Evaluating the environmental literacy of undergraduate students at the University of Otago: guidelines for departments

Introduction

In 2011 the University of Otago introduced environmental literacy (EL) to its list of graduate attributes (see page 2 of the University of Otago Teaching and Learning Action Plan http://www.otago.ac.nz/staff/otago027123.pdf). The University anticipates that its teachers, programmes, and departments will encourage students to develop environmental literacy during their Otago higher education. In response to this new graduate attribute, a group of research active academic staff from several departments (informally identified as the Education for Sustainability Research Group) received a 2012 CALT (Committee for the advancement of learning and teaching) research grant to produce an evaluative tool that would enable departments to routinely evaluate the environmental literacy of their students, in a similar way to that used to evaluate the quality of teaching. If environmental literacy is to be fostered within the university, departments need to have some means of monitoring its occurrence and development.

Environmental Literacy Evaluation Instrument (ELEI)

The ELEI (Environmental Literacy Evaluation Instrument) developed by the Otago team of researchers, was designed to include the EL domains outlined in a report *Developing a Framework for Assessing Environmental Literacy* published by the North American Association of Environmental Education (NAAEE) (Hollweg et al., 2011). This report is a comprehensive, research-based description of environmental literacy as well as a framework for assessing environmental literacy. The *Framework* intends to promote consistency within and across assessments in order to gather evidence and develop understandings regarding environmental literacy across countries, and among learners of different ages within countries (Hollweg et al., 2011).[It should be noted that Assessment in the USA often refers to processes more usually described as Evaluation in Australasia].

The ELEI contains four sections designed to record demographic information and to evaluate knowledge, dispositions (affect) and competency as described in the Framework:

Section A: Includes a set of demographic questions (age, gender, programme of study, ethnicity). Respondents are asked to record a seven-digit code made up of indicated letters from their name and combinations of numbers from their birth date. The code is designed so that students can recalculate it again in the future (with no recourse to memory) but without researchers being able to identify them through it. This information can be used by departments who may wish to use the ELEI to explore individual (but anonymous) changes.

Section B: Includes the 15 item Revised New Environmental Paradigm (NEP) used to address EL *dispositions* and records ecological worldview, environmental attitude, or environmental concern. Dispositions are thought to be important determinants of behaviours related to the environment and influence value perspectives as well as motivation to participate in public debate about environmental issues.

Section C: Includes a 10 item multiple-choice knowledge test designed to address a wide range of facets of EL knowledge identified by the NAAEE (e.g. physical and ecological systems, environmental issues, citizen participation and action strategies, etc.). The test incorporated inclusion by students of the confidence they have in their knowledge and analysis included certainty-based marking.

Section D: This section addresses the environmental competency of respondents. In its current form it includes a single scenario (i.e. fracking in New Zealand) and respondents must answer two multiple-choice items related to two of four competencies identified in the Framework. Competencies are a cluster of skills and abilities (i.e. Identify environmental issues, Ask relevant questions, Analyse environmental issues, Investigate environmental issues, Evaluate and make personal judgments about environmental issues, Use evidence and knowledge to defend positions and resolve issues, and Create and evaluate plans to resolve environmental issues) which are influenced by knowledge and dispositions.

The ELEI is designed to be used in paper form within classes (where a substantial proportion of each department students are available), to take no longer than 20 min to complete (so that its use does not greatly disrupt a timetabled series of lectures within a course) and to be sufficiently variable so as to be reusable with the same students as they experience a degree course over several years.

There are currently 4 versions of the ELEI and each incorporates one competency in common (i.e. ability to identify environmental issues), and one that is different. Use of these four versions randomly within a cohort will address 5 competencies (Ability to identify environmental issues, Ask relevant questions, Analyse environmental issues, Investigate environmental issues and Create and evaluate plans to resolve environmental issues). The NAAEE Framework identifies seven competencies, but only five are addressed in the ELEI. Two additional competencies (Evaluate and make personal judgments about environmental issues, Use evidence and knowledge to defend positions and resolve issues) proved too complex to incorporate in our pilot research project, but are included in an untested version in Appendix 2.

Synopsis of results from the pilot use of the ELEI in 2012

The ELEI was used with more than 600 students in papers from more than 8 departments during 2012. We identified substantial and statistically significant differences between disciplines in environmental attitude (as indicated by mean in NEP scores, section B of the ELEI), environmental knowledge (section C) and some differences in measured competency (section D). They were no clear differences in these parameters in relation to year of study or gender, but interestingly certainty-based marking suggested that female students have less confidence in their environmental knowledge than do male students. A bibliography of research outputs from this research group is included in Appendix 3.

Processes for departmental adoption of the ELEI

The Education for Sustainability Research Group encourages all departments to consider how they may foster the environmental literacy of their students and to consider if the ELEI is a suitable tool to support monitoring of this process. Departments may like to identify a paper in each year of study where the ELEI could be administered and the process whereby the data could be collected and analysed.

- Departments could elect to undertake independently all of the processes required to administer the ELEI and collate its results. We hope that this report will be helpful. Advice and instructions for administration of the ELEI are provided in Appendix 4.
- Our CALT funded project has resulted in some expertise and resources that may be of assistance to individual departments. The software Remark is available, by negotiation, within the Department of Mathematics and Statistics, for departments to use to read the ELEI. Lynley Deaker (Assistant Research Fellow in HEDC, lynley.deaker@otago.ac.nz) is able to offer some assistance in this process.

- If many departments wish to routinely evaluate the extent to which students acquire environmental literacy, and other Otago graduate attributes, some more centrally coordinated service would be necessary. The instrumentation, software and approaches used by the ELEI are, by design, very similar to those used by HEDC to support collection of student feedback on papers and on teaching. Evaluating the quality of our teaching has much in common with evaluating the extent to which Otago's graduates acquire graduate attributes.

Customize the ELEI to Department or Discipline

Departments are encouraged to adapt the ELEI to their discipline. For example, departments may want to develop a scenario for Section D that is discipline specific (see Appendix 2 for an example of an Ecotourism competency). The competency section was the most challenging section to develop for our research group. For this reason only 4 of the 7 competencies identified in the NAAEE framework are addressed in the pilot ELEI. Our research group strongly encourages the development of new versions of the ELEI that are optically readable by Remark, and adequately tested for reliability.

Evaluation of Affective Graduate Attributes

Otago graduate attributes that have significant affective elements include appreciating global perspectives and cultural understanding. In general, these qualities are not assessable by conventional processes. The most suitable method to evaluate how a department's students are progressing toward attainment of a graduate attribute with significant affective elements is through a cohort approach. A cohort-based evaluation allows a department to see how widespread the attribute is held by its students, as well as determine if there is general improvement in the attribute over time, without putting individual students in a position where they may feel that they are obliged to show a 'correct value or attitude'. Anonymity is vital if we are to reasonably interpret the data that students provide.

Kerry Shephard[1], John Harraway[2], Brent Lovelock[3], Sheila Skeaff[4], Liz Slooten[5], Mick Strack[6], Mary Furnari[1] and Tim Jowett[1,2]

[1]Higher Education Development Centre, HEDC; [2]Department of Mathematics &Statistics; [3]Department of Tourism; [4]Department of Zoology; [5]Department of Human Nutrition; [6]School of Surveying; all at University of Otago, Dunedin, New Zealand

Acknowledgements

The research group would like to acknowledge the help of over 600 anonymous students, numerous university teachers, several heads of academic departments and colleagues from around the University (including Gillian Elliot, representing the University's Environmental Studies Working Group and Hilary Phipps, University Sustainability Coordinator) for their efforts in helping to develop and to pilot the ELEI. We would also like to acknowledge the developers of the NAAEE Framework for Assessing Environmental Literacy, who provided invaluable advice and feedback during the development of the ELEI. We especially wish to thank William McBeth and Trudi Volk for their detailed description of their process used to develop and validate competency items. We would also like to thank Nicole Kibert for her generosity in allowing us to draw items from her master's thesis.

References

Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy*. Washington, DC: North American Association for Environmental Education. Available at http://www.naaee.net.

Appendices

Appendix 1 The four versions of the pilot ELEI
Appendix 2 Section D Alternative but untested competency example
Appendix 3 A bibliography of recent related research outputs from the Education for Sustainability Research Group
Appendix 4 Advice and instructions for administration of the ELEI

Appendix 1 The four versions of the pilot ELEI

Environmental Literacy: Research at the University of Otago #1

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ID CODE

Please fill in like this →

Not ✓ or ✗

A	A	A	0	0	0	0
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C	C	C	2	2	2	2
D	D	D	3	3	3	3
E	E	E	4	4	4	4
F	F	F	5	5	5	5
G	G	G	6	6	6	6
H	H	H	7	7	7	7
I	I	I	8	8	8	8
J	J	J	9	9	9	9
K	K	K				
L	L	L				
M	M	M				
N	N	N				
O	O	O				
P	P	P				
Q	Q	Q				
R	R	R				
S	S	S				
T	T	T				
U	U	U				
V	V	V				
W	W	W				
X	X	X				
Y	Y	Y				
Z	Z	Z				

SECTION A: About Yourself…

What is your current programme of study and major subject(s)?

How many years (including this one) have you studied at university?

1 ○ 2 ○ 3 ○ 4 ○ 5+ ○

Age: ☐ Gender: Female ○ Male ○

Which ethnic group do you belong to? Mark the space or spaces that apply to you?

- ○ NZ European
- ○ Maori
- ○ Pacific Islander
- ○ Chinese
- ○ Indian
- ○ Other: ☐

Exploring the environmental literacy of Otago's students: information for participants

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SECTION B

Please indicate the extent to which you agree or disagree with the following statements:	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
B.1) We are approaching the limit of the number of people the earth can support.	○	○	○	○	○
B.2) Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○
B.3) When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○
B.4) Human ingenuity will ensure that we do NOT make the earth unliveable.	○	○	○	○	○
B.5) Humans are severely abusing the environment.	○	○	○	○	○
B.6) The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○
B.7) Plants and animals have as much right as humans to exist.	○	○	○	○	○
B.8) The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○
B.9) Despite their special abilities humans are still subject to the laws of nature.	○	○	○	○	○
B.10) The so called "ecological crisis" facing humankind has been greatly exaggerated.	○	○	○	○	○
B.11) The earth is like a spaceship with very limited room and resources.	○	○	○	○	○
B.12) Humans were meant to rule over the rest of nature.	○	○	○	○	○
B.13) The balance of nature is very delicate and easily upset.	○	○	○	○	○
B.14) Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○
B.15) If things continue on their present course we will soon experience a major ecological catastrophe.	○	○	○	○	○

SECTION C

Please answer each of the questions below by <u>filling in only ONE of the open circles to the right of the question</u> <u>AND</u> <u>indicate how confident you are that your answer is correct by filling in one of the certainty level circles.</u> Certainty levels 1, 2, 3 gain marks of 1, 2, or 3 if the answer is correct; but if the answer is incorrect, marks may be lost (Certainty level 3, 6 marks lost; Certainty level 2, 2 marks lost; Certainty level 1, 0 marks lost).

		Certainty in your selected answer:		
		Low(1)	Mid(2)	High(3)
Some insecticides that were once effective in killing insects no longer work very well. This is because…	○ New insect species develop every day ○ The wrong kind of insecticides were used ○ Insects with natural resistance survived and multiplied ○ The insects produced many more offspring than the insecticides could kill	○	○	○
The rate of species' extinction is higher now than at any time since the period of the dinosaur extinction. The main cause of this rapid decline in biodiversity is:	○ Habitat alteration by humans ○ The illegal poaching or collecting of animals and plants. ○ Changes in the earths atmosphere due to human activities. ○ Hunting by humans for food or sport.	○	○	○
Which of the following factors contributes least to desertification in global terms?	○ Overpopulation ○ Deforestation ○ Overgrazing ○ Open-pit mining	○	○	○
There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea? Is it…	○ Genetics ○ Populations ○ Evolution ○ Biodiversity	○	○	○
Fishermen buy and trade in quotas to catch fish. This system is designed to:	○ Maximise the number of fish caught ○ Minimise the number of fish caught ○ Regulate the number of fish caught ○ Ensure that everyone catches the same amount of fish	○	○	○
Local groups often gather together to plant trees. What is their primary reason for doing this?	○ Community support ○ Habitat reinstatement ○ Eco tourism ○ Environmental activism	○	○	○
Which of the following modes of transport would be a viable way to minimise the carbon footprint of NZ food exports?	○ Bulk transport by cargo ships out of local ports ○ Bulk Air transport ○ Every airline passenger carries a quota of food exports ○ Truck to Auckland then bulk transport by cargo ships out of Port Auckland	○	○	○
How is most of the electricity in NZ generated?	○ Burning oil, coal and wood ○ Wind power ○ Solar energy ○ Hydro generated electricity	○	○	○
Which of the following energy sources contributes the least to global warming?	○ Wood ○ Natural gas ○ Oil ○ Coal	○	○	○
Which of the following options is the best way to prevent the extinction of endangered species?	○ Outlaw the sale or possession of endangered species ○ Create breeding programs in zoos for endangered animals ○ Use environmentally friendly farming methods ○ Maintain large protected natural areas where they can live	○	○	○

SECTION D

D.1) Below you will see a short passage giving you information about an environmental issue. After you have read the passage, please select the statement that you believe best identifies the environmental issue described in this passage.

Hydraulic Fracturing, also known as fracking, is a method of extracting oil and gas from rock strata by injecting a water, sand and chemical mix at high pressure into rock to force it to fracture slightly and facilitate the release of oil and gas which is extracted.

Some environmental risks include contamination of sub-surface aquifers that supply water for domestic and agricultural use, pressure leaks of the chemical mix up to the surface of the land, managing the disposal of well residues, and restoration of well site surface land. Fracking also releases other toxic chemicals from sub-surface layers that have the potential to severely contaminate surface land, air and water.

A well recognised resource management and sustainability principle is the Precautionary Principle, which states that if there is uncertainty about the effects of any activity, we should err on the side of caution. Opponents say that the risks are too uncertain and too high, and that the marginal economic benefit of extracting this oil is not worth the environmental costs.

Industry advocates claim that this technology has been used for at least 50 years and the environmental effects and even risks are minimal, and can be readily managed. Furthermore, advocates point to the necessary continued production and consumption of oil, and suggest that fracking in New Zealand will enhance our self reliance on energy, and contribute to the economic growth and wellbeing of our economy.

Which of four statements (below) best identifies the environmental issue discussed in the paragraphs above?

- ○ Fracking should be allowed in New Zealand to help ensure energy independence.
- ○ Fracking threatens New Zealand's clean and green image.
- ○ Fracking to extract oil and gas has the potential to contaminate air, land and water.
- ○ Fracking should be banned because it may cause earthquakes.

D.2) Assume that you are opposed to fracking for energy production and you know others who feel the same—basically you do not want fracking in New Zealand.

Below you will find (6) strategies. These action strategies are ones that might be used to prevent fracking in New Zealand. You are to <u>select only two of them</u> .

Your task is to carefully read through each strategy, and then select what you believe are <u>the two (2) most effective strategies from the six strategies</u> listed below.

- ○ Write to your local MP to propose legislation to oppose fracking In New Zealand.
- ○ Organize a regional group of citizens who want to increase awareness about the environmental risks of fracking. Then ask for a meeting with the Otago Regional Council to lobby against fracking.
- ○ Organize a local group of citizens opposed to fracking and connect up with other NZ environmental groups, like Forest & Bird. This 'multi-group approach' could influence the central government to oppose fracking in New Zealand.
- ○ Circulate a petition to propose a referendum opposing fracking new sites in New Zealand.
- ○ Write letters to the editor of the Otago Daily Times opposing fracking in New Zealand because it threatens New Zealand's clean and green image and tourism.
- ○ Organize a local group to pass out leaflets at Saturday Market to inform the public about the environmental and health risks of fracking in New Zealand.

Thank you for participating in this Survey

Environmental Literacy: Research at the University of Otago #2

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J	J	J	9	9	9	9
K	K	K				
L	L	L				
M	M	M				
N	N	N				
O	O	O				
P	P	P				
Q	Q	Q				
R	R	R				
S	S	S				
T	T	T				
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		Certainty in your selected answer:
The process of photosynthesis in green plants…	○ Uses sunlight to burn energy in plants ○ Changes light energy into chemical energy ○ Changes chlorophyll into sugar ○ Is a process used to burn sugar in plants	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following countries was listed as having the highest per capita carbon dioxide emission in 2008?	○ Taiwan ○ United states of America ○ Australia ○ New Zealand	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following contributes to air pollution and acts as a shield against ultraviolet rays in the upper atmosphere?	○ Nitrous oxide ○ Methane ○ Ozone ○ Sulphur dioxide	Low(1) Mid(2) High(3) ○ ○ ○
There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea? Is it…	○ Genetics ○ Populations ○ Evolution ○ Biodiversity	Low(1) Mid(2) High(3) ○ ○ ○
Biofuels can come from which source(s):	○ Palm oil ○ Alcohol ○ Used fryer grease ○ All of the above	Low(1) Mid(2) High(3) ○ ○ ○
Local groups often gather together to plant trees. What is their primary reason for doing this?	○ Community support ○ Habitat reinstatement ○ Eco tourism ○ Environmental activism	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following modes of transport would be a viable way to minimise the carbon footprint of NZ food exports?	○ Bulk transport by cargo ships out of local ports ○ Bulk Air transport ○ Every airline passenger carries a quota of food exports ○ Truck to Auckland then bulk transport by cargo ships out of Port Auckland	Low(1) Mid(2) High(3) ○ ○ ○
How is most of the electricity in NZ generated?	○ Burning oil, coal and wood ○ Wind power ○ Solar energy ○ Hydro generated electricity	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following energy sources contributes the least to global warming?	○ Wood ○ Natural gas ○ Oil ○ Coal	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?	○ Carrying capacity ○ Species loading ○ Non-sustainable growth ○ Ecological footprint	Low(1) Mid(2) High(3) ○ ○ ○

SECTION D

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Industry advocates claim that this technology has been used for at least 50 years and the environmental effects and even risks are minimal, and can be readily managed. Furthermore, advocates point to the necessary continued production and consumption of oil, and suggest that fracking in New Zealand will enhance our self reliance on energy, and contribute to the economic growth and wellbeing of our economy.

Which of four statements (below) best identifies the environmental issue discussed in the paragraphs above?

- ○ Fracking should be allowed in New Zealand to help ensure energy independence.
- ○ Fracking threatens New Zealand's clean and green image.
- ○ Fracking to extract oil and gas has the potential to contaminate air, land and water.
- ○ Fracking should be banned because it may cause earthquakes.

D.2) Assume that you are unsure about the benefits and risks of fracking in New Zealand.

Below are (5) statements which describe strategies to investigate the question of fracking in order to determine how best to resolve this environmental issue.

Your task is to read carefully through each of the 5 statements below and then select what you believe are the <u>(2) best ways to investigate the issue of fracking</u> .

- ○ Government should consult with environmental groups about the environmental and health-related risks of fracking in New Zealand.
- ○ Government should commission a task force made up of representatives from the main political parties, industry experts, and conservationists to report on the long-term economic and environmental impact of fracking.
- ○ Geologists should be employed by government to investigate the impact of existing fracking sites on earthquake activity in New Zealand.
- ○ Government should commission a panel of experts (i.e. environmental engineers, conservationists, and industry representatives) to report on the economic impact of fracking, both positive and negative.
- ○ Government should commission a report on the environmental impact of fracking in New Zealand for the last 25 years.

Thank you for participating in this Survey

Environmental Literacy: Research at the University of Otago #3

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ID Code example for Fred Smith born 23/2/1985: F**R**ed S**M**it**H** gives**:** RMH for the three letter code**.** 23 + 2 + 1985 = 2010 for the four digit number. The example ID Code will be: RMH2010.

ID CODE

Please fill in like this →

Not ✓ or ✗

A	A	A	0	0	0	0
B	B	B	1	1	1	1
C	C	C	2	2	2	2
D	D	D	3	3	3	3
E	E	E	4	4	4	4
F	F	F	5	5	5	5
G	G	G	6	6	6	6
H	H	H	7	7	7	7
I	I	I	8	8	8	8
J	J	J	9	9	9	9
K	K	K				
L	L	L				
M	M	M				
N	N	N				
O	O	O				
P	P	P				
Q	Q	Q				
R	R	R				
S	S	S				
T	T	T				
U	U	U				
V	V	V				
W	W	W				
X	X	X				
Y	Y	Y				
Z	Z	Z				

SECTION A: About Yourself…

What is your current programme of study and major subject(s)?

How many years (including this one) have you studied at university?

1 ○ 2 ○ 3 ○ 4 ○ 5+ ○

Age: ☐ Gender: Female ○ Male ○

Which ethnic group do you belong to? Mark the space or spaces that apply to you?

- ○ NZ European
- ○ Maori
- ○ Pacific Islander
- ○ Chinese
- ○ Indian
- ○ Other: ☐

Exploring the environmental literacy of Otago's students: information for participants

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SECTION B

Please indicate the extent to which you agree or disagree with the following statements:	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
B.1) We are approaching the limit of the number of people the earth can support.	○	○	○	○	○
B.2) Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○
B.3) When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○
B.4) Human ingenuity will ensure that we do NOT make the earth unliveable.	○	○	○	○	○
B.5) Humans are severely abusing the environment.	○	○	○	○	○
B.6) The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○
B.7) Plants and animals have as much right as humans to exist.	○	○	○	○	○
B.8) The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○
B.9) Despite their special abilities humans are still subject to the laws of nature.	○	○	○	○	○
B.10) The so called "ecological crisis" facing humankind has been greatly exaggerated.	○	○	○	○	○
B.11) The earth is like a spaceship with very limited room and resources.	○	○	○	○	○
B.12) Humans were meant to rule over the rest of nature.	○	○	○	○	○
B.13) The balance of nature is very delicate and easily upset.	○	○	○	○	○
B.14) Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○
B.15) If things continue on their present course we will soon experience a major ecological catastrophe.	○	○	○	○	○

SECTION C

Please answer each of the questions below by <u>filling in only ONE of the open circles to the right of the question</u> <u>AND</u> <u>indicate how confident you are that your answer is correct by filling in one of the certainty level circles.</u> Certainty levels 1, 2, 3 gain marks of 1, 2, or 3 if the answer is correct; but if the answer is incorrect, marks may be lost (Certainty level 3, 6 marks lost; Certainty level 2, 2 marks lost; Certainty level 1, 0 marks lost).

		Certainty in your selected answer:
In recent years the honey bee population has decreased massively (about 30-50%) in most parts of the world. Which one of the following has been identified by scientists as a major contributing factor for this	○ Parasites nesting in beehives ○ Selective breeding ○ Genetic mutation ○ Global warming	Low(1) Mid(2) High(3) ○ ○ ○
Hydroelectric energy is said to be renewable, what exactly is renewable about it?	○ Stream beds are rejuvenated ○ Energy is supplied without further habitat destruction ○ River ecology can not be further damaged by humans ○ Fish populations renew themselves	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following items of household rubbish is not collected for recycling in Dunedin?	○ Glass ○ Metal cans ○ Polystyrene ○ Plastic shopping bags	Low(1) Mid(2) High(3) ○ ○ ○
There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea? Is it…	○ Genetics ○ Populations ○ Evolution ○ Biodiversity	Low(1) Mid(2) High(3) ○ ○ ○
Proper disposal of hazardous toxic waste is essential as exposure to it can cause serious problems for human health. Which is potentially the safest means of disposing of the most hazardous toxic wastes?	○ Municipal incineration ○ Industrial high temperature incineration ○ Landfills ○ Chemical treatment	Low(1) Mid(2) High(3) ○ ○ ○
Local groups often gather together to plant trees. What is their primary reason for doing this?	○ Community support ○ Habitat reinstatement ○ Eco tourism ○ Environmental activism	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following modes of transport would be a viable way to minimise the carbon footprint of NZ food exports?	○ Bulk transport by cargo ships out of local ports ○ Bulk Air transport ○ Every airline passenger carries a quota of food exports ○ Truck to Auckland then bulk transport by cargo ships out of Port Auckland	Low(1) Mid(2) High(3) ○ ○ ○
How is most of the electricity in NZ generated?	○ Burning oil, coal and wood ○ Wind power ○ Solar energy ○ Hydro generated electricity	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following energy sources contributes the least to global warming?	○ Wood ○ Natural gas ○ Oil ○ Coal	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following is currently losing the most ice through melting every year?	○ The Greenland Ice Sheet ○ The Antarctic Ice Sheet ○ The sum of Northern Hemisphere glaciers ○ The sum of Southern Hemisphere glaciers	Low(1) Mid(2) High(3) ○ ○ ○

SECTION D

D.1) Below you will see a short passage giving you information about an environmental issue. After you have read the passage, please select the statement that you believe best identifies the environmental issue described in this passage.

Hydraulic Fracturing, also known as fracking, is a method of extracting oil and gas from rock strata by injecting a water, sand and chemical mix at high pressure into rock to force it to fracture slightly and facilitate the release of oil and gas which is extracted.

Some environmental risks include contamination of sub-surface aquifers that supply water for domestic and agricultural use, pressure leaks of the chemical mix up to the surface of the land, managing the disposal of well residues, and restoration of well site surface land. Fracking also releases other toxic chemicals from sub-surface layers that have the potential to severely contaminate surface land, air and water.

A well recognised resource management and sustainability principle is the Precautionary Principle, which states that if there is uncertainty about the effects of any activity, we should err on the side of caution. Opponents say that the risks are too uncertain and too high, and that the marginal economic benefit of extracting this oil is not worth the environmental costs.

Industry advocates claim that this technology has been used for at least 50 years and the environmental effects and even risks are minimal, and can be readily managed. Furthermore, advocates point to the necessary continued production and consumption of oil, and suggest that fracking in New Zealand will enhance our self reliance on energy, and contribute to the economic growth and wellbeing of our economy.

Which of four statements (below) best identifies the environmental issue discussed in the paragraphs above?

- ○ Fracking should be allowed in New Zealand to help ensure energy independence.
- ○ Fracking threatens New Zealand's clean and green image.
- ○ Fracking to extract oil and gas has the potential to contaminate air, land and water.
- ○ Fracking should be banned because it may cause earthquakes.

D.2) Consider that you personally need to make a decision about this issue in the future. What additional information do you think is of greatest importance to help you to come to a good decision.

Below you will find (5) questions about the issue of fracking. Your task is to read carefully through each question, and then select what you believe are the <u>(2) best questions to ask about the issue of fracking</u> from all the examples listed below.

- ○ Using data from NZ and from overseas, how do the economic advantages compare with the costs to mitigate the environmental damage from fracking?
- ○ How will river fishing be affected by fracking in New Zealand?
- ○ What are the potential health-related costs associated with fracking?
- ○ How might we go about finding an appropriate balance between environmental risk and economic benefit?
- ○ What animal species are threatened by fracking?

Thank you for participating in this Survey

Environmental Literacy: Research at the University of Otago #4

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ID Code example for Fred Smith born 23/2/1985: F**R**ed S**M**it**H** gives**:** RMH for the three letter code**.** 23 + 2 + 1985 = 2010 for the four digit number. The example ID Code will be: RMH2010.

ID CODE

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Not ✓ or ✗

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G	G	G	6	6	6	6
H	H	H	7	7	7	7
I	I	I	8	8	8	8
J	J	J	9	9	9	9
K	K	K				
L	L	L				
M	M	M				
N	N	N				
O	O	O				
P	P	P				
Q	Q	Q				
R	R	R				
S	S	S				
T	T	T				
U	U	U				
V	V	V				
W	W	W				
X	X	X				
Y	Y	Y				
Z	Z	Z				

SECTION A: About Yourself…

What is your current programme of study and major subject(s)?

How many years (including this one) have you studied at university?

1 ○ 2 ○ 3 ○ 4 ○ 5+ ○

Age: ☐ Gender: Female ○ Male ○

Which ethnic group do you belong to? Mark the space or spaces that apply to you?

- ○ NZ European
- ○ Maori
- ○ Pacific Islander
- ○ Chinese
- ○ Indian
- ○ Other: ☐

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SECTION B

Please indicate the extent to which you agree or disagree with the following statements:	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
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B.2) Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○
B.3) When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○
B.4) Human ingenuity will ensure that we do NOT make the earth unliveable.	○	○	○	○	○
B.5) Humans are severely abusing the environment.	○	○	○	○	○
B.6) The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○
B.7) Plants and animals have as much right as humans to exist.	○	○	○	○	○
B.8) The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○
B.9) Despite their special abilities humans are still subject to the laws of nature.	○	○	○	○	○
B.10) The so called "ecological crisis" facing humankind has been greatly exaggerated.	○	○	○	○	○
B.11) The earth is like a spaceship with very limited room and resources.	○	○	○	○	○
B.12) Humans were meant to rule over the rest of nature.	○	○	○	○	○
B.13) The balance of nature is very delicate and easily upset.	○	○	○	○	○
B.14) Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○
B.15) If things continue on their present course we will soon experience a major ecological catastrophe.	○	○	○	○	○

SECTION C

Please answer each of the questions below by <u>filling in only ONE of the open circles to the right of the question</u> <u>AND</u> <u>indicate how confident you are that your answer is correct by filling in one of the certainty level circles.</u> Certainty levels 1, 2, 3 gain marks of 1, 2, or 3 if the answer is correct; but if the answer is incorrect, marks may be lost (Certainty level 3, 6 marks lost; Certainty level 2, 2 marks lost; Certainty level 1, 0 marks lost).

		Certainty in your selected answer:
What is the most common reason to clear rain forest?	○ Mining ○ Residential development ○ Agriculture ○ None of these	Low(1) Mid(2) High(3) ○ ○ ○
In the long term, which of the following would be the most sustainable way to lessen the problem of solid waste?	○ Incinerate waste materials ○ Reduce consumption and reuse the materials for other purposes ○ Recycle materials ○ Dump the materials in secure landfills	Low(1) Mid(2) High(3) ○ ○ ○
Melting sea ice has the potential to raise sea level by:	○ 0 metres ○ 0.5 metres ○ 5 metres ○ 50 metres	Low(1) Mid(2) High(3) ○ ○ ○
There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea? Is it…	○ Genetics ○ Populations ○ Evolution ○ Biodiversity	Low(1) Mid(2) High(3) ○ ○ ○
What is the largest source of man-made carbon monoxide pollution of the atmosphere?	○ Coal-burning power plants ○ Automobiles ○ Natural gas-burning power plants ○ Heating	Low(1) Mid(2) High(3) ○ ○ ○
Local groups often gather together to plant trees. What is their primary reason for doing this?	○ Community support ○ Habitat reinstatement ○ Eco tourism ○ Environmental activism	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following modes of transport would be a viable way to minimise the carbon footprint of NZ food exports?	○ Bulk transport by cargo ships out of local ports ○ Bulk Air transport ○ Every airline passenger carries a quota of food exports ○ Truck to Auckland then bulk transport by cargo ships out of Port Auckland	Low(1) Mid(2) High(3) ○ ○ ○
How is most of the electricity in NZ generated?	○ Burning oil, coal and wood ○ Wind power ○ Solar energy ○ Hydro generated electricity	Low(1) Mid(2) High(3) ○ ○ ○
Which of the following energy sources contributes the least to global warming?	○ Wood ○ Natural gas ○ Oil ○ Coal	Low(1) Mid(2) High(3) ○ ○ ○
What is the purpose of the Kyoto protocol?	○ To reduce ozone depletion by restricting the use of CFC's ○ To protect the rainforests ○ To ban whaling ○ To stabilise greenhouse gas concentrations in the atmosphere	Low(1) Mid(2) High(3) ○ ○ ○

SECTION D

D.1) Below you will see a short passage giving you information about an environmental issue. After you have read the passage, please select the statement that you believe best identifies the environmental issue described in this passage.

Hydraulic Fracturing, also known as fracking, is a method of extracting oil and gas from rock strata by injecting a water, sand and chemical mix at high pressure into rock to force it to fracture slightly and facilitate the release of oil and gas which is extracted.

Some environmental risks include contamination of sub-surface aquifers that supply water for domestic and agricultural use, pressure leaks of the chemical mix up to the surface of the land, managing the disposal of well residues, and restoration of well site surface land. Fracking also releases other toxic chemicals from sub-surface layers that have the potential to severely contaminate surface land, air and water.

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Industry advocates claim that this technology has been used for at least 50 years and the environmental effects and even risks are minimal, and can be readily managed. Furthermore, advocates point to the necessary continued production and consumption of oil, and suggest that fracking in New Zealand will enhance our self reliance on energy, and contribute to the economic growth and wellbeing of our economy.

Which of four statements (below) best identifies the environmental issue discussed in the paragraphs above?

- ○ Fracking should be allowed in New Zealand to help ensure energy independence.
- ○ Fracking threatens New Zealand's clean and green image.
- ○ Fracking to extract oil and gas has the potential to contaminate air, land and water.
- ○ Fracking should be banned because it may cause earthquakes.

D.2) Use the value definitions listed below to answer the items below. Your task is to read each action statement carefully and identify the value represented by the statement. <u>You may use any of the values more than once, but choose only one value for each question</u> .

Value Definitions	
Environmental:	pertaining to human activities with natural resources such as plants, animals, air, water and soil.
Legal:	relating to national, regional, or local laws, law enforcement.
Cultural:	pertaining to focus on the fulfilment of social/cultural goals.
Economic:	relating to the use and exchange of money, materials, and/or services.
Ethical:	relating to the practical means of determining a moral course of action.

	Environmental	Legal	Cultural	Economic	Ethical
All efforts should be made to block the approval of additional fracking sites in New Zealand to protect our valuable environment.	○	○	○	○	○
Environmental issues should be ignored to ensure fracking for valuable production of oil and gas	○	○	○	○	○
The impact of fracking on air, land and water should be monitored in New Zealand.	○	○	○	○	○
Multinational companies engaged in fracking should be held accountable to New Zealand citizens for any environmental degradation to air, land or water.	○	○	○	○	○
Fossil fuel industries should be required by law to meet strict environmental regulations to prevent contamination of the environment.	○	○	○	○	○

Thank you for participating in this Survey

Appendix 2 Section D Alternative but untested competency example

NAAEE EL Competencies

Competencies are clusters of skills and abilities that may be called upon and expressed for a specific purpose. These include the capacity to:

- **Identify environmental issues** – including the ability to describe and provide evidence for the dimensions of the issue, human disagreements central to it, and factors that cause or contribute to it;
- **Ask relevant questions** – about environmental problems as well as human dimensions and historical or geographical features of an issue. This also includes the ability to ask higher-order questions aimed at discovering conditions that have implications for the issue;
- **Analyze environmental issues** – the interpretation and use of knowledge regarding physical, ecological and sociopolitical systems, and of information about stakeholders, their positions, beliefs and value perspectives. Also, this includes the ability to determine relevant factors and to discern interactions among those factors, and to predict likely consequences of issues;
- **Investigate environmental issues** – by gathering new information about an issue as well as locating and using relevant sources of additional information, synthesizing, and communicating the outcomes of the investigation;
- **Evaluate and make personal judgments about environmental issues** – constructing dispassionate evaluations and explanations based on available information and the beliefs and values of stakeholders, and articulating views about actions that may be warranted. Critical thinking is at the core of this competency;
- **Use evidence and experience to defend positions and resolve issues** – constructing and defending a sound evidence-based argument about what it will take to resolve or help resolve an issue; and
- **Create and evaluate plans to resolve environmental issues** – by assuming the responsibility for acting, frequently with others, and engaging in planning based on the environmental conditions, available resources, and socio-political contexts to resolve or help resolve issues.

Introduction to Ecotourism

The International Ecotourism Society defines Ecotourism as "responsible travel to natural areas that conserves the environment and improves the welfare of local people" but many other interpretations are possible and it is common for individual cases of ecotourism to be challenged as not meeting the aspirations of conservationists. Ideally ecotourism involves travel to natural destinations in ways that minimise adverse impacts on what is deemed as 'natural'. It builds environmental or ecological awareness, in the travellers and local communities. It provides direct financial benefits for conservation and both empowers local people and motivates them to conserve their ecological assets. It respects local cultures and supports human rights and democratisation. Sometimes, however, tourism ventures labelled as ecotourism may fail to match these aspirations in several respects. They may adversely exploit natural areas and those who have historically maintained them. Financial benefits may fail to reach those who should most benefit and rather than empower local people, inappropriate ecotourism may simply promote government and corporate control of ecological assets. Ecotourism involves travel, often over long distances, and perhaps using unsustainable travel options, possibly

contributing to global warming and threatening the survival of the ecological system that provided the purpose for travel.

Ecotourism 1

Competency =

- **Identify environmental issues** – including the ability to describe and provide evidence for the dimensions of the issue, human disagreements central to it, and factors that cause or contribute to it;

Which one of the four statements (below) **best** identifies the environmental issues discussed in the paragraphs above?

1. All international tourists to New Zealand are eco-tourists because this is a nice place to live.
2. New Zealand has no pristine natural habitat left so it is not a suitable ecotourism destination.
3. Ecotourism is important to create employment in poor areas.
4. Ecotourism has the potential to be highly beneficial to the conservation of threatened species and habitats, but may also have adverse effects.

Ecotourism 2

Competency =

- **Create and evaluate plans to resolve environmental issues** – by assuming the responsibility for acting, frequently with others, and engaging in planning based on the environmental conditions, available resources, and socio-political contexts to resolve or help resolve issues.

Directions: Assume that you are a member of a local conservation society. You are worried about the number of visitors that ecotourism is bringing to your area, the environmental damage that they may be causing and the impact that their international travel may be having on global warming. You know others who feel the same—basically you hope that ecotourism in New Zealand could be better regulated to ensure that on balance it provides positive outcomes for the environment.
Below you will find (6) strategies. These action strategies are ones that might be used to prevent ecotourism in New Zealand. **You are to select only <u>two</u> of them**.
Your task is to carefully read through each strategy, and then select what you believe are ***the <u>two</u> (2) most effective strategies*** from the six strategies listed below.
On your answer sheet darken the number for the two statements that you selected.

1. Write to your local MP to propose legislation to regulate ecotourism In New Zealand.
2. Organize a regional group of citizens who want to increase awareness about the environmental risks of ecotourism. Then ask for a meeting with the Otago Regional Council and Dunedin City Council to lobby for tighter regulation for ecotourism.
3. Organize a local group of citizens interested in ecotourism and attempt to connect up with other NZ environmental groups. This ‘multi-group approach’ could influence the central government to better regulate ecotourism in New Zealand.

4. Circulate a petition to propose a referendum asking for tighter regulation of ecotourism sites in New Zealand.
5. Write letters to the editor of the Otago Daily Times supporting tighter regulation of ecotourism in New Zealand.
6. Organize a local group to pass out leaflets at Saturday Market to inform the public about the environmental benefits and risks of ecotourism in New Zealand.

Ecotourism 3

Competency =

- **Investigate environmental issues** – by gathering new information about an issue as well as locating and using relevant sources of additional information, synthesizing, and communicating the outcomes of the investigation;

Assume that you are unsure about the benefits and risks of ecotourism in New Zealand.
Directions: Below are (5) statements which describe strategies to investigate the question of ecotourism in order to determine how best to resolve this environmental issue.
Your task is to read carefully through each of the 5 statements below and then select what you believe are the ***two (2) best ways to investigate the issue of ecotourism.***
On your answer sheet darken the letter for the two examples that you selected.

1. Government should consult with the tourism industry about the environmental risks of ecotourism in New Zealand.
2. Government should commission a task force made up of representatives from the main political parties, tourism industry experts, and conservationists to report on the best ways to avoid damaging environmental impact of ecotourism.
3. Tourism experts should be employed by government and local councils to investigate the environmental impact of existing ecotourism ventures in New Zealand.
4. Government should commission a panel of experts (i.e. environmental managers, conservationists, and tourism industry representatives) to report on the economic impact of ecotourism, both positive and negative.
5. Government should commission a report on the environmental social and economic impact of ecotourism in New Zealand for the last 25 years.

Ecotourism 4

Competency =

- Competency = **Ask relevant questions** – about environmental problems as well as human dimensions and historical or geographical features of an issue. This also includes the ability to ask higher-order questions aimed at discovering conditions that have implications for the issue;

Consider that you personally need to make a decision about this issue in the future. What additional information do you think is of greatest importance to help you to come to a good decision.
Directions: Below you will find (5) questions about the environmental issue associated with ecotourism. Your task is to read carefully through each question, and then select what you believe are ***the two (2) most important environmentally-relevant questions to ask about the issue of ecotourism*** from all the examples listed below.
On your answer sheet darken the number for the two examples that you selected.

1. Using data from NZ and from overseas, how do the economic advantages compare with the costs to mitigate the environmental damage from ecotourism?
2. How will river fishing be affected by ecotourism in New Zealand?
3. What are the potential health-related costs associated with ecotourism?
4. How might we go about finding an appropriate balance between environmental risk and economic benefit in relation to ecotourism?
5. What animal species are threatened by ecotourism?

Ecotourism 5

Competency =

- **Analyze environmental issues** – the interpretation and use of knowledge regarding physical, ecological and sociopolitical systems, and of information about stakeholders, their positions, beliefs and value perspectives. Also, this includes the ability to determine relevant factors and to discern interactions among those factors, and to predict likely consequences of issues;

Directions; Given that travel associated with international ecotourism may be contributing to global warming use your own analytical processes to identify which **one (1)** of the following statements best summarises the links between ecotourism and global warming.

1. Too many people traveling to the same destination cause excessive erosion.
2. Air travel releases carbon dioxide which is a greenhouse gas, so contributes to global warming. Some ecotourism destinations are particularly vulnerable to global warming.
3. Air travel attracts visitors who are more interested in having a holiday, than in conservation.
4. Ecotourism encourages businesses which are not good for conservation.
5. Air travel brings large numbers of tourists to sensitive destinations and leads to overpopulation in areas that have traditionally had low populations.

Ecotourism 6

Competency =

- **Evaluate and make personal judgments about environmental issues** – constructing dispassionate evaluations and explanations based on available information and the beliefs and values of stakeholders, and articulating views about actions that may be warranted. Critical thinking is at the core of this competency;

Consider that you personally have no opinion on the matters in question. You are asked to make a dispassionate, logical dissection of the issue.
Directions: Below you will find (5) statements about the issue of ecotourism. Your task is to read carefully through each and then select what you believe are ***the two (2) most reasonable statements.***
On your answer sheet darken the number for the two examples that you selected.

1. Ecotourism is simply not acceptable in a civilised nation.
2. It may be impossible to determine in an objective way the relative advantages of and problems associated with particular examples of ecotourism, so local people should decide on each by conventional democratic means.
3. With controversial ecotourism ventures, economic arguments should always prevail over environmental and conservation concerns.
4. Ecotourism issues and controversies are highly complex. Each case needs a thorough evidence-based analysis taking into account both local and global perspectives.
5. Local people who support ecotourism should stop visiting these destinations themselves to avoid them becoming over-crowded.

Ecotourism 7

Competency =

- **Use evidence and experience to defend positions and resolve issues** – constructing and defending a sound evidence-based argument about what it will take to resolve or help resolve an issue;

Consider that you personally have no opinion on the matters in question. You are asked to construct an evidence-based argument to help resolve current differences about proposed expansion of New Zealand's ecotourism sector.
Directions: Below you will find (5) statements about the issue of ecotourism. Your task is to read carefully through each and then select two that together create a powerful evidence-based process for making progress towards a decision on ecotourism in New Zealand.
On your answer sheet darken the number for the two examples that you selected.

1. It would help me to decide on whether ecotourism in New Zealand should continue if I knew by how much my standard of living would rise if we approve this expansion.
2. No-one has yet named one species that has become extinct as a result of ecotourism. Until they do we should continue ecotourism.
3. Our universities and research institutes should research the environmental, social and economic issues associated with ecotourism and advise our government.
4. Given the potential risks to our environment we should temporarily halt expansion of ecotourism until we have gathered evidence about the extent of the likely problems and ways to reduce the risks.
5. New Zealand gets large numbers of tourists so a few more shouldn't matter.

Appendix 3 A bibliography of recent related research outputs from the Education for Sustainability Research Group

Shephard, K., Harraway, J., Lovelock, B., Skeaff, S., Slooten, E., Strack, M., & Jowett, T. (2012). Monitoring changes in the sustainability attributes of higher education students in a New Zealand university. In W. Leal (Ed.), *Sustainable Development at Universities: New Horizons* Frankfurt: Peter Lang Scientific Publishers.

Harraway J, Broughton-Ansin F, Deaker L, Jowett T and Shephard K (2012) Exploring the use of the Revised New Ecological Paradigm Scale (NEP) to monitor the development of students' ecological worldviews. *Journal of Environmental Education* 43(3), 177–191.

Shephard K and Furnari M Exploring what university teachers think about education for sustainability *Studies in Higher Education* (in press) 10.1080/03075079.2011.644784

Mann, S, Harraway, J, Broughton-Ansin F, Deaker, L and Shephard K (2011) Seeking richer descriptions of learners' sustainability attributes and learning needs *International Journal of Sustainability in Higher Education* (in press)

Shephard K (2011) Exploring the impact of higher education experiences on students' ecological worldviews, In Cotton, M, & Motta, B.H. (eds.) *Engaging with Environmental Justice. Governance, Education and Citizenship* (e-book, ISBN: 978-1-84888-062-7)

Shephard K, Smith N, Deaker L, Harraway J, Broughton-Ansin F and Mann S (2011) Comparing Different Measures of affective attributes relating to sustainability *Environmental Education Research* 17 (3) 329-340.

Buissink-Smith, N., Mann, S. and Shephard, K. (2011)How do we measure affective learning in higher education? *Journal of Education for Sustainable Development* 5, 101-114

Shephard, K (2010) Higher education's role in 'education for sustainability' *Australian Universities' Review* 52(1) 13-22.

Shephard K. , Mann S. , Smith N. and Deaker L. (2009) Benchmarking the environmental values and attitudes of students in New Zealand's post-compulsory education. *Environmental Education Research* 15 (5) 571-587.

Shephard K. (2008) Higher education for sustainability: seeking affective learning outcomes. *International Journal for Sustainability in Higher Education* 9 (1) 87-98.

Appendix 4 Advice and instructions for administration of the ELEI

1. Copy the required number of forms. Each batch of forms should consist of four versions of the ELEI with different questions in some sections. The 4 tested versions are provided in Appendix 1.

2. Once the students are seated, *read out the instructions given below*:

Instructions to students:

- Please complete the form by filling in the appropriate circles not by ticks or crosses. If you want to change your answer, cross out your first answer and fill in your preferred choice.
- Give a personal ID code by writing the code in the appropriate box AND filling in the circles. The code should be devised using the instructions at the top of the page. This process is designed to ensure that you remain anonymous. Please do not write your name or any other identifying information on the ELEI.
- Please fill in your personal details in Section A. Background information about the assessment is also provided is provided on the first page.
- The assessment is given in Sections B to D which is expected to take between 15 to 20 minutes to complete. Please read the statements and questions carefully before answering. Please do not copy or talk with other students. Please do not use the internet to find answers during the test.
- Once you have completed the form, please wait quietly for the other students to finish.
- This assessment is not compulsory and has no effect on the mark that you receive for the paper.

3. The forms should then be handed out. To ensure that the same test is not given to adjacent students, please hand out the forms sequentially from 1 to 4.

4. After the students have finished (the assessment should take about 20 minutes), ask them to pass the forms along to the end of the row and then collect the forms.

5. The completed forms need to be unstapled prior to scanning. The fastest way to do this is to cut off the top left hand corner off the form. Sort the completed forms from the four versions into four ``batches'' ready for scanning.

6. Feed each batch of completed forms through the automatic feeder of the scanner. Any modern Photocopier/Scanner will be suitable for the job. Don't forget to select the double-sided scan option and save the san as a PDF file. There will be at least 4 batches of forms (one for each version). Depending on the capacity of the automatic feeder, for large surveys it may be necessary to scan each batch over multiple "sub-batches".

7. At the end of each batch (or sub-batch), email or save the PDF file to an appropriate directory on a computer. The PDF file name should include the test version (and sub-batch number if required), the paper and the survey date.

8. The next step is to process the forms in the optical mark reading software programme: Remark Office OMR. The processing described below must be carried out for each of four versions of the test where each version of the test has a specific Remark Template. Detailed information on the use of Remark can be found by selecting the "Help" option and online software manual in ReMark.

9. Remark reads the data through "Templates" (saved as .omr files) which must be created prior to reading the data. Details about template development can be found in the software manual and

inline guides. To create a Remark template, a blank PDF version of each survey form is required. The company: Gravic, that developed and markets Remark offers a service to check templates for their suitability in terms of space between regions and layout. Assuming that a Remark template has been created, the following process is required to process the data.

10. Open the appropriate Remark template with: File→Open Template. Push the "Read Wizard" button and select "Read from Image File" then select "Next". Navigate to select the PDF file(s) for the version of the test being processed. For large surveys there will be multiple PDF files for each version. If this is the case then select all of the PDF files associated with the test version being processed. To read the selected files push the "Read" button.

11. The next step is to look for and where possible correct issues relating to incorrect form entry by the students or 'read issues'. Push the "Data" button and then select "Review Exceptions". By looking at the exceptions as shown on the PDF image at the bottom of the page, where possible make corrections.

12. Once the data has been read and corrected, the data should be saved using File→Save Data As. First save as a Remark data file with the .rmk file extension. Then save as a data file for subsequent data analysis. We saved files in the SPSS (.spss) and text file (.txt) formats. We used SPSS and other statistical analysis software to analyse our data.