Mpumalanga students had higher mean scores (see Table 5).

Table 4. Frequency distribution, means, standard deviation and *t*-tests of the *awareness, knowledge and attitude* by *age* in both provinces.

		Province					
		Mpumalanga		Gauteng			
Variable	Age in years	*M*	SD	*M*	SD	*t*	df
Awareness	13–15	48.06	5.8	48.03	5.8	0.042	273
	16–17	47.77	6.1	45.60	9.2	2.597	338
	18 and more	48.34	5.9	45.41	8.3	2.424	136
Knowledge	13–15	41.45	5.7	32.10	5.4	13.714*	273
	16–17	41.81	6.0	30.51	6.3	16.912*	338
	18 and more	42.56	5.8	32.49	6.5	9.581*	136
Attitude	13–15	47.68	7.4	45.81	5.9	2.245	273
	16–17	47.28	7.1	43.94	9.0	3.823*	338
	18 and more	48.62	7.0	49.04	8.9	0.621	136

*$p < 0.0019$.

Table 5. Frequency distribution, means, standard deviation and *t*-tests of the *awareness, knowledge and attitude* by *grade level* in both provinces.

		Province					
		Mpumalanga		Gauteng			
Variable	Grade	*M*	SD	*M*	SD	*t*	df
Awareness	8	48.27	5.7	46.97	5.0	1.591	194
	9	48.09	6.2	47.58	6.6	0.512	165
	10	47.84	6.0	47.56	5.8	0.301	163
	11	47.25	6.4	44.44	11.3	2.080**	192
	12	49.83	3.2	47.38	4.1	1.870	29
Knowledge	8	41.55	6.0	33.49	5.2	9.402*	194
	9	41.67	5.4	31.99	6.3	10.673*	165
	10	41.97	6.4	31.18	5.6	11.306*	163
	11	41.45	5.4	30.00	6.4	13.3280	192
	12	45.39	4.2	30.00	5.6	8.756*	29
Attitude	8	47.73	7. 1	44.64	5.2	3.180*	194
	9	48.03	7.4	45.42	6.2	2.418	165
	10	47.57	7.6	45.54	6.9	1.767	163
	11	46.75	6.7	42.23	10.9	3.404*	192
	12	50.56	6.7	42.46	8.9	2.895	29

*$p < 0.0019$.

Effect of school type

In terms of *awareness*, statistically significant differences, t (258) = 4.009, $p = 0.0001$, were only established between students from the private schools. With respect to *knowledge*, statistically significant differences were computed for both school types. The differences were t (491) = 17.833, $p = 0.0001$ (public schools); (258) = 18.139, $p = 0.0001$ (private schools). Similarly, statistically significant differences were established for *attitude*. Here, the differences were t (491) = 4.793, $p = 0.0001$ (public schools) and t (258) = 4.519, $p = 0.0001$ (private schools). It can be observed from the Table 6 that students from Mpumalanga had significantly higher mean scores in all the AKA variables.

Sources of environmental information

Students were asked to rank 10 different sources of environmental information in the order of importance to them, the highest being 1 and the lowest 10. It is observable from Table 7 that the rankings were virtually the same for six sources. Newspapers were reported to be the highest source of information for about a quarter of the students (Mpumalanga 24.40%; Gauteng 28.76%). This was followed by school lessons, at 19.84 and 21.55%, respectively. Differences were reported only for four sources of information (in bold type in Table 7). These related, for example, to magazines and television. Sources such as parents and friends were the lowest ranked sources by students from both provinces.

Discussion and conclusion

This comparative study assessed the levels of AKA about environmental pollution of secondary school students in two provinces of South Africa. Effects of students'

Table 6. Frequency distribution, means, standard deviation and *t*-tests of the *awareness, knowledge and attitude* by *school type* in both provinces.

		Province					
		Mpumalanga		Gauteng			
Variable	School type	*M*	SD	*M*	SD	*t*	df
Awareness	Public	48.16	6.3	47.48	6.1	1.217	491
	Private	47.74	5.4	43.54	11.5	4.009*	258
Knowledge	Public	42.11	5.9	32.31	6.3	17.833*	491
	Private	41.39	5.6	28.92	4.4	18.139*	258
Attitude	Public	47.82	7.4	44.79	6.6	4.793*	491
	Private	47.48	6.9	42.36	11.3	4.519*	258

*$p < 0.0019$.

Table 7. Students' percentages and rankings of their sources of environmental information.

	Province			
	Mpumalanga		Gauteng	
Sources	%	Ranking	%	Ranking
Newspapers	24.40	1	28.76	1
Magazines	**7.70**	**4**	**7.58**	**3**
Television	**7.61**	**5**	**6.33**	**6**
Radio	**7.03**	**6**	**6.55**	**5**
Internet	**7.88**	**3**	**7.21**	**4**
Books	6.28	10	5.09	10
Parents	6.45	7	5.73	7
Friends	6.32	9	5.55	9
Extra-curricular activities	6.39	8	5.67	8
School lessons	19.87	2	21.55	2

demographic variables on the three AKA variables were examined, as well as students' most important sources of environmental information. Regarding comparison of students' AKA scores between the two provinces, the result revealed statistically significant differences with respect to their mean scores for only knowledge and attitude. Here, students from Mpumalanga had higher levels of knowledge and attitude than their counterparts in Gauteng. These findings are consistent with those reported in other comparative studies such as that between Canadian and Taiwanese students (Huang and Yore 2003); the US and Singapore (Benton and Funkhouser 1994) and Eastern/Coastal and Western/Inland regions of China (Tiefenbacher et al. 2011).

Regarding the effects of students' demographic variables on the AKA variables: for *awareness*, statistically significant gender differences between students in the two provinces were established only for males. For *knowledge*, statistically significant differences were computed for both males and females. In terms of *attitude*, no statistically significant differences between students in the two provinces were computed for either males or females. This suggests that in the two provinces, gender has an effect only on students' environmental awareness and knowledge. The effect of gender on the AKA variables resonates with findings reported by Huang and Yore (2003), who also reported significant differences with respect to gender. However,

the study of Shobeiri, Omidvar, and Prahallada (2007) reported no significant gender differences. With regard to age of student and environmental awareness, no statistically significant differences were established across the age groups. However, statistically significant difference was reported for *knowledge* for students in all the age groups and for *attitude* only for students in one group (16–17-year-olds). These results were also in agreement with studies conducted in other parts of the world, for example, O'Brien (2007) and Yiu (2004).

With respect to grade level, no statistically significant differences were established in terms of awareness for students in all the grade levels. However, as was the case for age, statistically significant differences were reported with respect to knowledge and attitude between students in some of the grade levels. Grade level has also been found to have an influence on students at different levels in other parts of the world (e.g. Aydin, Kaya, and Coşkun 2011; Harun, Hock, and Othman 2011). However, other studies have reported no significant differences with respect to grade level (e.g. Astalin 2011; Oguz, Çakci, and Kavas 2010). In respect of school type, statistically significant differences between students attending public schools and those at private schools were established. These findings were also consistent with other studies reporting this (e.g., Shobeiri, Omidvar, and Prahallada 2007; Tuncer et al. 2005). In a Nigerian study, however, no significant differences were reported (Akomolafe 2011).

This study could be considered significant because it was conducted from the perspective of students' schooling and living in two different ecological conditions. The differences reported here might be (from Mpumalanga students' viewpoint), as a result of the undesirable experience of living and schooling in a polluted environment. For example, in a conversation with one school principal in EMalahleni Mpumulanga, she intimated '… children and almost everybody inhale air and drink water that is contaminated … many as a result of constant health problems are being hospitalized from time to time apparently without realising that their health issues may be linked to the pollution in this area' (Personal communication, 15 September 2010). It could be that experiencing these environmental problems made them more environmentally conscious than their counterparts. Conversely, the possibility is that in Gauteng, there is nothing similar to drive students' environmental consciousness. This assumption is in agreement with a study conducted in South Africa, where it was reported that those most directly affected by pollution were also most likely to see it as a problem than those who were not affected (Anderson et al. 2007).

Concerning the sources of environmental information, a number of researchers from different countries have reported television as students' most important source (Chapman and Sharma 2001; Huang and Yore 2003; Liarakou, Athanasiadis, and Gavrilakis 2011; Said, Yahaya, and Ahmadun 2007). This was, however, not the case in this study. Here, students from both provinces rated newspapers as the most important source of information. This finding is comparable to that reported in Singapore, where media (newspapers, magazines, radio and television) accounted for 53.7% of the information, while school education accounted for 30.7% (Ivy et al. 1998). Also, in this study, the students rated their parents and friends among the least common sources of information. This finding is similar to that reported among Indian and Filipino students (Chapman and Sharma 2001). What is significant here is that people in the immediate circle of the students, such as parents and friends, were not perceived as useful sources of information. This is significant because it shows that there is a gap there and potential for assisting students to adopt

proper awareness, knowledge and positive attitudes so that they will pass these to their families and friends.

The fact that students rated newspapers as the most important source of environmental information over and above school lessons should be a cause for concern to the education community. In the South African context, this may be due to the fact that these environmental concepts are scattered within different courses and not presented as a separate subject. On the part of teachers, it may be that they concentrate only on the concepts they are familiar and comfortable with, and avoid or give less attention to those they do not know. What this study reveals, however, is the importance of media such as newspapers from the students' viewpoint in informing them about environmental matters. Although media could be a source of information on environmental issues for students, the information may be brief, ambiguous and inadequate. This is because it is reported that the mass media focus narrowly on specific environmental issues (Huang and Yore 2003). These authors believe that ideally it is the school that should be the primary source of environmental information to students, while other sources could be secondary. In effect, such secondary sources will enhance what students have gleaned from schooling.

While we are not suggesting making environmental education a separate subject in the school curriculum, clearly this study suggests that there may be need for more environmental concepts to be reflected and well integrated into the various school subjects. These concepts should be made more visible in the various environmental education career subjects in school curriculum. Furthermore, it is recommended that there should be proper training of teachers handling these environmental concepts so that they will be able to teach them to their students effectively. In fact, it is reported that teachers' understanding and proper knowledge about environmental concepts goes a long way in affecting and influencing their students' knowledge about the concepts. (Loubser et al. 2001). Therefore, if these teachers are not environmentally literate, it will be impossible for them to produce environmentally literate students. It is also suggested that government should try and make policies which ensure that schools are not located close to mines and industries. Existing schools if possible may be relocated far away from vicinity of mines and other polluting industries.

The authors accept responsibility for all the claims in this paper; however, the study could be extended further in the future looking into other provinces, towns and different polluting industries.

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