An interactive computer program for South African urban primary school children to learn about traffic signs and rules

Aubrey Fransman[1]
Faculty of Education Sciences, Geography Education and Environmental Education, North-West University

Barry Richter
Faculty of Education Sciences, Geography Education and Environmental Education, North-West University

Schalk Raath
Faculty of Education Sciences, Geography Education and Environmental Education, North-West University

ABSTRACT

Road accidents significantly contribute to severe injury and death of young children. Knowledge of road safety signs and traffic rules are regarded as necessary basic knowledge to improve the safety of children in traffic situations. Resources available for the education and learning of road signs and road safety rules for learners are limited. This study assessed the effectiveness of an interactive computer program as a teaching tool to contribute to the improvement of the knowledge base of young children on road safety in South Africa. A quasi-experimental approach was employed to conduct this study. Primary school learners (n= 75) aged 11 - 12 years participated in the pilot study. Findings indicated that there was a meaningful change in the learner's knowledge of road signs and road safety rules after participation in the program.

Keywords: pedestrians, road safety rules, traffic signs, education and learning of road safety rules.

INTRODUCTION

A report by the World Health Organization (WHO, 2017) shows that more than 270 000 pedestrians annually lose their lives in road accidents. The report also indicates that Africa has the highest rate of deaths among pedestrians. According to Arrive Alive (2017), the figure in South Africa of pedestrians killed in road accidents is between 35-40% of all the deaths caused by road accidents. In 2003, 28.4% of injuries and deaths in SA were caused by traffic injuries and children and young adults below 20 years of age made up 17% of these numbers. The same study also mentioned that more than 4000 children and young adults younger than 20 died on South African roads during 2003. The report estimated that road fatalities among children in SA are double that of the average rate in the world. The National Injury Mortality Surveillance System (NIMSS) revealed that in 2001 children in South Africa amongst the ages 5 to 14 were the most vulnerable and motor vehicle collisions were responsible for the most significant cause for death (Matzopoulos, Du Toit, Dawad & Van As, 2008). Factors that lead to these fatalities include drunk pedestrians, recklessness, distractedness, such as cell phone usage while walking, pedestrians who fail to abide by traffic signals, those who are walking on the road and also those who are not visible to drivers (Arrive Alive, 2017).

Hammond, Cherrett, and Waterson (2014) noted that road safety depends on interventions working as part of a system to ensure that traffic injuries are minimised. They stated that in the context of global motorisation, walking and cycling may be neglected as there is often less political importance placed on walking and cycling issues

1 Please direct all correspondence to: Dr Aubrey Fransman, Faculty of Education Sciences, North-West University, Private Bag X1290, Potchefstroom, 2520, South Africa; Email: aubrey.fransman@nwu.ac.za

when compared to issues presented by motorisation. In high-income countries, like the United Kingdom, elderly people are more at risk, while in low and middle-income countries like South Africa, children and young adults are more affected (WHO, 2017). In the United Kingdom, a pilot project named *Kerbcraft* (Hammond et al., 2014) aimed to train children about safety for pedestrians involving 75 local authorities. The project was successfully implemented from 2002 to 2007. Kerbcraft used volunteer trainers to supervise small groups of children and to deliver the pedestrian training at roadsides for these children. Training was divided into three terms when the following skills were assessed per term:

- Choosing safe places and routes
- Crossing between parked cars and crossing at junctions.

The two skills mentioned above was assessed in each of the three terms. The training has been evaluated as an excellent training programme to equip children for road safety. The *Kerbcraft* project was used to inform the development of the interactive computer program used as the educational intervention in this article. The Zahav Bagan Program in Israel is a unique educational program that involves senior citizens to enhance road safety among young children as a way of life (Ben-Bassat & Avnieli, 2016). The activities in the program include education in the behaviour of children on the road, as passengers, as bike riders and as pedestrians.

Measures to achieve effective road safety education are traditionally referred to as the three E's: (a) enforcement measures, (b) engineering measures, and (c) education measures. From the experiences of the best-performing countries, it has become evident that a holistic approach is needed in road safety education in which the three E's are combined (Organisation for Economic Co-operation and Development [OECD], 2004).

Safe participation in traffic is a complex task requiring skills like rule application, speed estimation and prediction, and it is self-evident that extensive practice is needed to acquire these skills (Rothengatter, 1981). Road safety training should continue to focus on the development and application of roadside skills, but young children should also be trained in the basic concepts of error-avoidance road user behaviour so that they can perceive themselves as having personal responsibility for maintaining safety (Rodgers, Andree, Pearson, & Thornton, 1999). To comply with these concepts of error avoidance learners in the age group 11 – 12 years need to have more than a sound knowledge base of road traffic and traffic rules. The OECD (2004) suggests that road safety education programmes should start with practical pedestrian training, then bicycle skills and then increasingly involve higher level skills to match learners increasing independence as pedestrians, cyclist and ultimately as young adult drivers.

Schools have a responsibility to educate learners on how to obey traffic signs and rules. Although it can be argued that school programmes should have a significant road safety focus and develop knowledge, values, attitudes and behaviours amongst learners, teachers in South Africa confine their teaching efforts to what is described in the National School Curriculum (NSC). In the Curriculum Assessment Policy Statement (Department of Education [DoE], 2011), a revised curriculum document focusing on the implementation of the NSC, the subjects Life skills and Life Orientation respectively refer to:

- transport modes, under the personal and social well-being topic in the foundation phase (Grade R– 3: children with ages 6-9 years old), and
- traffic rules relevant to road users: pedestrians and cyclists in the Intermediate Phase (Grade 4 – 6: children with ages 10-12 years old).

To support teachers in educating traffic rules relevant to road users, pedestrians and cyclists, the subject group Geography Education and Environmental Education of the North-West University (NWU), Potchefstroom Campus, developed an interactive computer program for learners to support knowledge acquisition on the topics mentioned above in the curriculum. With this research, the subject group wanted to contribute to the prevention of injuries and deaths amongst children in traffic.

This article aims to determine the effectiveness of an interactive computer program regarding the acquisition of a sound knowledge base on traffic signs and basic traffic rules to enhance road safety among grade seven learners and to formulate some recommendation to improve teaching praxis on road safety.

CONCEPTUAL AND THEORETICAL FRAMEWORK

When evaluating road safety instructional material for learners, it is important to have a strong theoretical base for understanding how learning occurs. It has traditionally been assumed that if learners were provided with information, their knowledge about road safety would automatically increase (Zeedyk, Wallace, Carcary, Jones, & Larter, 2001). However, this simple linear model of knowledge through attitudes to changes in behaviour has been challenged (Stern, 2000). The influence of knowledge on behaviour is complex. While there is agreement that knowledge alone will not motivate people to adopt a new behaviour, it is equally clear that a lack of knowledge can be a barrier to changing behaviour (Schultz & Zelezny, 1998). Although the authors concur with the emerging view in the literature that knowledge-based education programmes on their own do not provide sufficient training for children regarding road safety, they, however, regard knowledge on road signs and traffic rules as basic components of road safety education. They also argue that road safety education programmes have to be based on the available theoretical knowledge about child development and should, therefore, focus the programme on the development stage of the learners (OECD, 2004). Child developmental theories, therefore, give directions for programme development and how to determine how successfully road safety education programmes are, taking into account the constraints inherent in the child's development (Dragutinovic & Twisk, 2006).

Albert Bandura's social cognitive theory also informed the development of this interactive computer program to support knowledge on road safety rules. This theory emphasises a dynamic, interactive process among environmental, behavioural and personal factors to explain human functioning (Burney, 2008; Louw, Van Ede, Louw & Botha, 1998). The strength of the social cognitive theory is that it synthesises cognition and behaviour and in this way can help to bridge the rigid divisions that may exist between understanding road safety rules and signs and implementing them in practical situations (Slavin, 2006). Bandura believes that external reinforcement to support learning is not the only way that people learn new things. Instead, intrinsic reinforcements such as a sense of pride, satisfaction and accomplishment also lead to learning (Bandura, 1997). Intrinsic reinforcements were incorporated in this interactive programme by building in the recognition of progression using encouraging slogans when learners answer questions successfully. The psychologists Piaget and Inhelder (1969), as well as Vygotsky and Cole (1978) also believed that children learn actively and through hands-on experiences if the programme is well designed. Through the interactive nature of the programme, learners become *homo ludens* (the playing human) (De Beer & Henning, 2011; Huizinga, 1955). In the developed interactive programme, the learners are in control and only advance to a next question when they desire to do so.

Piaget identified a series of four key stages of cognitive development: the sensorimotor stage from birth to 2 years, the pre-operational stage from 2 years to 7 years, the concrete operational stage from 7 to 11 years and the formal operational stage from ages 12 and up. During the concrete operational stage, children gain a better understanding of the mental operation. Learners in the concrete operational stage are fairly good at the use of inductive logic which involves going from a specific experience to a general principle (Rathus, 2012). The learner at this stage is more socio-centric and less egocentric.

Albert and Dolgin (2010) found that short-term training that was done with pre-school children in a classroom situation yielded good results on conceptual understanding. It proved that play could improve positive behaviour during the crossing of roads. Hammond et al. (2014) also found that road safety education, training, and publicity are accident reduction measures designed to increase understanding and promote desirable behaviour about road safety. It commonly starts in childhood and continues throughout the formative years, in and out of school.

RESEARCH DESIGN

QUASI- EXPERIMENTAL DESIGN

A quasi-experimental design was used because the authors wanted to know if the intervention of using the interactive computer program caused better knowledge of road safety rules and road signs (Du Plooy-Cilliers & Cronje, 2014). According to Jann and Hinz (2016), quasi-experimental designs cover a broad range of approaches that are used when researchers wish to investigate causal questions, but experimental data is not available. It also refers to research, as in this case, where the treatment was manipulated, and randomisation was not applied. Jann and Hinz (2016) further concur that quasi-experimental designs often enlists pre-treatment and post-treatment measurements for both the treatment group and the control group. In the quasi-experimental correlation research design the difference in difference option was followed (Du Plooy-Cilliers & Cronje, 2014). In this design, it is not the difference between the experimental and control groups that is being compared, but the size of the difference between the two groups. This project was approved by and complied with all the ethical regulations of the University's Ethical Committee.

RESEARCH METHOD

INSTRUMENTATION

The program was developed according to the standards of an existing product of the North-West University's Driving School intended for school learners. The difference between the two products is that the newly developed "Game" will be focusing on a different age range and to test the traffic road sign skills of the learners. The program makes use of WPF (Windows Presentation Foundation) technologies. This product is functional on Windows 7 and higher versions. There are possibilities that the game can function on a lower version of Windows.

The program makes provision for 41 screen layout questions with five different levels of advancement. After successful completion of each question, a thumbs-up emoji appears on the screen with the typical "TaDa" sound. If a question is answered wrongly, a head-scratching emoji appears on the screen with a bike horn sound. The traffic road signs in the program appear in the original colours that are reflected on South-African Roads. All questions and possible alternative answers are posed in English. For each question that appeared on the computer screen, the learner was first asked to identify what it means, given four options to choose from. They were only able to continue if the correct option was chosen. Acquisition of knowledge was accomplished by allowing each learner of the intervention group individually to control a computer program testing their knowledge on road safety rules and road signs and in the process educating themselves. The interactive program had an element of assessment and teaching and is therefore regarded as the educational intervention.

POPULATION AND SAMPLING

A non-probability convenience sampling method was followed (Maree & Pietersen, 2016). There was no random selection of the population. The specific school was identified by the Department of Basic Education in the Potchefstroom Circuit as it is one of few primary schools with a fully functional computer laboratory in a previously disadvantaged school. It is a no-fee public school in the suburb of Ikageng with an enrolment of 800 learners. The school also forms part of the Quality Improvement, Development, Support and Upliftment Program (QUIDS-UP) of the Department of Education which aims to:

a. ensure adequate provisioning of **resources** to support learning and teaching;
b. improve learner competency levels in **literacy;**
c. improve learner competency levels in **numeracy;**
d. improve **leadership, management and governance** in the targeted schools; and
e. strengthen **monitoring and evaluation** at school level to ensure that there is maximum utilisation of available resources and increased focus on learning and teaching (DoE, 2007).

The principal, and the school management team of the school also agreed to participate in the study. All the learners in Grade 7 of the primary school (n= 75), aged 11 - 12 years, participated in the study. The reason why all the learners in this grade was included was to give them all a chance to participate and to avoid undue influence. The method was convenient as the population elements were selected based on the fact that they were easily and conveniently available. Two class groups of the school's Grade 7 A and B groups were used just as they were in the standard school programme. One group formed the intervention group (group A) and the other the control group (group B). The control group was also offered the intervention after the completion of the study. The school programme was not disrupted as the research was conducted during the Life Orientation subject periods (Life Orientation is a subject offered in South African schools as part of the curriculum).

Purposive, non-probability sampling was applied in the selection of the intervention and control groups in that the selection was based on the characteristics of the population: the Grade 7 learners in a disadvantaged urban primary school and the objective of the study: to teach primary school children about traffic signs and rules (Crossman, 2018). Non-probability sampling refers to a situation in which the probability of including every element of the population in a sample is unknown. Generalisation can therefore not be made from the findings of this study (Bless & Higson-Smith, 2000).

DATA COLLECTION PROCEDURES

A questionnaire on road safety was given as a pre-test (before intervention) for the intervention (group A) as well as for the control group (group B) to determine the baseline and then a post-test (after the intervention) for both groups to determine the knowledge after the intervention. A multi-choice questionnaire consisting of 35 questions (35 road signs) with four alternatives as the possible correct answer was set up as the pre-test. The post-test consisted of the same 35 road signs asked during the pre-test. Here only the traffic signals were illustrated without giving the learners the four alternatives to choose from. The learners then had to indicate which traffic signal they thought was indicated. After the pre-test, the learners were given the opportunity to visit the computer laboratory and complete the computer game as part of the intervention. After the intervention leaners than had to do the post-test. The reason the questions were kept identical for the pre- and post-tests was to measure if the instrument, which is the interactive computer program, was effective to teach the primary school learners traffic signs and rules. These questions were based on the Road Traffic Management Corporation of South Africa's (Department of Transport, 2000) road traffic signs (sheets 1, 2 and 4 of sheets 5), specifically aimed at pedestrian and cycling road users. The questionnaire was based on a pilot project that was undertaken by the Environmental Education for Sustainable Development entity of NWU's Faculty of Education Sciences (Potchefstroom Campus) during 2014. The following main types of road traffic signs were included:

- regulatory, e.g. stop signs: signs that regulate and control the actions of road users; they prohibit or command road users to perform certain actions;
- command, e.g. speed limit signs: tell you what you must do;
- prohibition, e.g. speed limit signs: specify behaviour or actions which are not permitted;

- reservation, e.g. parking reservation signs: indicate that a road or a part of it is reserved for certain vehicles only;
- warning, e.g. T-junction signs: warning signs alert road users in time to dangerous conditions on or next to the road; and
- signals, e.g. traffic lights: signalling devices positioned at road intersections, pedestrian crossings and other locations to control the flow of traffic.

The pre-test for experimental group A consisted of 35 participants. The pre-test for the control group B consisted of 35 participants. The experimental group took part in the interactive computer program. The last step in this design was to determine the difference between the end line and the baseline scores of both groups. The difference between the two is then compared, and the result is recorded (Du Plooy-Cilliers & Cronje, 2014).

DATA ANALYSIS

In order to analyse the data, a table for each pre- and post-test for both groups was set up resulting in a total of 4 tables. Each participant's scores for each of the signs (under each of the road traffic signs' columns) correctly scored was then recorded and added up to give each participant's total score. Under each road traffic sign that appeared on the lists, the total of all participant's scores were also added up to give the total of each traffic signal scored in a group.

All raw data was then captured and analysed by the North-West University's analytical services using the Statistical Analysis System [SAS] (SAS, Institute Inc. 2005). The Cronbach's alpha (*d*) was used to measure the effect of this intervention. The practical significance of differences between means is indicated by Cohen's *d* as follows: small effect ($d = 0.2$), medium effect ($d = 0.5$, and large effect ($d = 0.8$) (Cohen, 1992; Ellis & Steyn, 2003).

RESULTS

The following effect size estimates (*d*) were reported: regulatory signs: $d = 0.75$; prohibition signs: $d = 0.97$; warning: $d = 0.49$; command: $d = 0.49$; reservation: $d = 0.35$ and signals: $d = 0.23$. As can be seen in Table 1, in the use and application of prohibition signs, the effect was $d = 0.97$ and for regulatory signs $d = 0.75$ which is a large effect > $d = 0.5$. This is a positive result of the intervention of using the interactive computer program. For the other three signs, warning: $d = 0.49$; command: $d = 0.49$; reservation: $d = 0.35$ the effect according to Cronbach's alpha was meaningful.

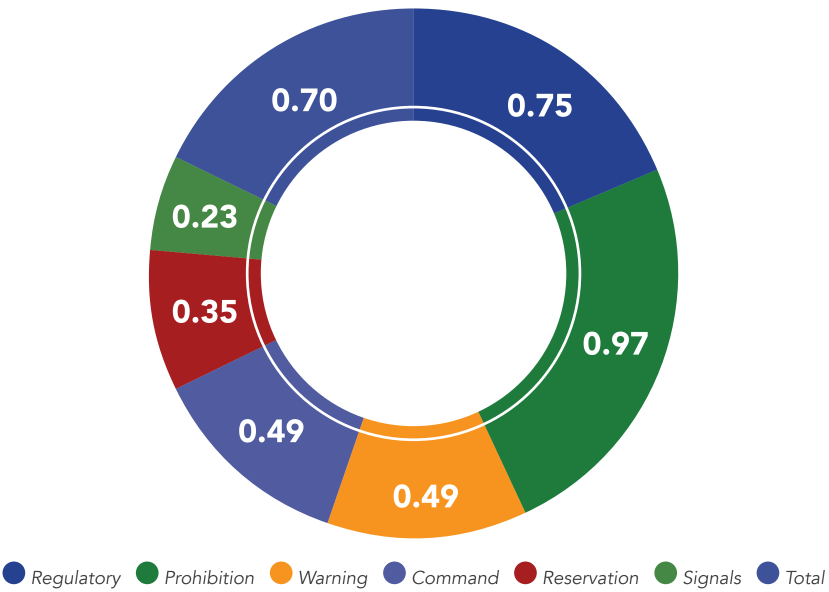
For all the road signs used in the study the effect (0.70) was large < 0.5. Cohen (1992) guidelines for the interpretation of the effect size reflects the following: (a) small effect: $d = 0.2$, (b) medium effect: $d = 0.5$ and (c) large effect: $d = 0.8$.

From Figure 1 and Table 1 it can be concluded that the prohibition signs in the interactive program scored the highest with a *d* value of 0.97 followed by regulatory signs at 0.75, warning signs at 0.49, command signs at 0.49, reservation signs at 0.35 and traffic signals at 0.23. It seems that the responses of learners who participated in this study were more inclined to pay attention to road traffic signs that specify behaviour or actions which are not permitted – the prohibition traffic signs.

Table 1: Analysis of the raw data obtained from the questionnaires .

Gender	n	Mean	Std. Deviation	Std. Error Mean	Effect size (d)
Regulatory_5	19	2.84	0.90	0.21	0.75
	16	2.13	0.96	0.24	
Prohibition_6	19	2.84	1.02	0.23	0.97
	16	1.69	1.20	0.30	
Warning_14	19	5.79	1.59	0.36	0.49
	16	4.50	2.66	0.66	
Command_6	19	4.05	1.47	0.34	0.49
	16	3.25	1.65	0.41	
Reservation_1	19	0.21	0.42	.010	0.35
	16	0.06	0.25	0.06	
Signals_3	19	0.05	0.22	0.05	0.23
	16	0.00	0.00	0.00	
Total__35	19	15.79	3.97	0.91	0.70
	16	11.63	5.93	1.48	

Figure 1. Proportional figures achieved by the intervention group



DISCUSSION

Improvement of knowledge regarding regulatory signs which aim to control the actions of road users and warning signs that alert road users to dangerous conditions have been recorded. Knowledge of reservation signs that indicate that a road or a part of it is reserved for certain vehicles and warning signs that alert road users in time to dangerous conditions did not improve sufficiently after the intervention of the interactive program. This situation supports the finding in a study done by Trifunović, Pešić, Čičević, and Antić (2017). They found that the majority of children recognise the traffic signs representing a marked crossing (91.1%) while prohibitory traffic signs received the lowest scores (25%) of the correct answers. The finding by Trifunović et al. (2017) indicated that children do have a problem understanding the message of what is prohibited by a traffic sign.

According to Muir et al. (2017), children are the most vulnerable group of road users. Their vulnerability stems from their small physique, their level of perceptual and cognitive abilities and the lower development of sensory facilities (Koekemoer, Van Gesselleen, Van Niekerk, Govender, & Van As, 2017; Muir et al., 2017). Modern traffic settings pose complex and high requirements for young children (Trifunović et al., 2017). Trifunović et al. (2017) also stated that safe pedestrian behaviour is dependent on the combined development of a number of cognitive processes overlapping with developing skills such as perception of relevant spatial and situational attributes, attention and memory and information–processing capacity, decision making and as well as motor abilities which increases over age. Each phase of a child's development is characterised by distinctive levels of physical and psychological skills (Koekemoer et al., 2017; Trifunović et al., 2017).

The interactive computer program of this study aimed to change the cognitive abilities through the reinforcement of their knowledge base of traffic signs and ultimately to improve the pedestrian behaviour of grade 7 learners (11-12 years) (Muir et al., 2017). Astington and Olson (1995) suggest that acquisition of critical concepts (such as road signs) permits the development of an increasingly complex understanding of social interactions which in turn lead to more advanced conceptual structures.

According to the literature learning about road safety in the age group 11 – 12 years contributes towards a sound knowledge base regarding traffic for development of positive values, attitudes and behaviours of these learners (OECD, 2004). Cullen (1999) confirmed the last statement when he indicated that young children hold a considerable body of declarative knowledge about the conventions of road safety signs and that they can modify this knowledge on the basis of their experience. We recommend that teachers must interact with children about their content learning about road signs to increase their metacognitive awareness of their learning so that they can modify this knowledge on the basis of their experience in real traffic situations. Insight from the road safety studies of Cullen (1999) showed that children who participated in reflective dialogues with teachers were able to conceptualise their learning about road safety in a coherent, integrated way that revealed their understanding of roads and traffic as a system. This in line with Vygotsky's theory (1978) that children's learning is embedded in social contexts and processes.

From the author's study with the grade 7 learners (11-12 years) in the primary school, the results yielded positively regarding a sound knowledge base after using the interactive computer program, as was the case with the Kerbcraft (Hammond et al., 2014) computer program used in the United Kingdom. Extensive practice is needed to acquire these skills (Rothengatter, 1981). During the implementation of the computer program in the school, the authors come to the conclusion that through consecutive exercise on the computer game, the learner's skills improved drastically. The OECD (2004) suggests that road safety education programmes should start with practical pedestrian training, then bicycle skills and then increasingly involve higher level skills to match learners increasing independence as pedestrians, cyclists and ultimately as young adult drivers. Van Schagen and Rothengatter (1997), on the basis of a literature survey, concluded that classroom activities could improve young children's knowledge but they do need training in the traffic environment to profit effectively from road safety education. Quasi-experiments have a low internal validity due to the absence of random assignment of participants. The quasi-experimental design can therefore only indicate the possibility of a cause (Du Plooy-Cilliers & Cronje, 2014). As this study was only done in one school, it cannot be assumed that the results would yield the same results for other schools. The study did, however, inform how the interactive computer program can improve knowledge acquisition in the cognitive domain to include both subject-specific understandings and general cognitive abilities. It is still unknown whether the use of this computer program will effectively reduce the risks of pedestrian accidents. To improve road safety education, it is recommended that a practical session should be incorporated in training. This training would, for example, include assimilation of relevant road signs on the school playgrounds made from recyclable items with some learners acting as pedestrians whilst others act as vehicle drivers.

RECOMMENDATIONS

The data of this article was obtained using pre- and post-questionnaires and the findings of the pilot study indicate that there was a statistically significant improvement by using the computer program. The research results stated in the article serve as proof that the use of computer simulations can serve as a supplement to road safety training. Children may possess the knowledge of traffic signs but still not be able to apply them when needed. It is therefore recommended that training should include exposure to real situations and that interactions with teachers can evoke processes of learning (metacognitive strategies and awareness of the content of learning) to promote understanding of content knowledge. Training that includes exposure to real situations will help to improve understanding of traffic signs.

It is the view of the authors that it will be worthwhile to research the use of computer simulations in a larger longitudinal study to gain insights on how the relationship between the various abilities to understand traffic sign change with age in order to improve the road safety curriculum in schools. They are also of the view that this is a good pedagogical method for current and future generation as they grow up using computers.
They also recommend that added to the interactive computer simulations program teachers must also develop positive values, attitudes and behaviours in learners regarding road safety. Road safety education must also include the development of the meta-cognitive process of awareness and control. Hammond et al. (2014) state that road safety education depends on interventions working as part of a system. If learners acquire these skills and values, they will develop more appropriate attitudes towards road safety. It is important to establish the degree of overlap between children's symbolic and real behaviour. Rather than adapting children to traffic, the traffic environment must be adapted to accommodate children through various measures such as clearer signs to convey safety messages (Trifunović et al., 2017; Waterson & Monk, 2014).

It is recommended that government departments in South Africa with interest in road safety, and initiatives like Arrive Alive, must make funds available to invest in the design, research and improvement of interactive computer programs so that this type of education can be rolled out to more schools by the Department of Basic Education in order to make a more meaningful contribution towards road safety.

REFERENCES

Albert, R. R., & Dolgin, K. G. (2010). Lasting effects of short-term training on preschoolers' street-crossing behavior. *Accident Analysis & Prevention, 42*(2), 500–508. doi:10.1016/j.aap.2009.09.014.

Arrive Alive. (2017). *Pedestrian safety in South Africa*. Retrieved from https://www.arrivealive.co.za/Pedestrian-Safety-Advice

Astington, J., & R. Olson, D. (1995). The cognitive revolution in children's understanding of mind. *Human Development, 38*(4-5), 179–189. doi:10.1159/000278313.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Ben-Bassat, T., & Avnieli, S. (2016). The effect of a road safety educational program for kindergarten children on their parents' behavior and knowledge. *Accident Analysis & Prevention, 95*(Part A), 78–85. doi:10.1016/j.aap.2016.06.024.

Bless, C., & Higson-Smith, C. (2000). *Fundamentals of social research methods: An African perspective* (3rd ed.). Lansdowne: Juta.

Burney, V. H. (2008). Applications of social cognitive theory to gifted education. *Roeper Review, 30*(2), 130–139. doi:10.1080/02783190801955335.

Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychological Bulletin, 112*(1), 155–159.

Crossman, A. (2018). *Understanding purposive sampling: An overview of the method and its applications.* Retrieved from https://www.thoughtco.com/purposive-sampling-3026727.

Cullen, J. (1999). Children's knowledge, teachers' knowledge: Implications for early childhood education. *Australian Journal of Teacher Education, 24*(2), 13–27.

De Beer, J., & Henning, E. (2011). Retreating to a Vygotskian stage where pre-service teachers play out social, 'dramatical collisions'. *Acta Academica, 43*(4), 203–228.

Dragutinovic, N., & Twisk, D. (2006). *The effectiveness of road safety education: A literature review* (SWOV publication R-2006-6). Retrieved from https://www.researchgate.net/publication/251880437_The_effectiveness_of_road_safety_education_a_literature_review

Du Plooy-Cilliers, F., & Cronje, J. (2014). Quantitative data collection. In F. Du Plooy-Cilliers, C. Davis, & R. M. Bezuidenhout (Eds.), *Research matters* (pp. 147–172). Lansdowne: Juta.

Ellis, S., & Steyn, H. S. (2003). Practical significance (effect sizes) versus or in combination with statistical significance (p-values). *Management Dynamics, 12*(4), 51–53.

Hammond, J., Cherrett, T., & Waterson, B. (2014). The development of child pedestrian training in the United Kingdom 2002–2011: A national survey of local authorities. *Journal of Transportation Safety & Security, 6*(2), 117–129. doi:10.1080/19439962.2013.821566.

Huizinga, J. (1955). *Homo ludens: A study of the play-element in culture.* London: Routledge & Kegan Paul.

Jann, B., & Hinz, T. (2016). Research questions and design for survey research. In C. Wolf, D. Joye, T. W. Smith, & Y. C. Fu (Eds.), *The SAGE handbook of survey methodology* (pp. 122–141). Los Angeles: Sage.

Koekemoer, K., Van Gesselleen, M., Van Niekerk, A., Govender, R., & Van As, A. B. (2017). Child pedestrian safety knowledge, behaviour and road injury in Cape Town, South Africa. *Accident Analysis & Prevention, 99*(Part A), 202–209. doi:10.1016/j.aap.2016.11.020.

Louw, D. A., Van Ede, D. M., Louw, A. E., & Botha, A. (1998). *Human development.* Cape Town: Kagiso Tertiary.

Maree, K., & Pietersen, J. (2016). Sampling. In K. Maree (Ed.), *First steps in research* (p. 197). Pretoria: Van Schaik.

Matzopoulos, R., Du Toit, Nelmarie, Dawad, S., & Van As, Sebastian. (2008). In A. Van Niekerk, , S. Suffla, & M. Seedat (Eds.), *Crime, violence and injury prevention in South Africa: Data to action* (pp. 14–27). Tygerberg: MRC-UNISA.

Muir, C., O'Hern, S., Oxley, J., Devlin, A., Koppel, S., & Charlton, J. L. (2017). Parental role in children's road safety experiences. *Transportation Research Part F: Traffic Psychology and Behaviour, 46*(Part A), 195–204. doi:10.1016/j.trf.2017.01.014.

Organisation for Economic Co-Operation and Development (OECD). (2004). *Keeping children safe in traffic.* Retrieved from http://www.oecd-ilibrary.org/docserver/download/7704011e.pdf?expires=1507188641&id=id&accname=oid010567&checksum=65B68C8327CB2B36E3AFBBE5D4165970

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* London: Routledge & Kegan Paul.

Rathus, S. A. (2012). *Psych* (4th ed.). Belmont: Wadsworth.

Rodgers, N., Andree, K., Pearson, A., & Thornton, S. (1999). Taking the child's perspective seriously. *The Psychologist, 12*(8), 393–394.

Rothengatter, J. A. (1981). The influence of instructional variables on the effectiveness of traffic education†. *Accident Analysis & Prevention, 13*(3), 241–253. doi:10.1016/0001-4575(81)90007-5.

Schultz, P. W., & Zelezny, L. C. (1998). Values and proenvironmental behavior. J*ournal of Cross-Cultural Psychology, 29*(4), 540–558. doi:10.1177/0022022198294003.

Slavin, R. E. (2006). E*ducational psychology: Theory and practice*. Boston: Pearson/Allyn & Bacon.

South Africa. Department of Basic Education. (2011). *Curriculum Assessment Policy Statement (CAPs).* Pretoria.

South Africa. Department of Education. (2007). *Quality improvement, development, support and upliftment program*(qids-up). Retrieved from http://pmg-assets.s3-website-eu-west-1.amazonaws.com/docs/2007/071019qidsup.htm

South Africa. Department of Transport. (2000). *Road traffic sign*s. Retrieved from http://www.rtmc.co.za/images/docs/RS_Engineering/Road_Traffic_Signs_charts.pdf

Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*(3), 407–424. doi:10.1111/0022-4537.00175.

Trifunović, A., Pešić, D., Čičević, S., & Antić, B. (2017). The importance of spatial orientation and knowledge of traffic signs for children's traffic safety. *Accident Analysis & Prevention, 102*(Supplement C), 81–92. doi:10.1016/j.aap.2017.02.019.

Van Schagen, I., & Rothengatter, T. (1997). Classroom instruction versus roadside training in traffic safety education. *Journal of Applied Developmental Psychology, 18*(2), 283–292. doi:10.1016/S0193-3973(97)90042-3.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Waterson, P., & Monk, A. (2014). The development of guidelines for the design and evaluation of warning signs for young children. *Applied Ergonomics, 45*(5), 1353–1361. doi:10.1016/j.apergo.2013.03.015.

World Health Organization. (2017). *Make walking safe: A brief overview of pedestrian safety around the world make walking safe* (WHO/NMH/VIP13.02). Retrieved from http://www.who.int/violence_injury_prevention/publications/road_traffic/make_walking_safe.pdf.

Zeedyk, M. S., Wallace, L., Carcary, B., Jones, K., & Larter, K. (2001). Children and road safety: Increasing knowledge does not improve behaviour. *The British journal of educational psychology, 71*(Pt 4), 573–594.