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A Proposal to Integrate the Management of Electronic Waste into the Curriculum of Primary Schools

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Today's children are growing up in an environmentally damaged and technology orientated world. The advent and advances of technology, has resulted in the production of millions of electronic devices, which eventually become waste when they reach their end-of-life. These devices contain toxic components that are not only polluting the environment but can be dangerous to human health. A way forward will be to transfer the global problem of e-waste to educated individuals. The task is to equip young learners with the values, attitudes, knowledge and skills needed on how to manage e-waste and secure a healthy and a sustainable future for all. The qualitative study proposed curricula for a subject on environmentally sustainability (Grades four to seven).

Keywords: Education, environment, recycling, sustainability, technology.

INTRODUCTION

In the 21st century, countries are challenged by obstinate environmental issues such as pollution and the management of wastes that will affect the lives of young children now and in the future (Olowu, 2012). More than thirty years ago Mabbutt (1984) warns that the earth is not able to assimilate all wastes and this will contribute to the depletion of the ozone layer, global warming and climate change.

Electronic waste (e-waste) has been identified as the fastest growing waste tributary in the world and contributes 2-5% of municipal waste (Advanced Tropical Environment [AET], 2012, p. 92). E-waste is an informal word used to describe electronic products that are not in use due to the development of new technology. A widely accepted international definition of e-waste is "anything that runs on electricity and has become outdated" (Williams, Kahhat, Allenby, Xu & Junbeum, 2008). This includes computers, entertainment electronics, mobile phones, household appliances and less obvious items such as spent fluorescent tubes and batteries that have been discarded by their original users (Finlay & Lietchi, 2008).

The amount of e-waste generated by electronic devices such as discarded computers, copiers, fax machines, electric lamps, cell phones, batteries, televisions, stereos and others, is increasing annually (Williams et al., 2008). Olowu (2012) predicts that e-waste production will triple in developing and industrialised countries in a few years' time. This increase of e-waste can be connected to the population's demand for greater functionality and competition between producers of electronic devices which continually increases the rate at which these devices become out dated (Electronics TakeBack Coalition, 2009).

It is projected that 50 million metric tonnes of e-waste are generated every year in the world (Olowu, 2012). In 2005 the weight of electronic appliances in the European Union (EU), accumulated to 9.3 million tons (UNEP, 2007). In the United States of America (USA), 139 million portable communication devices, such as cell phones, pagers or smart phones were manufactured in 2006 and approximately 152 million communication

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State of the literature

- Electronic waste has a worst effect on the environment when compared to other types of waste.
- Many developing countries have to endure the negative consequences of becoming dumping sites of toxic e-wastes.
- The dangerous impact of e-waste on human lives, necessitates that all students should be educated from a young age to address this problem. Comprehensive education is needed where children at an early age develop problem solving, critical and creative thinking skills to make critical decisions on environmental issues that can be harmful for themselves and the environment.

Contribution of this paper to the literature

- Prescribed primary school curricula and practice are far removed from each other. A major revision of existing curricula is needed to help build a sustainable future.
- The author proposes the need of a compulsory subject that will educate children at a young age (primary school) on how to manage environmental issues (such as e-waste, waste, pollution, global warming, depletion of the ozone and others) to protect our natural environment and life on earth.
- Education of young children can lead to permanent behavioural change and the development of positive attitudes and values which they can use to influence negative behaviours of others

devices were expected to be sold in 2008 (UNEP, 2011). In industrialising economies such as China, 14 million computers were installed and in India five million computers (UNEP, 2011). An estimated 896 million mobile phones had been sold in a developing country, South Africa in 2006 and in 2008 more than 14 million computer equipment was purchased (Finlay & Lietchi, 2008). Approximately two million tonnes of e-waste quantities are produced in South Africa annually with no specific legislation for e-waste management (Webster, Holland, Curry, & Chang, 2005).

Jones (2010) maintains that electronic waste has a worst effect on the environment when compared to other types of waste. Research of Owusu (2010) finds that poorer developing countries have to endure the negative consequences of becoming dumping sites of toxic e-wastes. According to Zhao, Wang, Dong, Rao and Luo (2008) and Zheng, Wu, Li, Qi, Han and Zhang (2008) limited policies, legislation and educational safeguards on the safe disposal of imported e-waste have led to serious environmental and human problems in countries such as Nigeria, Cambodia, China, Indonesia, Thailand and Pakistan. Apart from large volumes of e-waste that is exported to developing countries the concern is the hazardous compounds (mercury, lead, chromium, cadmium, barium and others) released from the e-waste which pose serious and harmful risks to human health and the environment (Osibanjo & Nnorom, 2007). Thus, pragmatic methods of managing e-waste need to be found, which if not handled effectively could become a potential hazard.

Although the production and trans-boundary movement of harmful e-waste have attracted attention of governments, scholars, activists and other institutions, the management of e-waste has received insignificant scholarly attention thus far (Olowu, 2012). According to McKeown (2002) education can be considered as the key instrument to attain environmental sustainability. Challenges facing the continent need the involvement of young educated citizens who are adequately prepared for the future they will inherit. The education they acquire should enable students to form the complex conceptual relations between, benefits to society, economic prosperity, environmental health and their own well being (Boarini, Johansson & d'Ercole, 2006).

Studies of Bryant and Hungerford (1977) and Asunta (2003) emphasise that young children's attitudes towards the environment start developing at an early stage and once formed do not change easily. Piaget (1983, p. 52) elaborates that young students at the age of nine years are influential, able to understand mental activities, reason and think logically.Therefore it is important to educate students from an early age (nine years) on how to live "green" to save our natural resources and manage e-waste. Apart from the school curriculum, Duvall and Zint (2007) point out that parents' educational role cannot be ignored as they teach their children attitudes, beliefs and values which influence their children's view on how to sustain the environment. Thus some parents may have well-established environmentally harmful attitudes and behaviours that should be 'unlearned' to limit negative influences on their children. In contradiction Damerell, Howe and Milner-Gulland (2013) and Knafo and Galansky (2008) show that educated children can influence their parent's environmental knowledge and improve their attitudes on sustaining the environment.

Slade (2006) postulates that (even in countries where the management of waste including e waste is intensely educated at an early age) comprehensive education is needed which not only includes the mastery of different subject matters, but also the development of problem solving skills and critical and creative thinking. Environmental challenges pose excellent opportunities for developing and exercising many of these skills in formal education. In addition, countries are encouraged

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by various scholars to execute a major revision of: existing science and technology curricula, the development of objectives, content themes, teaching and learning methods, the assessment processes, ethical motivation and the ability to work with others to help build a sustainable future (UNESCO, 2005).

Based on the need of a literate society, a 'new generation' that is able to sustain and manage the environment, this paper highlights the need for compulsory subjects for all Grades four to seven students, which will enable them to develop skills, knowledge and positive attitudes that can contribute to environmental sustainability.

LITERATURE REVIEW

In developing countries, informal recycling is common practice where e-waste products are reused and repaired to produce a 'second life' (Ongondo, Williams & Cherrett, 2011). E-waste products are stockpiled, repaired, reused, disposed with municipal waste or crudely recycled (Osibanjo & Nnorom, 2007). The biggest danger of crude recycling is the lack of infrastructure, where the methods deployed result in unmanaged air, and underground water and landfill pollution (Ongondo et al., 2011). This initiative unfortunately allows developing countries to become e-waste dumping grounds for developed countries.

Markets emerged in developing countries from this dumping to extract usable components such as gold and copper and precious metals from the unusable devices obtained from developed countries. This recovering of usable components and metals contributes to trans-boundary trade in e-waste (Sinha-Khetriwal, Kraeuchi & Schwaninger, 2005).

To manage e-waste globally, a platform, the European Recycling Platform (ERP) was formed, that assists manufacturing companies to comply with the Waste Electrical and Electronic Equipment (WEEE) directive. The European (EU) directive on WEEE aims to shift the responsibility of recycling and management of e-waste not only to the individual as consumer but also to producers, this action is referred to as Extended Producer Responsibility (ERP) (Gottberg, Morris, Pollard, Mark-Herbert & Cook, 2006). The two main objectives of ERP are to improve product designs that can easily be dismantled in an environmentally friendly manner when they reach their end of life (Van Rossem, Tojo & Lindhqvist, 2006).

Various initiatives and legislation are implemented to address the e-waste problem globally. United Nations (UN) initiatives, like Global Compact, StEP (Solving the e-waste Problem) Millenium goals (Van der Graaf, de Koning, Ravazzini & Miska, 2005) and the e-Waste Association of South Africa [eWASA], are dedicated projects to help countries solve and manage e-waste in order to create a sustainable environment. The Basel Convention aims to control and reduce trans-boundary movements of hazardous e-waste and the active promotion of the transfer and use of technologies (Ramachandra & Saira 2004).

Other initiatives are the ecoATM (Daniel, 2012) that offers money for e-waste and the Electronics TakeBack Coalition (2009) that takes back old electronic devices and recycles them. The Eurogroup Consulting developed a 'green' (sustainable) information technology framework in 2010, that outlines organisational responsibilities and issues towards the environment and can be used to make critical business decisions (Van der Graaf et al., 2005).

Of the European countries, Switzerland is the first country that implemented an e-waste recycling system (Sinha-Khetriwal et al., 2005). Currently Switzerland is using two producer responsibility organisations (PROs) to focus on e-waste, namely, Communication and Organisation Technology (SWICO) that focuses on office and ICT waste and the SWISS Foundation for Waste management (SENS) that focuses on household appliance waste (Johnson, 2006). Since 2003 the WEEE directive has enforced legislation for all EU countries to ensure that their manufactured products can be disposed of or recycled in an environmentally friendly manner (European Directive of the European Parliament and Council, 2003). The main objective is to preserve, protect and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally. The WEEE directive states that all electronic equipment sold (in Europe) after 1 July, 2006 must be toxin free, especially of: lead, cadmium and mercury (Mears, 2006).

Agenda 21 is also an attempt to impose a global centrally planned quasi-government administered by the United Nations. All central government and local authority signatories should conform strictly to a common prescribed standard on how to manage e-waste (Department Environmental Affairs Act. [DEAT], 2009).

The biggest factor that has a major impact on e-waste management is the recycling and disposure cost. Many electronic components cannot be disposed of with other solid wastes and need specialised processes and well trained people to facilitate these processes (Finlay & Liechti, 2008). In contradiction to European countries, developing countries are not financially able to supply advanced equipment and processes to recyclers functioning in these countries. For example, Rectile South Africa is a recycling company that imports technology from other countries to aid in the recycling and disposing processes of fluorescent discharge of bulbs (Finlay & Liechti, 2008). Light-emitting diode (LED) bulbs are currently replacing the old bulbs as they last 25 times longer, use 80% less power and

contain less mercury resulting in a decrease of e-waste (Philips, 2011).

Finlay and Liechti (2008) claim that although the recycling rates in some of the developing countries are improving it is not at an international standard yet due to poor education and the high cost of e-waste recycling.

Hazardous Effects of e-Waste on Human Health

Electronic waste stored in landfills produces contaminated leachates which pollute the underground water. An example is Hong Kong, which is experiencing water shortages due to the illegal disposal of e-waste such as, the melting of computer chips, if disposed on the ground causes acidification of soil that contaminates the city's water resources (Widmer et al., 2005).

Research in various developing countries points out some environmentally problematic practices by the e-waste recyclers which include: premises that are not properly contained to prevent run-off of contaminated water, land-filling with potentially harmful plastics for which no market can be found, e-waste exposed to rain, many recyclers do not treat effluents/leaching or water, or test land filled fraction for toxicity, the mechanical shredding of monitors and white goods such as fridges, the stockpiling of hazardous fraction, passing hazardous fraction on to other recyclers (Finlay & Lietchi, 2008).These practices pose hazardous effects on the environment and human health.

When certain electronic devices such as circuit breakers, condensers and cathode ray tubes are destroyed, dangerous ions will dissolve and leach into the soil and groundwater. Open-air burning of e-waste plastics to recover copper and other metals can be considered the most dangerous form of burning e-waste (Widmer et al., 2005). Highly toxic deposits caused by the open-air burning of these by-products, pollute the air and environment globally (Ramachandra & Saira, 2004).

In view of the hazardous effects of e-waste on human health and the environment there is an urgent need for global education of all human beings to address the challenges posed by e-waste. A well-educated population in the recycling and disposal of e-waste, in developing and developed countries, is essential for the conservation of the earth.

Motivation to Propose a Subject on Environmentally Sustainability for Grades Four to Seven Students

Owusu (2010) emphasises that all children need to be educated on how to use technology effectively, consider the health of others and how to maintain the environment, as many rural areas of countries become dumping sites for hazardous e-waste material. Young children as future leaders, need to be equipped and prepared with values, knowledge and skills that will enable them to make critical decisions for the challenging future they will inherit (Du Preez & Roux, 2010; Chen, Bi, Zhao, Chen, & Tan, 2009). They should learn how their decisions and actions can make a difference to the sustainment of the earth. According to Duvall and Zint (2007) positive attitudes, values and beliefs of teachers should set the foundation for students' lifelong learning on how to live in a sustainable world during their early years. Leeming, Porter, Dwyer, Cobern, and Olivier (1997) elaborate stating that the advantages of educating young children are that they are less likely to have environmentally established behaviours that need to be 'unlearned', will live a longer period to maintain the environment, are able to promote environmental responsible behaviours and change negative behaviours in others. This is in accordance with Damerell et.al. (2013) pointing out that educated students can on the other hand influence their parents' attitudes in a positive manner and improve their environmental knowledge.

Although topics, to mention a few, such as: maintaining a healthy environment and personal health, pollution (air, water and land) including illegal dumping sites, recycling of waste materials, strategies to keep environments healthy, conservation of environment, are prescribed in primary school curricula (Life Skills, Natural Sciences and Technology, Social Studies, Economics and Management and others) the management of e-waste is not sufficiently addressed (South Africa Basic Education 2011). Furthermore, Jacobs (2011) points out that prescribed curricula and practice are far removed from each other and teachers are not always able to teach all the prescribed themes in curricula. This contributed to the notion of the proposal of a compulsory subject that will focus only on environmentally sustainability.

Environmentally sustainability can be described as the maintenance of the factors and practices that contribute to the quality of environment on a long-term basis (Widmer et al., 2005). Morelli (2011) defines *environmentally sustainability* as the state in which the needs of all people are placed on the environment, to allow all people to live well, now and in the future. This process where renewable resources are harvested, pollution created, and non-renewable resources depleted should be continued indefinitely, without reducing the environment's capacity.

The UN pointed out that as developed countries get more and more educated and their incomes increase, more and more strain is placed on their natural resources (The Basel Convention, 2011). Therefore, the purpose of a subject on environmentally sustainability is

to teach all Grades four to seven students the basic skills, knowledge and values they need to manage e-waste. The reason for using this age group is because students are in the most influential age bracket where changes in perspectives and values regarding the management of e-waste can be made (Department of Environment and Heritage, 2005; Kohlberg, 1973; Piaget, 1983, p. 52). They should be able to use their acquired knowledge and skills to effectively apply waste management measures. According to Du Preez and Roux (2010) and findings of studies presented at the World Summit on Sustainable Development 9 (2002) students should: understand and value the interdependence of social, cultural, economic and ecological dimensions at local, national and global levels, reflect critically upon how this interdependence affects communities; families and workplaces; reason on values in different contexts to express their moral life in different ways, use basic universal values as a point of reference to make decisions, develop attitudes and skills which are conducive to the achievement of a sustainable future; protect the health and well-being of people and be knowledgeable about how to manage, reuse, repurpose and recycle e-waste.

Thus the world's future relies on well-educated citizens that are able to make difficult conceptual connections between economic growth, advantages to society, environmental sustainment and their own well being.

Theoretical Foundation

Tuncay, Yılmaz-Tüzün and Teksoz (2012) report that students' decisions on solutions to problems related to environmentally sustainability problems, are not only influenced by using knowledge to reason and think about rules for ethical conduct but are also influenced by affective forms such as empathy and moral values. Thus, in the context of e-waste management, the way in which students interpret the cognitive and affective domains is closely related to their moral development. According to Kohlberg (1973), moral development involves moral reasoning and occurs in stages, based on different ages. In developing moral reasoning, different cognitive and affective skills are used by students during those stages to decide what is right or wrong. Thus, a person's morality may change throughout life, according to their moral developmental levels. Kohlberg (1973) categorises moral reasoning in pre-conventional (lowest level of moral development where values are controlled by punish and rewards) –conventional (intermediate level of internalisation of moral values occur under the control of parents and the laws of society), and post-conventional (highest level, and moral decisions are made based on students' awareness of alternative moral values based on different moral, legal, social, and political process, and make their own decisions, which are best for them).

Research findings of various scholars presented at the World Summit on Sustainable Development no 9 (2002) highlighted the importance of the education of students for environmentally sustainability with an emphasis on transformational change in values and behaviour from the individual to a global scale. Education on how to manage e-waste can influence students' values and behaviour positively, to alter the way they interact with other people and how they perceive their environment. It is therefore important to educate students from a young age on how to sustain their environment, as this can lead to a permanent behavioural change.

Therefore, the study proposes that when students reach the age of nine (the conventional level of internalisation of moral values), they should be educated on how to manage e-waste. To ensure the successful education of students on e-waste management teachers should be sufficiently trained on how to manage e-waste. Botha and Reddy (2011) point out that experienced mentors at schools can assist with the practical training of teachers.

The limitation of the study is that the author is not able to determine whether the outcome of the programme will have a negative or positive impact on students when implemented and if students' will develop positive attitudes towards the maintaining of the environment.

RESEARCH METHODOLOGY

The qualitative research approach was followed to investigate participants' perspectives, perceptions and experiences on the implementation of curricula of a compulsory subject on environmentally sustainability for students of Grades four to seven.

Education specialists (n= 18), Grades four to seven teachers (n=20) of five primary schools of the Gauteng Province in South Africa (developing country), curriculum specialists (n=8) and technology specialists (n=6) of various institutions in South Africa were randomly selected to participate in the research study. These participants were identified as role players in the successful implementation of a proposed subject on environmentally sustainability in primary schools.

Data Collection Methods

Data was collected by means of a literature study and structured interviews. A literature study was used to draft curricula of a compulsory subject on environmentally sustainability for students of Grades four to seven. Before the interviews commenced the proposed curricula themes were sent to all participants

for intensive review. During the interviews all were requested to answer two structured questions to establish their different views on the curricula and the age bracket. The views of all participants were:

- Grouped together representing the most frequent comments; or
- Quoted to exemplify comments.

The diverse views were used to review curricula themes and to finalise the proposed curricula that will then be introduced to all stake holders for implementation. Considering that very little research on this topic had been done in South Africa, the study was to a great extent of an exploratory nature.

Curricula themes for Grades four to seven

Themes of the curricula were compiled from:

- International environmental sustainment programmes implemented successfully in primary schools such as: The GreenWay Model (2012), Bollard's (2008) Growing up Greener, United States Environmental Protection Agency (2007); and
- Research findings, perspectives, recommendations of Daniel (2012), Electronics TakeBack Coalition (2009), Environmental Affairs (2010), Ercan and Bilen (2014), Finlay and Liechti (2008), Jones (2010), Mears (2006), Nnoroma and Osibanjo (2008), Ramachandra and Saira (2004), Sinha-Khetriwal et al. (2005), The Basel Convention (2011) and Widmer et al. (2005). The above studies were used as they were mostly in coherence with one another in indicating what every citizen should know in order to manage e-waste effectively.

The most frequent findings of both, successfully implemented programmes in primary schools and research findings were used to compile themes for Grades four to seven and grouped according to each Grades' students' potential cognitive level. The proposed themes of all the curricula were sent to all participants for intensive review. Thus participants were invited not only to comment on the proposed subject but also to add or delete themes they felt were irrelevant or too difficult for students.

The following drafted themes for the curricula were presented to all participants during the interviews for comments.

A Proposed Curriculum for a Grade Four Subject on Environmentally Sustainability

Time allocation per week: one period (30-45 minutes)

Grade: four

The following topics will be included in the curriculum:

- *Handling of household waste*
- *Global warming*

Prevention

Identify hazardous factors that affect the environment.

The use of Green Information Technology (IT) principles to extend the life of

- *Information and Communication Technology (ICT) and thus reduce electronic waste:*

Buy certified energy sufficient IT products (known brands EnergyStar)

Turn off and unplug devices that are not being used

Use power mode functions (sleep, standby, hibernate)

Do not print unnecessary.

Use online service to save on paper and fuel

Re-purpose, reuse and recycle old IT equipment

Choose appropriate energy sufficient hardware, for example choosing a LCD/LED monitor instead of a cathode ray tubes (CRT) monitor.

A Proposed Curriculum for a Grade Five Subject on Environmentally Sustainability

Time allocation per week: one period (30-45 minutes)

Grade: five

The following topics will be included in the curriculum:

- *Handling of household waste*
- *E-waste composition and recycle potential*

Students should be able to identify and determine the composition of components in e-waste.

The consumption of e-waste and its recyclable potential is specific for each appliance. In order to handle this complexity, the parts/materials found in e-waste may be divided broadly into six categories as follows:

- *Iron and steel, used for casings and frames*
- *Non-ferrous metals, especially copper used in cables, and aluminium*
- *Glass used for screens, windows*
- *Plastic used as casing, in cables and for circuit boards*
- *Electronic components*
- *Other (Rubber, Wood, Ceramic etc.).*

A Proposed Curriculum for a Grade Six Subject on Environmentally Sustainability

Time allocation per week: one period (30-45 minutes)

Grade: six

The following topics will be included in the curriculum:

- *E-waste composition and recycle potential*

Students should be able to dismantle and segregate components in e-waste

- Dismantling

-Segregation of ferrous metal, non-ferrous metal and plastic

- *Determine the hazards of e-waste*

Identify the composition of e-waste

Identify possible hazardous contents of e-waste

A Proposed Curriculum for a Grade Seven Subject on Environmentally Sustainability

Time allocation per week: one period (30-45 minutes)

Grade: seven

The following topics will be included in the curriculum:

- *Recycle, reuse and recovery options*

The major approach to treat e-waste is to reduce the concentration of these hazardous chemicals and elements through recycling and recovery. In the process of recycling or recovery, certain e-waste parts act as secondary raw material for recovery of valuable items. The recycle and recovery includes the following unit operations.

-Refurbishment and reuse

-Recycling/recovery of valuable materials

-Treatment/disposal of dangerous materials and waste

- *Treatment & Disposal Options*

Landfilling

Incineration

The emphasis of the above curricula is on the practical handling of waste products. Only a few themes are addressed in each grade to ensure that students develop practical skills and knowledge on how to manage e-waste. The challenging levels of skill development increase as students progress in Grades.

Interviews

In this study two structured questions were used to investigate participants' perceptions of proposed environmentally sustainable curricula for Grades four to seven. The questions were based on the following assumptions:

- Interviews with teachers, education, curricula and technology specialists allow all participants to express their alternative view points on the curricula for Grades four to seven.
- Analysis and discussion of these alternative perspectives can contribute to reviewing and reforming curricula of a compulsory subject on environmentally sustainability for students of Grades four to seven.

FINDINGS AND DISCUSSION: RESPONSES TO THE STRUCTURED QUESTIONS

From the findings five themes emerged from question one and four themes from question two. Themes are discussed below and exemplified by means of verbatim presented quotations.

Question 1

"Review the proposed curricula of Grades four to seven students. What is your opinion on the themes and the implementation of the proposed curricula?"

The Need for e-Waste Management Curricula

All respondents indicated that there is an urgent need for global education to combat the challenges posed by e-waste. Of the respondents stated the need as follows:

> "The implementation of a subject focusing on the practical handling of e-waste should not be debated. Our future is dependent on how we educate our citizens on maintaining our natural resources."
>
> "A well-educated population in the recycling and disposal of e-waste, is essential for the conservation of the earth."

The need of e-waste education is in accordance with studies conducted in South Africa of Finlay and Lietchi (2008) who point out the environmental hazardous practices of e-waste recyclers that affect the maintaining of natural resources. These practices include: contaminated water, e-waste exposed to rain, using harmful plastics for land-filling and do not test the toxicity in these landfills, untreated effluents/leach or water, mechanical shredding of monitors and the passing of hazardous fraction to other recyclers (Widmer et al., 2005). As these practices pose hazardous effects on the environment and human health education is needed to protect, preserve, and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally.

The Curricula

Some of the respondents felt that some of the terminology of the proposed curricula might be too difficult for primary school students to understand. While, others suggested that household waste management should be included in all curricula and additional curricula compiled for Grades eight and nine students.

Of the participants also assumed that although topics such as: a healthy environment, personal health, pollution (air, water and land) including illegal dumping

sites, strategies to keep environments healthy, conservation of environment, economic and environmental factors influencing the environment, attitudes and values and others are included in various curricula of the primary school, the practical management and handling of e-waste is not sufficiently addressed. One of them stated this clearly:

> "A compulsory subject is needed as the development of practical skills on how to handle e-waste is not sufficiently addressed in the sub-divisions of current curricula".

This statement is in agreement with Jacobs' (2011) argument that prescribed curricula and practice are far removed from each other. There is a need to execute a major revision of existing curricula to help build a sustainable future.

The Role of Teachers as Implementers

Most of the participants, especially the teachers indicated that they are not always able to teach all themes of the curricula effectively, due to the time constraint and insufficient training and knowledge on certain environmental themes (e.g. e-waste management). It was also pointed out that the successful education of students on e-waste management requires well-trained teachers on how to manage e-waste. One respondent remarked:

> "Teachers will have to be sufficiently trained on how to teach students the skills they need to manage e-waste, for example to dismantle computer components."

Research of Finlay and Lietchi (2008) prove that the dismantling and recycling of e-waste are specialised processes and need well trained people to facilitate these processes and to educate others. On the other hand the two main objectives of eWASA, are to improve product designs that can easily be dismantled in an environmentally friendly manner when they reach their end of life, making it easier for teachers to educate students (Van Rossem, Tojo & Lindhqvist 2006). Furthermore, Botha and Reddy (2011) suggest that experienced mentors at schools can assist with the practical training of teachers as a possible solution to insufficient trained teachers.

Attitudes of Teachers

Most of the participants felt that education on how to manage e-waste can influence students' values and behaviour positively, to alter the way they interact with other people and how they perceive their environment. A respondent was quoted below:

> "The attitudes of teachers will be central in the implementation of a subject to sustain the environment."

This is in line with Duvall and Zint's (2007) view that teachers' beliefs, attitudes and values influence students' views on how to sustain the environment. Damerell et al. (2013) elaborate by stating that educated students can on the other hand influence their parents' attitudes in a positive manner and improve their environmental knowledge. While, Du Preez and Roux (2010) show that the development of positive attitudes, values and skills are conducive to the achievement of a sustainable future; protect the health and well-being of people and manage, reuse, repurpose and recycle e-waste prudently and rationally. It is therefore important to educate students from a young age on how to sustain their environment, as this can lead to a permanent behavioural change.

Educating Students in Different Socio–Economic Contexts

Participants raised the concern that the human rights of communities in rural areas are not always considered when dumping waste and may remain isolated from the usage of electronic devices. The need of rural communities to manage e-waste will not be the same as for those living in urban areas. As one stated below:

> "Students' educational needs on how to manage e-waste will differ, as they grow up in various socio-economical contexts."

In many countries rural areas become dumping sites for toxic waste material, consigning a bigger responsibility on these areas to educate students effectively on how to manage e-waste (Owusu, 2010; Chen et al. 2009). Because of the marked differences in social and cultural practices in rural and urban areas, curricula should provide for the recognition of traditional rights of people to make their own decisions on how to educate and manage their environment. Citizens should be empowered with knowledge and skills on how to find solutions to their environmental issues. Thus, the demand for well-trained teachers and effective e-waste education will become a priority in rural areas.

Question 2

"How will the age bracket of students (Grades four to seven) affect the successful implementation of a compulsory subject on environmentally sustainability?"

To Develop Values That will Enable Them to Make Environmental Decisions.

Ninety-two percent indicated that students should be educated at a young age that will enable them to make decisions concerning the management of waste

products that are harmful for themselves and the environment. It was stated that students should be educated from as early as possible in their life to: develop the values they need to make decisions concerning their environment and be empowered to use their acquired knowledge and skills to effectively apply waste management measures. One of the participants emphasised the need of early education as follows:

> "In view of the hazardous effects of e-waste on human health and the environment, I feel strongly that students need to be educated positive values at an early age on how to maintain the environment as they need the earth to allow them to live well, now and in the future."

Widmer et al. (2005) agree that young children should be taught the basic skills, knowledge and values they need to manage e-waste and contribute to the quality of environment on a long-term basis. The UN points out that values and attitudes should form the foundation of sustainable development (The Basel Convention, 2011). Thus the need of young education cannot be ignored.

Students at This Age are Influential

Comments of the respondents were in agreement with Kohlberg (1973) and Piaget (1983), indicating that students at this age group are in the most influential age bracket where changes in their perspectives and values can be made.

A respondent stated:

> "Students at a young age can be influenced to change their attitudes and behaviours towards the environment"

Leeming et al. (1997) claim that the advantages of educating young children are: they are less likely to have environmentally established behaviours that need to be 'unlearned', able to promote environmental responsible behaviours and change negative behaviours in others and have a longer period of maintaining the environment.

The Development of Critical Thinking and Problem Solving Skills

Participants indicated the need of problem solving, critical and creative thinking skills. A concern was raised that not all young students are always able to think abstractly, develop problem solving and critical thinking skills to have an effect on the environment. Slade (2006) differs from this argument by emphasising the need of comprehensive education at an early age, which not only includes: the mastery of different subject matters, but also the development of students' critical thinking and problem solving skills that will enable them to make crucial environmental maintaining decisions and enable them to learn for life.

Terminology is Too Difficult

Eight percent of the participants pointed out that terminology used in the curricula of Grades four and five students may be too difficult for the proposed ages and that some of the suggested themes will not only be difficult for Grades four to seven but also for the teacher to teach.

Frequent comments from interviews indicated that: the development of practical skills on how to handle e-waste is not sufficiently addressed in students' current curricula, some of the proposed curricula themes are too difficult for primary school students to grasp, the importance of household waste management should be emphasised in all curricula, curricula should also be compiled for Grades eight and nine students, teachers will have to be sufficiently trained on how to manage e-waste, resources should be available to practice on, especially in rural areas that may be isolated from the usage of electronic devices, the recognition of traditional rights of people must go hand in hand with measures to enforce responsibility in resource use and teachers' attitudes will have to be considered.

RECOMMENDATIONS

A well educated population is necessary for the recycling and disposal of e-waste to conserve the earth and to prevent hazardous practices. Comprehensive education is needed where children at an early age develop problem solving, critical and creative thinking skills to make critical decisions on environmental issues that can be harmful for themselves and the environment. Education of young children can lead to permanent behavioural change and the development of positive attitudes and values which they can use to influence negative behaviours of others (such as negative attitudes of parents).

Prescribed primary school curricula and practice are far removed from each other. A major revision of existing curricula is needed to help build a sustainable future. A compulsory subject is proposed on environmentally sustainability for students of Grades four to seven.

Proposed themes indicated in curricula were compiled from previously successfully implemented programmes in international primary education and research findings of various studies.

The teacher as the main implementer of the proposed subject:

- Should be knowledgeable on how to teach students for example: the dismantling and recycling of e-waste. These are specialised processes and well-

trained teachers to facilitate and teach these processes are needed. If teachers are not sufficiently trained on how to execute the practical part of e-waste management experienced mentors can assist with the practical training of teachers.

- Should reflect positive attitudes, beliefs and values that can influence students' views on the sustainment of the environment.

The author proposes the need of a compulsory subject that will educate children at a young age (primary school) on how to manage environmental issues (such as e-waste, waste, pollution, global warming, depletion of the ozone and others) to protect our natural environment and life on earth.

CONCLUDING REMARKS

The economy of every country is dependent on its natural resources for economical growth. But, if the environment is not maintained the future survival of human beings will be in severe danger. In most countries worldwide, several e-waste projects have been initiated and legislation enforced to address the problem with e-waste, but still these drastic measures are not achieving the goal to sustain our environment.

Previous research findings and the global acknowledgment of countries on the dangerous impact of e-waste on human lives, necessitates that all students should be educated from a young age to address this problem. Educating Grade four (nine years old) students on how to handle e-waste could have a major impact on maintaining the environment as students at this age are: able to class logic findings, self-disciplined able to achieve goals and can work independently or in groups.

In this article previous research findings assisted the author in compiling the proposed curricula for a compulsory subject based on environmentally sustainability for Grades four to seven. These curricula should emphasise the development of students' practical skills that will enable them to handle e-waste. Interviews were conducted with various role players to investigate their opinions on the proposed curricula. To mention a few findings: the majority of them support the implementation of a compulsory subject on environment sustainability, some of the terminology in the curricula is too difficult for primary school students, many rural areas do not always use electronic devices and the attitude of teachers will play a major role in the successful implementation of these curricula.

As teachers will determine the successful education of students in the management of e-waste, additional research is important to examine their attitudes, and views in implementing such a subject.

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