A Case for Enhancing Environmental Education Programs in Schools: Reflecting On Primary School Students' Knowledge and Attitudes

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ABSTRACT

Environmental education in schools is of increasing importance as the world population increases with the subsequent demand on resources and the potential for increased pollution. In an effort to enhance the standing of environmental education in the school curriculum, this study was designed to determine primary students' knowledge about the environment, their attitudes towards helping the environment and what they actually have done to help the environment. The Year 4 and 5 students in regular and gifted classes in one primary school answered a questionnaire called the *Children's Environmental Attitude and Knowledge Scale* (*CHEAKS*) and several students in both Year levels were interviewed in pairs to elaborate on their responses. In the interviews, students discussed what they had been taught in school in relation to the environment. The findings include (1) Year 4 students had a higher commitment to the environment than Year 5 students; (2) gifted students had more knowledge than regular students; and (3) girls were more verbally committed to the environment than boys. Having knowledge about the environment did not necessarily mean that the student was committed to saving the environment, nor did it mean that the student took action to solve environmental problems. While this study was conducted in one school, the implication is the need for the implementation of a curriculum to help students develop their knowledge and attitudes to take proenvironmental actions.

Introduction

From time to time, catastrophic environmental events like the Boxing Day tsunami of 2004 and the Fukushima nuclear disaster of 2011 remind us of the power of nature, the human influence on the environment, and the importance

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of caring for the environment. It is necessary for us to be informed, take control,
and prevent further environmental problems. Unfortunately, the general public knows very little about energy production and its use even though our civilization is getting more and more energy intensive. Coal is the most abundant fossil fuel in many countries but it is inevitably linked with air pollution and climate change, even with the use of carbon capture and sequestration technology (Harun-Or-Rashid et al., 2014; Jacobson & Delucchi, 2011). Renewable energy sources like wind, water, and sunlight are becoming more cost-effective but their seasonal availability requires alternative or supplementary energy production and storage (Baños et al., 2011; Haas et al., 2011). Considering various issues involving energy production and environmental concerns, we must become more prudent in the use of energy and be active in conserving energy.

In order to serve society in addressing environmental issues, it is important to provide learning opportunities for students, as future citizens, to develop their understandings and values of energy related issues (DeWaters, Qaqish, Graham & Powers, 2013). Schools need to be involved so that students from a young age become aware of social and environmental issues in their local communities and around the world, and thus be motivated to take action to improve and maintain the environment (Ramsey, 2001). Indeed, environmental education should be recognized as a lifelong study of everyone in the world to respond to an everchanging world. Recognizing the importance of the environmental education, Rachel Carson, as early as 1957, claimed that environmental education was necessary for everyone on this planet (Lear, 2003). Carson argued that we need to teach the wonderful beauty and power of nature so that we recognize that human beings are only one part of nature but have the potential to irreversibly damage or positively influence it. UNESCO set up the environmental education guidelines in 1978 to help education community to examine major environmental issues from local and international perspectives, understand the complexity of environmental problems, and emphasize environmental sensitivity, knowledge, and problemsolving skills.

Despite the international recognition of the importance of the environmental education, it has been usually a minor component of formal school education (National Environmental Education Advisory Council, 1996; Stevenson, 2007). Researchers have found that the environmental education is still in an inadequate level in terms of curriculum presence, consistency, depth, and impact (Hungerford & Volk, 2003). According to Ramsey (2001), "Most school-based educators have not adopted a frame of reference of either environment curriculum or instruction, although they are widely used in non-formal contexts" (p. 111). The same situation still applies many years later as "most environmental learning in our society occurs outside of schools in parks, museums, nature centres, arboreta, zoos, aquariums and other environmental organizations, and through newspapers, television, movies, agency outreach programs and radio" (Heimlich, 2010, p. 182).

Teachers have found that it is not simple or easy to guide students, in regular school settings, to develop their knowledge, skills, and attitudes so that they can understand the ever-changing environments and take actions to make life better. Teachers have great challenges in multiple levels when they try integrating environment education in real school teaching practice (Stevenson, Brody, Dillon, & Wals, 2013). One aspect of such challenges is that the goal of environmental education is not compatible with the perceived objectives and structures of schools in modern society (Stevenson, 1987). Environmental education is, by its very nature, oriented towards social involvement and transformation, and it requires highly interdisciplinary, system-oriented thinking. Wheeler and Bijur (2000) assert that in schools, teaching of science and social studies, for example, is often not well coordinated to provide students with interdisciplinary learning opportunities to thoroughly investigate environmental issues. Environmental

education is only taught to the extent that teachers want to include it within existing subject boundaries. In addition, environmental education involves a complex, integrated system thinking when approaching environmental sustainability issues. Children need to experience ways of looking at issues in multiple perspectives and coming up with alternative ways of thinking. Without such a comprehensive thinking framework, it is difficult to recognize the interconnections and multiple aspects in environmental issues, and apply a new understanding to their own lives and communities.

To tackle the challenges of environmental education, it is not unusual for groups of educators and researchers to implement environmental education projects that investigate local environmental issues with community members' participation (National Environmental Education Advisory Council, 1996). For example, primary school students and teachers participated in an environmental research-action project with support from local scientists, education researchers, and community members and addressed environmental issues of the neighbourhood in Chicago (Bouillion & Gomez, 2001). The Issue Investigation and Action Training Model (Ramsey, 1993) includes instruction through community investigation and citizenship participation based on the action research and community problem-solving model of early proponents of environmental education (Stapp, 1969). Such action research projects appear to have made a positive impact on students' knowledge and attitudes towards environmental issues to further develop their understanding of environments and take responsible actions (Volk & McBeth, 2001). Peterson (2000) argues that in order to build successful environmental education, educators should not conceptualize schools as a contained institution away from the society and social issues. Rather, school education should reclaim its identity as a centre for the whole community.

Since the review by Posch (1993), research in environmental education has expanded internationally and become more methodologically diverse and sophisticated. Hart and Nolan (1999) claim, "environmental education research is a more complex and controversial field than it was a decade ago" (p. 1), and the trend can be observed now (Stevenson et al., 2013).

In science education pedagogy, it is necessary to start with investigating the learners' background knowledge at the local level to plan and reflect on effective, customized instruction to support productive learning (Treagust, Duit, & Fraser, 1996). Such understanding of students is valuable knowledge in itself and also could work as a basis for moving on to more comprehensive understandings of learning of environmental issues (McBeth et al., 2008; UNESCO, 2001). This study was conducted in an effort to learn about students' environmental knowledge, attitudes and behaviour of primary students. According to the metaanalysis by Hines, Hungerford, and Tomera (1986/1987) and later by Bamberg and Möser (2007), researchers have conducted studies to identify various factors influencing students' pro-environmental attitudes and behaviours. From various components, the authors of this paper chose four factors: students' verbal and actual commitment towards the environment, their attitudes towards environment, and their knowledge of the environment. By examining not only students' environmental knowledge but also their attitudes and actions, we intended to supply the background information for primary educators to refer to, so that they can effectively plan and implement new environmental education programs or policies to bring about changes in students' knowledge and attitudes (Hungerford & Simmons, 2003; Rickinson, 2001).

Method

Research Design

This study employed a survey design involving a convenience sampling of students to elicit quantitative information about their knowledge and attitudes about the environment using an established questionnaire, the *Children's Environmental Attitude and Knowledge Scale* (*CHEAKS*) The classes in the school

were the intact, pre-existing groups among whom comparisons are possible (Punch, 1998). The study was designed to provide a basis upon which others may develop and implement a curriculum for environmental education. Comparison was made between Years 4 and 5 students (gifted versus regular, boys versus girls) over two years. Among other aspects, the findings would provide information on how motivated students were to take action within their school, homes and their community. Furthermore, the findings would reveal any change in students' knowledge and attitudes from year to year without any additional treatment or formal modification of the curriculum. For this reason, the study was conducted with two cohorts of students over two years.

Participants

Years 4 (9-10 years old) and 5 (10-11 years old) students from one public primary school in Miami, Florida, participated in the study. Approval to conduct the research was received from Curtin University and from the participating primary school as well as Miami-Dade County public school administration. Each Year 4 and Year 5 teacher was sent a letter to explain the study, and they agreed to participate. Parental permission forms were received for all children who participated in the study. The data were collected over two years totalling 305 participants in the first cohort and 378 in the second cohort. A breakdown of the figures is shown in Table 1. Prior to the data collection, Year 4 students were involved in the study of Florida in science and social studies. They had heard speakers from the Officer Snook Water Pollution Programme and Friends of the Everglades. They also had been to a live performance of Earth Man and his band, and watched him on television every school day for a month in class.

Table 1. Number of students and teachers involved in the study

Year Level	Cohort 1				Cohort 2	
	Total	Regular	Gifted	Total	Regular	Gifted
4	176	140	36	181	128	53
5	125	105	20	197	159	38
Total	301	245	56	378	287	91

Questionnaire

The *Children's Environmental Attitude and Knowledge Scale* (*CHEAKS*) (see Appendix A) had previously been administered to primary students and found to be valid and reliable with Cronbach's alpha ranging from .88 to .90 (Leeming, Dwyer & Bracken, 1995). The questionnaire considered students' knowledge of environmental issues (Knowledge scale) and attitudes toward the environment (Attitude scale). Permission to use the CHEAKS was sought and obtained from its originator, Dr. Leeming.

The Attitude scale comprised three subscales and 36 items: 12 items reflected Verbal Commitment, 12 measured Actual Commitment and 12 assessed students' feelings (Affective factor). These attitudinal items are distributed over six contentdependent sub-domains, with two items from each of the subscales: animals, energy, water, pollution, recycling and general issues. Examples of items from each of the six sub-domains of the Attitude categories, namely Verbal Commitment, Actual Commitment and Affect-Feelings, are given in Figure 1.

Verbal Commitment	
Animals:	I would be willing to stop buying some products to save animal's lives.
Energy:	I would **not** be willing to save energy by using less air conditioning.
Water:	To save water, I would be willing to use less water when I bathe.
Pollution:	I would be willing to ride the bus to more places in order to reduce air pollution.
Recycling:	I would **not** be willing to separate my family's trash for recycling.
General:	I would **not** give $15 of my own money to help the environment.
Actual Commitment	
Animals:	I have asked my parents not to buy products made from animal fur.
Energy:	To save energy, I turn off lights at home when they are not in use.
Water:	I turn off the water in the sink while I brush my teeth to conserve water.
Pollution:	I have **not** written someone about a pollution problem.
Recycling:	I have asked my family to recycle some of the things we use.
General:	I have talked with my parents about how to help with environmental problems.
Affect – Feelings	
Animals:	I get angry when I think about companies testing products on animals.
Energy:	It makes me happy to see people trying to save energy.
Water:	I am **not** worried about running out of water.
Pollution:	I get angry about the damage pollution does to the environment.
Recycling:	It makes me happy when people recycle used bottles, cans, and paper.
General:	I am frightened to think people don't care about the environment.

Figure 1. Examples of questions from the *CHEAKS* Attitude scale

Responses to the 36 items in the Attitude scale were based on a Likert-scale with responses ranging from (1) for 'very false', (2) for 'mostly false', (3) for 'not sure', (4) for 'mostly true' and (5) for 'very true'. Responses to negatively worded items were reversed for coding to have the most pro-environmental response to each item being credited 5 points while the least pro-environmental response receiving 1 point. Hence, possible total scores on the Attitude scale ranged from 36 to 180.

The Knowledge scale comprised 30 items covering six content-dependent subdomains, namely: animals, energy, pollution, recycling, water, and general issues. Each sub-domain consists of five items. Examples of an item from each of the six sub-domains in the Knowledge scale are given in Figure 2.

Animals	Most elephants are killed every year to provide people with:
	a. trophies.
	b. ivory.
	c. meat.
	d. oil.
	e. skin.
Energy	Burning coal for energy is a problem because
	a. it releases carbon dioxide and other pollutants into the air.
	b. it decreases needed acid rain.
	c. it reduces the amount of ozone in the stratosphere.
	d. it is too expensive.

	e. it pollutes the water in aquifers.

Pollution	The most pollution of our water sources is caused by:
	  a. dams on rivers.
	  b. chemical runoff from farms.
	  c. methane gas.
	  d. leaks in the sewers.
	  e. human and animal wastes.

Recycling	Compared to other paper, recycled paper:
	  a. takes more water to make.
	  b. takes less energy to make.
	  c. is less expensive to buy.
	  d. is harder to write on.
	  e. produces more pollutants.

Water	Phosphates are harmful in sea water because they:
	  a. cause cancer in fish.
	  b. stop reproduction in fish.
	  c. make fish nervous.
	  d. make the water cloudy.
	  e. suffocate fish by increasing algae.

General	Ecology assumes that man is what part of nature?
	  a. special.
	  b. related to all other parts.
	  c. not important.
	  d. the best part.
	  e. the first part.

Figure 2. Examples of questions from the *CHEAKS* Knowledge scale

The content validity of the *CHEAKS* instrument in this study was ascertained by the second author who had been teaching the content at this year level for 20 years. The Sunshine State Standards (SSS) (Florida Department of Education, 2002) mandated what students are expected to learn in each year level, and the items on the *CHEAKS* instrument are part of the standards that each child should have been taught by Year 5. Also, the second author covered a range of environmental issues, which she considered should be in the primary school curriculum.

The reliability of the scales of the *CHEAKS* was measured by Cronbach alpha resulting in the values shown in Table 2 using the Year 4 and Year 5 students in the first year of the study (n = 305); all scales had acceptable reliabilities (> 0.60) (Punch, 1998) though slightly lower that Leeming et al.'s results. Eta² values also showed that all scales, except Actual Commitment, are able to differentiate students' perceptions from different groups.

Table 2. Internal Consistency Reliability (Cronbach Alpha Coefficient) and ANOVA Results for CHEAKS instrument from this study (n=305)

Scale	Number of Items	Alpha Reliability	Eta^2
Verbal Commitment	12	.73	.10***
Actual Commitment	12	.67	.05
Affective	12	.83	.09**

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Knowledge (cognitive)	30	.62	.31***

**p < 0.01   ***p < 0.001

Interviews

Twenty-eight students from the first year cohort were interviewed and recorded on video to obtain their elaborate responses towards the questionnaire questions. Students were chosen by their availability and teacher recommendation. Nine were Year 4 students (four were male and five were female) and 19 were in Year 5 (11 were male and eight were female). Comments from four Year 4 gifted students (two girls and two boys) included rich explanations on their answers.

Results

Students' Environmental Attitudes and Knowledge: Quantitative Aspects

Generally, the attitudes of students in this study towards environmental issues were not especially pro-environmental (see Table 3). The average score ranged from 3.2 (neutral) to 3.9 (somewhat pro-environmental) for each subscale, Verbal Commitment, Actual Commitment and Affective. The Affective subscale has the highest average score while the Actual Commitment subscale has the lowest, meaning that students are more likely to feel that they are emotionally attached to the environment while they are less likely to take an action to protect or conserve the environment. Interestingly, in all three subscales of Attitudes, Year 4 students recorded higher scores than Year 5 counterparts. For the first cohort, the scores of Year 4 and Year 5 students were statistically different except for Verbal Commitment. For the second cohort, the drop in the students' attitudes toward the environment was statistically significant for all three attitudes subscales based on analysis with t-test (p < 0.01).

For the environmental knowledge scale, the participating students scored around 10 out of 30 questions. Different from the attitude scale, Year 5 students achieved slightly higher scores for the knowledge test than Year 4 students in both cohorts but these differences were not statistically significant. This result seems to suggest that the regular school education does improve students' knowledge of the environment but diminishes students' pro-environmental attitudes. It is similar to the results of McBeth et al.'s (2008) survey with Year 6 and 8 students.

Table 3. The CHEAKS subscales scores for Year 4 and Year 5 students for two years

					t
		Year			
Scales	Sub - scales	Cohort	Year 4		Year 5

			Mean	SD	Mean	SD	t
Attitudes	Verbal commitment	1		0.55	3.55	0.68	1.39
		2		0.45	3.28	0.47	4.92**
	Actual commitment	1		0.61	3.16	0.73	2.95*
		2		0.56	3.28	0.60	3.07**
	Affective	1		0.69	3.70	0.81	2.33*
		2		0.56	3.30	0.57	2.62**
			3.64				
			3.52				
			3.38				
			3.47				
			3.90				
			3.45				
Knowledge		1	9.44	4.07	10.23	3.60	1.77
		2	10.25	3.71	10.40	4.01	0.37

Year 4 gifted students displayed an advanced level of understanding of environmental issues (13.2 to 13.5) compared to their regular counterparts (8.1 to 8.7) that were statistically different ($p<0.01$) for both cohorts (see Table 4). However, their attitude subscale scores varied in relation to the regular students, with the exception of lower scores for affective subscales in both cohorts.

Table 4. The CHEAKS subscales scores for Year 4 regular and gifted students for two years

Scales	Sub-scales	Cohort Year	Year 4 Regular		Year 4 Gifted		t
			Mean	SD	Mean	SD	
Attitudes	Verbal commitment	1	3.58	0.53	3.98	0.55	3.53*
		2	3.53	0.44	3.48	0.47	0.66
	Actual commitment	1	3.35	0.59	3.54	0.69	1.44
		2	3.49	0.55	3.40	0.59	0.98
	Affective	1	3.85	0.68	3.18	0.69	2.19*
		2	3.52	0.55	3.30	0.56	2.36
Knowledge		1	8.74	3.88	13.19	2.88	6.81**
		2	8.10	3.17	13.49	2.83	9.56**

*$p < 0.05$, **$p < 0.01$

Likewise, Year 5 gifted students performed better in the environmental knowledge scale than Year 5 regular students, but to a lesser degree (see Table 5). The score difference between the gifted and regular students was statistically significant for the first cohort, but not the second cohort. For the attitudes subscales, the gifted students consistently scored lower than the regular students except one subscale for one cohort.

Table 5. The CHEAKS subscales scores for Year 5 regular and gifted students for two years

Scales	Sub-scales	Cohort Year	Year 5 Regular		Year 5 Gifted		t
			Mean	SD	Mean	SD	
Attitudes	Verbal commitment	1	3.61	0.66	3.32	0.71	2.03*
		2	3.30	0.48	3.19	0.46	1.32
	Actual commitment	1	3.19	0.74	3.04	0.68	0.95
		2	3.26	0.60	3.35	0.63	0.78
	Affective	1	3.80	0.80	3.37	0.75	2.70**
		2	3.33	0.55	3.17	0.66	1.39
Knowledge		1	9.81	3.32	11.70	4.18	2.28*
		2	10.31	3.72	10.79	5.08	0.55

*$p < 0.05$, **$p < 0.01$

This study also looked into the gender difference in students' attitudes and knowledge in environmental issues (see Table 6). The girls had consistently higher means on all the subscales for the first and second cohorts, but a statistically significant difference was only found for the Verbal Commitment subscale.

Table 6. The CHEAKS subscales scores for boys (n=157, 190) and girls (n=144, 188) for two years

Scales	Sub-scales	Cohort Year	Boys		Girls		t
			Mean	SD	Mean	SD	
Attitudes	Verbal commitment	1	3.53	0.62	3.67	0.60	1.97*
		2	3.34	0.49	3.45	0.46	2.23*
	Actual commitment	1	3.26	0.68	3.30	0.68	0.55
		2	3.32	0.63	3.42	0.55	1.70
	Affective	1	3.76	0.76	3.87	0.74	1.31
		2	3.34	0.58	3.41	0.55	1.20
Knowledge		1	9.50	3.99	10.11	3.74	1.36
		2	10.32	4.15	10.34	3.57	0.05

*$p < 0.05$

Students' Environmental Attitudes and Knowledge: Qualitative Aspects

For the *Verbal Commitments* towards the environment, the students' responses showed their affection to animals but also practical considerations of their living comforts. One of the questions reads: I would be willing to stop buying some products to save animals' lives. Of the 28 students interviewed, 18 stated that they would stop buying some products to save animal's lives. Most said that animals were important to them and they would not do anything to hurt animals, especially buying fur coats. One Year 4 female student commented, "You know when they use certain things like sunscreens and it says they test it on animals. That can be really bad because you don't know what it can do to the animals. So that's why I would stop buying some sunscreen they tested on animals or eye products or something like that". On the other hand, one Year 5 boy said, "I put 'very false' because I would still use leather in cars. I like to ride in a luxurious car with leather seats."

Using less air conditioning was one of the questions with least proenvironmental responses from students. Students were mostly concerned about their own comfort rather than considering the environmental issues. The question reads: I would not be willing to save energy by using less air conditioning. Of the 28 students interviewed, 12 stated they would *not* be willing to stop using air conditioning because of the heat in South Florida. One Year 5 boy said, "We need air-conditioning in Miami or we would not be able to survive." One Year 4 male student commented, "That's mostly true because down here in Miami, it can get pretty hot. I would die [in the heat]. But if it was a normal day, I would turn off the air conditioning or use less, if it was about 79 degrees (26°C). But, if it was about 90 degrees (32°C), I would not pay any attention about saving energy, if I was close to dehydration at that point." A couple of girls also mentioned that they do need air conditioning because they have asthma.

Regarding saving water, the majority of students were willing to use less water when they bathe (21 out of 28 interviewed students). One Year 4 boy stated he was very much willing to take a short shower for a different reason: "Yes, very true because I hate taking showers. Whether it's a good shower or a bad shower, I hate taking showers. So that's not a fact of whether I want to save water or not, it's just that I hate taking showers". Two Year 5 boys, on the other hand, chose 'very false' because they love to take long showers to relax.

For the *Actual Commitments* towards the environment, the students were already implementing some actions to conserve the environment while there were other actions yet to employ. For example, many students (21 out of 28 interviewed students) responded that their families were already recycling. One Year 4 girl commented, "I don't really have to ask them [to recycle the things we use]. I mean my mom knows already what the [effects] are if you don't recycle and stuff. It's very bad for the trees and animals. I don't really ask her. But when my grandparents came from England (to visit us), they weren't recycling that much, so I asked them and I talked to them about it. So, yeah."

However, writing a letter to someone about a pollution problem was rare. Of the 28 students interviewed, 22 had not written to someone about a pollution problem. One Year 5 boy stated, "I don't write to those environmental people. They are the authorities; they should be writing to us." However, completing the survey prompted some students to start thinking about writing a letter. One Year 4 boy commented, "When I had answered this survey, I had not written to anyone about pollution. But this is a month later after the survey, and I have [written]. In my community there was a problem with dredging (the sand from under the

ocean) and the fish were killed. And I have written to an environmental land use attorney". This student took action since the survey was given a month ago.

For the *Feeling* toward the environment, the students made some interesting, elaborate comments. One of the question reads: I am frightened to think people don't care about the environment. Of the 28 students interviewed, 17 agreed with this statement. One student responded, "I'm not really frightened. As you said, I'm not jumping out of my seat. What I am scared about is that eventually, we are going to run out of fossil fuels and we are going to have to maybe use [our own body work] to make electricity, or maybe worse, maybe discard all electrical items and forget about using electricity. And that would not have been so hard if we had not adapted and depended on electricity for so long. That's what really scares me, but mostly I'm angry." This student was really worried about the future prospects of the environment in relation to the energy sources. One Year 5 boy stated, "It's their choice. Why should we choose for them?" This student considered the conservation and protection of environment as a matter of personal preference.

For another question, 'I get angry about the damage pollution does to the environment', Of the 28 students interviewed, 23 said they do get angry about the damage pollution does to the environment. One Year 4 girl stated, "Well, I stated 'very true', because when things damage the environment, it hurts me because sometimes it can hurt the animals, too, because people throw glass bottles on the ground, animals can step on it. Sometimes I cry because, I mean, I love animals and I don't want to see them get hurt. And when they pollute it hurts the plants." For a question regarding recycling, 'It makes me happy when people recycle used bottles, cans, and paper', 23 students said it did make them happy when people recycle. One Year 5 boy stated, "A lot of things we use are reused. This helps the environment." Another boy in Year 4 said he would be happy if a whole community recycled, not just one or two people. He said, "I stated 'very true' because it makes me really happy when people recycle because knowing the [effects] of when people don't recycle, those are really bad. And then in the future, if something bad happens to our world, as I said in previous questions, we'll be saying 'I should have recycled this and I should have recycled that.' Because people, like children, are the future. And when they don't recycle and stuff and they don't know anything about conserving water, or saving animals, that's really bad. So, I'm very happy when people recycle". This student was very vocal about his belief that people should plan for the future and protect the environment.

For *Knowledge scale* questions, it was obvious that some questions were too difficult for many students. For example, one question asks the effect of phosphates in sea water for fish. This question is significant because phosphates are used to fertilize crops in Florida and end up in the waterways and ocean. Five students chose (a) phosphates cause cancer in fish; six students selected (b) phosphates stop reproduction in fish; three students picked (c) phosphates make fish nervous; five students selected (d) phosphates make the water cloudy; and only nine students answered (e) phosphates suffocate fish by increasing algae. Related to the question above, when students were asked about the major pollutant of the water sources, 12 students answered correctly by chemical runoff from farms while eight students chose methane gas, five students selected human and animal wastes, and two students chose leaks in the sewers. A few weeks after the survey, Year 4 students learnt about water pollution in the area with an aerial map take with infrared cameras, they realised that the colour red on the map denoted the heat rising from the crops around Lake Okeechobee and that the fertilizers were a huge problem for the waterways. For some knowledge questions, the majority of students got the right answers. For example, out of the 28 students interviewed, 22 knew that burning of coal for energy releases carbon dioxide and

other pollutants into the air. Some students incorrectly chose the option of burning coal reduces the amount of ozone in the stratosphere. For recycling of paper, about half of the interviewed students got the correct answer of the recycled paper takes less energy to make. Some students chose the option of the recycled paper is less expensive to buy (eight students) or it produces more pollutants (five students).

Conclusions

Consistent Several findings have emerged from this study involving Years 4 and 5 students from a primary school in Florida. First, Year 4 students demonstrated a higher commitment towards the environment than Year 5 students in all Verbal, Actual, and Affective subscales. A possible reason could be that Florida history and ecology are emphasised in the curriculum for Year 4 when students are immersed in learning it for many months. However, one would expect students in Year 5, who have already learned about Florida, to have more knowledge, a better attitude and more commitment toward helping the environment than would younger students. It turned out that this was not the case in this study. The Year 5 students may be less interested in learning about the environmental issues and less committed to the environment conservation because they probably needed constant reminders in the school curriculum that the environment is fragile. This raises the important issue of having regular environmental education lessons at each year level; these lessons could be brought into many areas of the curriculum and in school-community contexts (Fazio & Karrow, 2013). Second, the gifted students displayed better environmental knowledge than their counter parts. The gifted students are more avid readers than the regular students and may acquire more knowledge through reading. They may also have extended dialogue about environmental issues with their parents. Florida studies including the history of the state and its geography are a part of the Year 4 curriculum, but it is possible to teach only historical and geographical issues in the regular classes without emphasis on environmental education. The approach to the subject matter may be the reason for the gifted students' higher knowledge and commitment. Finally, girls in both cohorts appeared to demonstrate greater concern for the environment.

For policy makers, this study has significance in that the research provides evidence of environmental knowledge, attitudes and actions of primary school students. The survey instrument, *CHEAKS* was validated and was reliable for primary students in Miami. As this study involved a school that scored higher than the average in the county academically, the environmental attitudes and knowledge of students were particularly significant. The *CHEAKS* instrument acted as a catalyst to motivate some students, teachers and parents to participate in civic action to solve environmental problems. Teachers may be keen on administering this survey to their students. Also, teachers may want to interview their own students to find out about their misconceptions regarding the environment.

Environmental education provides a good system for developing critical thinking skills and provides topics and problems that cut across the school curriculum. Environmental education can enhance the integration of knowledge presenting real problems that can be studied or simulated and provides topics and problems that can be adjusted to the developmental levels of students. Indeed, the recent International handbook of research on environment education (Stephenson et al., 2013) illustrates the many directions that research on environmental education can be used to inform the school-aged population as well as the general population.

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In the future, the written *CHEAKS* questionnaire may be translated into other languages or some pictures may be added to clarify the meaning before administering it to students who speak English as a second language. Research could also be conducted to investigate why students perceive certain issues as more serious than others. Younger students may be surveyed in the future to find out what aspects of the environmental education curriculum would be needed to address students' attitudes and knowledge at an earlier age. With regards to primary school teachers, further research would be beneficial to find out about the environmental education programs they have been trained in as well as about their environmental knowledge and attitudes. Further research following this study that includes a larger number of students, schools and districts is recommended.

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No potential conflict of interest was reported by the authors.

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Appendix A

Children's Environmental Attitude and Knowledge Scale (CHEAKS)

Please circle what you would really do. (Verbal Commitment)

1. I would be willing to stop buying some products to save animal's lives.

a. very true b. mostly true c. not sure d. mostly false f. very false 2.

I would not be willing to save energy by using less air conditioning.

a. very true b. mostly true c. not sure d. mostly false e. very false 3.

To save water, I would be willing to use less water when I bathe.

a. very true b. mostly true c. not sure d. mostly false e very false

4. I would not give $15 of my own money to help the environment.

a. very true b. mostly true c. not sure d. mostly false e. very false

5. I would be willing to ride the bus to more places in order to reduce air pollution.

a. very true b. mostly true c. not sure d. mostly false e. very false 6.

I would not be willing to separate my family's trash for recycling.

a. very true b. mostly true c. not sure d. mostly false e. very false

7. I would give $15 of my own money to help protect wild animals.

a. very true b. mostly true c. not sure d. mostly false e. very false

8. To save energy, I would be willing to use dimmer (less bright) light bulbs.

a. very true b. mostly true c. not sure d. mostly false e. very false

9. To save water, I would be willing to turnoff the water while I wash my hands

a. very true b. mostly true c. not sure d. mostly false e. very false

10. I would go from house to house to pass out environmental information.

a. very true b. mostly true c. not sure d. mostly false e. very false

11. I would be willing to write letters asking people to reduce pollution.

a. very true b. mostly true c. not sure d. mostly false e. very false

12. I would be willing to go from house to house asking people to recycle.

a. very true b. mostly true c. not sure d. mostly false e. very false

Please circle what you really do. (Actual Commitment)

13. I have not written someone about a pollution problem.

a. very true b. mostly true c. not sure d. mostly false e. very false

14. I have talked with my parents about how to help with environmental problems.

a. very true b. mostly true c. not sure d. mostly false e. very false

15. I turn off the water in the sink while I brush my teeth to conserve water.

a. very true b. mostly true c. not sure d. mostly false e. very false

16. To save energy, I turn off lights at home when they are not in use.

a. very true b. mostly true c. not sure d. mostly false e. very false 17.

I have asked my parents not to buy products made from animal fur. a. very true b. mostly true c. not sure d. mostly false e. very false

18. I have asked my family to recycle some of the things we use.

a. very true b. mostly true c. not sure d. mostly false e. very false

19. I have asked others what I can do to help reduce pollution.

a. very true b. mostly true c. not sure d. mostly false e. very false 20.

I often read stories that are mostly about the environment

a. very true b. mostly true c. not sure d. mostly false e. very false

21. I do not let a water faucet run when it is not necessary.

a. very true b. mostly true c. not sure d. mostly false e. very false 22.

⊙⊙   I leave the refrigerator door open while I decide what to get out.

   a. very true b. mostly true c. not sure d. mostly false e. very false

23. I have put up a birdhouse near my home.

a. very true b. mostly true c. not sure d. mostly false e. very false

24. I do not separate things at home for recycling.

a. very true b. mostly true c. not sure d. mostly false e. very false

Please circle how you really feel (Affect).

25. I am frightened to think people don't care about the environment.

a. very true b. mostly true c. not sure d. mostly false e. very false 26.

I get angry about the damage pollution does to the environment.

a. very true b. mostly true c. not sure d. mostly false e. very false

27. It makes me happy when people recycle used bottles, cans, and paper.

a. very true b. mostly true c. not sure d. mostly false e. very false

28. I get angry when I think about companies testing products on animals.

a. very true b. mostly true c. not sure d. mostly false e. very false

29. It makes me happy to see people trying to save energy.

a. very true b. mostly true c. not sure d. mostly false e. very false

30. I am not worried about running out of water.

a. very true b. mostly true c. not sure d. mostly false e. very false

31. I do not worry about environmental problems.

a. very true b. mostly true c. not sure d. mostly false e. very false

32. I am not frightened about the effects of pollution on my family.

a. very true b. mostly true c. not sure d. mostly false e. very false

33. I get upset when I think of the things people throw away that could be
     recycled.

        a. very true b. mostly true c. not sure d. mostly false e. very false

34. It makes me sad to see houses being built where animals used to live.

a. very true b. mostly true c. not sure d. mostly false e. very false

35. It frightens me to think how much energy is wasted.

    a. very true b. mostly true c. not sure d. mostly false e. very false

36. It upsets me when I see people use too much water.

a. very true b. mostly true c. not sure d. mostly false e. very false

Please circle what you think. (Knowledge)

37. Most elephants are killed every year to provide people with:

a. trophies.

b. ivory.

c. meat.

d. oil.

e. skin.

38. Burning coal for energy is a problem because it:

a. releases carbon dioxide and other pollutants into the air.

b. decreases needed acid rain.

c. reduces the amount of ozone in the stratosphere.

d. is too expensive.

e. pollutes the water in aquifers.

39. Ecology assumes that man is what part of nature?

a. special

b. related to all other parts

c. not important

d. the best part

e. the first part

40. Phosphates are harmful in sea water because they:

a. cause cancer in fish.

b. stop reproduction in fish.

c. make fish nervous.

d. make the water cloudy.

e. suffocate fish by increasing algae.

41. Compared to other paper, recycled paper:

a. takes more water to make.

b. takes less energy to make.

c. is less expensive to buy.

d. is harder to write on.

e. produces more pollutants.

42. The most pollution of our water sources is caused by:

a. dams on rivers.

b. chemical runoff from farms.

c. methane gas.

d. leaks in the sewers.

e. human and animal wastes.

43. Ecology is the study of the relationship between

a. different species of animals.

b. plants and the atmosphere.

c. organisms and their environments.

d. man and other animals.

e. man and the environment.

44. The most common poisons found in water are:

a. arsenic, silver nitrates.

b. hydrocarbons.

c. carbon monoxide.

d. sulfur, calcium.

e. nitrates, phosphates.

45. Where does most of the garbage go after it is dumped from the garbage trucks?

a. to an aquifer where it is buried

b. into an ocean

c. recycled to make plastic

d. to a landfill where it is buried

e. to farmers to use as fertilizer

46. Which is most responsible for creating acid rain?

a. sulfur dioxide

b.   carbon dioxide

c. ozone

d. nitrogen

e. ultraviolet radiation

47. Catching tuna in the ocean:

a. is eliminating a main food source for whales.

b. protects baby sea turtles.

c. also kills many dolphins.

d. is now against the law.

e. is necessary to keep the population size down.

48. Which is an example of a perpetual energy source?

a. nuclear

b. oil

c. wood

d. uranium

e. solar

49. Which of the following is the most dangerous to the earth's environment?

a. damming rivers

b. overpopulation

c. tornadoes

d. household pets

e. nuclear power plants

50. Most of the lead in our air is caused by:

a. cars.

b. industrial plants.

c. airplanes.

d. burning refuse.

e. cigarettes.

51. Precyling means that:

a, people buy things that can be used again. b. more people should ride bicycles. c, small children should wear the clothes of their older brothers or sisters. d. items should be tested before we buy them.

e. environmental changes are always taking place.

52. Animals alive today are most likely to become extinct because:

a. natural selection kills weaker animals.

b. where they live is getting too warm.

c. they are unable to reproduce because of pollution.

d. the habitat where they live is destroyed.

e. their food supply is destroyed by acid rain.

53. Coal and petroleum are examples of:

a. fossil fuels.

b. renewable sources of energy.

c. energy sources that are plentiful.

d. alternative sources of energy.

e. recycled resources.

54. Environmental problems are a threat to:

a. mostly people in small countries.

b. only people who live in cities.

c. only wild animals and endangered species.

d. mostly tropical plants and animals.

e. all living things in the world.

55. Which of the following does **not** do much to reduce the pollution by
   automobiles?

a. properly tuned engine

b. high octane gas

c. low lead gas

d. smog control devices

e. propane engines

56. The main problem with landfills is that they:

a. take up too much space.

b. are ugly to look at and smell bad.

c. attract rats and other pests.

d. prevent farming of nearby land.

e. do not produce enough methane.

57. Building a dam on a river can be harmful because it:

a. makes the river muddy.

b. can no longer be used to make electricity.

c. increases level of pollution on the water.

d. causes the river to flood.

e. damages the river's natural ecosystem 58. Where is water under the ground
   found?

a. in landfills.

b. in ponds.

c. in low pressure areas.

d. in aquifers.

e. in rivers.

59. Killing animals like wolves that eat others:

a. is necessary and should be done.

b. may increase the number of other animals.

c. does not affect other animals in the area.

d. may decrease the number of other animals.

e. will help protect the environment.

60. An example of a non-renewable resource is:

a. petroleum.

b. trees.

c. ocean water.

d. sunlight.

e. animals raised for food.

61. Most air pollution in our big cities comes from:

    a.   cars.

b. jet planes.

c. factories

d. big trucks

e. landfills

62. An item which **cannot** be recycled and used again is:

a. disposable diapers.

b. newspapers

c. aluminum cans

d. motor oil

e. plastic bottles

63. What is the main problem with the use of aquifers for a water supply?

a. They recharge too quickly.

b. They are becoming used up.

c. They contain too much fresh water.

d. They contain too much salt water.

e. It is hard to get the water out.

64. A species that no longer exists is:

a. protected.

b. endangered.

c. abundant.

d. extinct.

e. wild game.

65. Which uses the most energy in an average house in the United States? a. lights.

b. TV.

c. hot water heater.

d. telephone.

e. refrigerator.

66. Which of the following groups is most interested in environmental issues?

a. Boy Scouts of America

b. The Sierra Club

c. Kiwanis

d. 4-H Club

e. The American Cancer Society

67. I have never taken a written environmental survey before.

a. true

b. false

68. I would like to learn more about the environment and how to protect our Planet Earth.

a. true

b. false