

# Benchmarking sustainability values of incoming computing students

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## ABSTRACT

The paper describes results from a survey of incoming computing students and characterises these students in terms of their sustainability worldview, knowledge and actions. Using recognized benchmarks, the computing students are compared with the wider intake of a vocational institution. This survey contributes to the understanding of the requirements of curriculum development so that computing graduates can usefully contribute to a sustainable society.

## Keywords

Sustainability, Practitioner, Teaching philosophy, Education

## 1. INTRODUCTION

There is much talk currently about sustainability and, more specifically, about the need to encourage a sustainable, societal conscience. There is a strong call by many for organisations and tertiary institutions to play a strong role in achieving this global sustainability vision (Blewitt & Cullingford 2004, Mann & Smith 2007). The call from the United Nations is that this is a matter for students of every discipline (Tilbury *et al.* 2006, UN 2004). Computing researchers have similarly promulgated a strong connection between computing and sustainability (Mann *et al.* 2008, Blevis 2007).

Computing organizations such as New Zealand's NACCQ have adopted policies that state:

*Computing and IT underpins every sector of society as a pervasive and influential discipline with global impact. The NACCQ vision is that our graduates, our practitioners and our academics understand the concepts of social, environmental and economic sustainability in order for them to evaluate, question and discuss their role in the world and to enable them to make changes where and when appropriate.*

*Moreover, computing educators must take a lead in sustainability so that computing practitioners can be encouraged and supported to promote sustainable use of technology. This can primarily be achieved by the fostering of sustainability as a core value of computing education.*

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A similar policy proposed for ACM (Mann *et al.* 2008) includes an agenda to implement this goal. Item 4 on the agenda states: "Develop an understanding of the current status of sustainability (values, awareness, knowledge, skills & behaviours) of all our stakeholders (students, intake, stakeholders, staff, graduates, professional/trade connections)." This paper addresses this item as it applies to incoming students.

The understandings and beliefs of computing students are critical to the development of curricula and teaching strategies to provide a stream of graduates who may usefully contribute to a sustainable society. Rather than a focus on current technical matters as they relate to sustainability (data consolidation, virtualization etc) we are particularly interested in understanding the deeper worldviews of the students – a focus on the affective attributes of values, attitudes and beliefs (Shephard *et al.* in press). This worldview is important as the desired approach to computing education for sustainability is one of integration or computing through the lens of sustainability (Blevis 2007) rather than additions to the crowded curriculum (McGettrick *et al.* 2004).

## 2. METHODOLOGY

A questionnaire was developed and distributed to all incoming students at the start of the 2008 academic year, for all students enrolled for 0.8EFT (effective full time) or greater.

To enable benchmarking, existing survey instruments were used. In early 2008, all incoming Otago Polytechnic (Mann and Smith 2008) students completed a questionnaire that will enable researchers to follow their progress in sustainable thinking throughout their education, and possibly beyond. After a pilot project in 2007 the questionnaire was designed as a combination of methods and included the revised New Environmental Paradigm Scale (NEP Dunlap *et al.* 2000) questions taken from an international study into young people and the environment (Fien *et al.* 2002); and an adaptation of a Personal Meaning Map (Storksdieck *et al.* 2005). The survey was distributed on paper within the first weeks of the academic semester with an information sheet (Otago Polytechnic Category B Ethics).

The first section of the questionnaire contained 15 items as the revised-New Ecological Paradigm (Dunlap *et al.* 2000). The items are shown in Table 1. Respondents were asked to indicate their agreement with each item on a five-point Likert-like scale (Strongly agree, mildly agree, unsure, mildly disagree, strongly disagree). The revised-NEP contains seven items worded so

that disagreement indicates a pro-ecological worldview and eight items worded so that agreement indicates a pro-ecological worldview. Items in each set were alternated and for our subsequent analysis the scores for seven disagreement = pro-ecological items were reversed, so that 1 (*strongly agree*) becomes 5 (*strongly disagree*), 2 becomes 4 and vice versa (Manoli et al. 2007). Missing data was replaced by the mean score for each item before subsequent analysis.

The questionnaire also asked respondents to record their gender, age group, ethnicity and current programme of study. Respondents were also asked to record a code-word or number so that they could remain anonymous within the survey yet allow later data to be collected and time-tracked to this benchmarking exercise.

### 3. RESULTS

There were 539 respondents (the approximate response rate was 65% with two substantial departments unable to contribute. Respondents in the total intake include students from IT (n=60), Business (n=59), Architecture and Engineering (n=20), Design (n=88), Nursing (n=71), Midwifery (n=62), Occupational Therapy (n=57).

Respondents were predominantly female (70%) with 53% between the ages of 15-19 years old and 84% under the age of 29. 82 % described their ethnicity as NZ European/Pakeha (a New Zealand term for citizens of predominantly European decent), 6.5% as Maori, 2.6% as Pacific Islander, 4.8% as Asian and 3.7% as other. The 60 IT students are not significantly different to the general intake in age or ethnicity. As might be expected, however, IT has a strong male bias being 83% male whereas the institution is only 38% male. Some departments are mostly female (Design 92% female, Midwifery 95% – includes foundation health), Nursing 97%, Occupational Therapy (93%). There are other male dominated departments: Engineering (80%) and the regional campus (91%).

#### 3.1 NEP

Responses to the 15 questions from the New Environmental Paradigm (NEP) are shown in Table 2. Remembering that shaded items are reverse polarity, the strongest pro-ecological statements for IT students are those concerning the rights of plants and animals, interference often disastrous, nature is a delicate balance, humans are abusing the environment, humans still subject to laws of nature, and a disagreement that there are plenty of resources. IT students’ anthropocentric beliefs include that the balance of nature is strong enough to cope with impacts, that humans will work out how to control nature, that the ecological crisis has been exaggerated, that humans are meant to rule over nature. These patterns are not dissimilar to the total sample where large standard deviations suggest a wide divergence of worldview.

There is a gender effect in the responses. While for the most part, the female responses are more pro-ecological, the women students are significantly more anthropocentric with humans are meant to rule over nature, the extent of the ecological crisis and humans right to modify nature.

A single-factor NEP was calculated with responses summed for each individual (with responses for reverse polarity questions reversed). This gives an NEP score for individuals theoretically ranging from 1 to 5. With this recoded data, a mean of 3.0

describes a neutral stance on the issue. Values below 3 are broadly pro-ecological. Values above 3 are broadly anthropocentric.

**Table 1:** The 15 item NEP. Words in bold provide the abbreviated term used in subsequent analysis

We are approaching the <b>limit</b> of the number of people the earth can support.
Humans have the right to <b>modify</b> the natural environment to suit their needs.
When humans <b>interfere</b> with nature it often produces disastrous consequences.
Human <b>ingenuity</b> will ensure that we do not make the earth unlivable.
Humans are severely <b>abusing</b> the environment.
The earth has plenty of natural <b>resources</b> if we just learn how to develop them.
<b>Plants</b> and animals have as much right as humans to exist.
The <b>balance</b> of nature is strong enough to cope with the impacts of modern industrial nations.
Despite their special <b>abilities</b> humans are still subject to the laws of nature.
The so-called “ecological <b>crisis</b> ” facing humankind has been greatly exaggerated.
The earth is like a <b>spaceship</b> with very limited room and resources.
Humans are meant to <b>rule</b> over the rest of nature.
The balance of nature is very <b>delicate</b> and easily upset.
Humans will eventually learn enough about how nature works to be able to <b>control</b> it.
If things continue on their present course we will soon experience a major ecological <b>catastrophe</b> .

The NEP for the entire intake is 2.47 (pro-ecological) with a standard deviation of .47. The most pro-ecological student is in Veterinary Nursing who was pro-ecological for every question. The least pro-ecologic student, in Communication Design was anthropocentric for every question.

The female NEP is 2.42, significantly more pro-ecological than the males 2.59 (p=0.003).

Table 3 shows the distribution of NEP factors for IT along with other departments for comparison. Table 3 also demonstrates how different departments vary according to a principal components analysis to extract four factors from this complete dataset (Shephard *et al.* 2008, Shephard *et al.* in press). These four factors provide subtly different concerns about the place of humans within nature. To aid in the translation of these factors for teaching and curriculum development, each is characterised as a tendency. Factor One, for example, essentially identifies facets of ‘the fragility of nature’s balance’ and ‘the possibility of an ecocrisis’ into one combined factor showing high internal correlation, described as “a tendency to conserve”. Factor two

describes a belief that nature provides limited resources (“a tendency to recycle”), Factor Three describes a belief that humans are subject to the laws of nature (“a tendency to be precautious”) and Factor four

that nature does not exist for the benefit of humans – “a tendency to support animal rights”.

Table 3 shows the complex interactions of these characteristics in the construction of the worldview. For example, IT significantly differs from Occupational Therapy in “Laws”. IT differs from Veterinary Nursing in “Human” and “Benefit”.

IT not significantly different from the total intake. IT is, however, strongly different to other departments – specifically the health departments. A large effect here is the gender effect. Gender, though, is not the whole story. Business (70% female) is not significantly different to IT. There are no significant differences between IT (total) and non-IT males.

**Table 2:** Frequency responses to NEP questions. The corrected mean shows the mean for each question corrected around zero, with pro-ecological values positive and anthropocentric values negative

	Strongly Agree	Agree	Unsure	Mildly disagree	Strongly disagree	IT mean	IT corrected Mean	Stdev	mean	stdev	All students corrected mean	Female corrected mean	Male corrected mean
<b>Limit</b>	0.25	0.25	0.30	0.12	0.08	2.53	-0.03	1.228	2.51	1.09	-0.01	-0.01	-0.02
<b>Modify</b>	0.05	0.42	0.14	0.25	0.14	3.27	-0.77	1.247	3.24	1.25	-0.74	-0.86 ***	-0.41
<b>Interfere</b>												0.31	
	0.27	0.40	0.18	0.10	0.05	2.26	0.24	1.125	2.25	1.12	0.25	***	0.1
<b>Ingenuity</b>	0.08	0.34	0.36	0.19	0.03	2.94	-0.44	1.047	2.92	1.05	-0.42	-0.44	-0.42
<b>Abusing</b>												0.52	
	0.27	0.52	0.13	0.05	0.03	2.01	0.49	1.128	2.02	1.11	0.48	***	0.32
<b>Develop</b>												0.55	
	0.29	0.51	0.14	0.07	0.00	1.98	0.52	0.969	1.98	0.96	0.52	**	0.48
<b>Plants</b>												0.97	
	0.53	0.23	0.15	0.05	0.03	1.60	0.9	0.992	1.63	1.00	0.87	***	0.64
<b>Balance</b>	0.08	0.15	0.13	0.45	0.18	3.65	-1.15	1.095	3.64	1.10	-1.14	-1.18	-1.06
<b>Abilities</b>	0.45	0.40	0.12	0.02	0.02	1.94	0.56	0.925	1.92	0.92	0.58	0.56	0.59
<b>ecological</b>	0.13	0.20	0.23	0.30	0.13	3.42	-0.92	1.144	3.39	1.16	-0.89	-0.99 ***	-0.64
<b>Spaceship</b>	0.12	0.42	0.15	0.27	0.03	2.53	-0.03	1.170	2.54	1.17	-0.04	-0.02	-0.06
<b>Rule</b>	0.07	0.15	0.22	0.22	0.35	3.51	-1.01	1.362	3.52	1.35	-1.02	-1.21 ***	-0.71
<b>Delicate</b>	0.23	0.47	0.18	0.10	0.02	2.08	0.42	0.982	2.09	0.98	0.41	0.45	0.28
<b>Control</b>	0.12	0.35	0.28	0.15	0.10	3.60	-1.1	9.870	3.52	9.36	-1.02	-0.71	-1.83
<b>Catastrophe</b>	0.25	0.46	0.25	0.03	0.00	2.08	0.42	0.970	2.07	0.96	0.43	0.42	0.41

\*\* 95 and \*\*\* 99% confidence significant differences in male/female responses.

**Table 3: NEP Characteristics by four factors for selected departments**

Dept	Human	Resources	Laws	Benefit	NEP
OCC	2.12	3.017	2.555	2.222	2.41
ICT	2.21	3.096	3	2.389	2.58
SAB	2.28	3.04	2.937	2.44	2.59
VET	1.78	2.791	2.583	1.687	2.12
COT	2.1	2.73	2.523	2.365	2.36
DES	2.16	2.953	2.675	2.017	2.39
ABE	2.36	2.95	2.916	2.916	2.7
Health	2.11	2.93	2.85	2.3	2.11
All	2.17	3.023	2.743	2.259	2.47

### 3.2 Priorities

Respondents were asked to rank a set of potential issues (Table 4). There were some significant differences here. IT students are more concerned about strengthening the economy ( $p=0.02$ ) and limiting population growth ( $p=0.07$ ) and less concerned about creating a fairer society ( $p=0.03$ ) than the total intake.

**Table 4:** Frequency of ranking of issues as priority items for IT students and whole intake (Otago Polytechnic: OP)

	IT	OP
Protecting the environment	77%	78
Overcoming poverty	55%	59
Preventing war and nuclear threats	47%	51
Improving education standards	38%	43
Strengthening the economy	34%	31
Protecting freedom of speech	32%	22
Creating a fairer, more humane society	30%	48
Improving the liveability of our cities	30%	24
Reducing unemployment	30%	29
Limiting population growth	23%	16
Building strong defence forces	11%	7

### 3.3 Knowledge

Respondents were asked whether they were familiar with a range of sustainability related concepts. Table 5 shows the results of this, along with Fien's (2002) results for the same questions. Overall, there is a decrease in reported unfamiliarity from Fien's 2002 survey and the 2008 cohort. While respondents were familiar with general and popularly known concepts – renewable resources, greenhouse effect etc – they were less confident with ecological concepts and specific

principles such as carrying capacity, the precautionary principle. Few students claimed familiarity with the relevant Maori concepts. There were no significant differences in responses between the IT students and the total sample.

**Table 5:** Unfamiliarity with sustainability concepts

	IT	OP others	OP total	Fien NZ
Renewable resources	0	5	5	9
The greenhouse effect	2	3	3	5
The ozone layer	2	1	1	3
Sustainable development	5	22	17	53
Ecology	10	22	11	22
The carbon cycle	11	15	15	25
Interdependence	25	31	30	20
Biodiversity	26	19	23	49
Carrying capacity	41	47	46	46
Intergenerational equity	58	60	59	60
The precautionary principle	71	75	75	69
The Maori worldview of Aotūroa	78	72	73	na
The Maori worldview of Papatūānuku	78	76	75	na
The Maori worldview of Pūtaiao	86	82	82	na

### 3.4 Making a difference

Respondents were asked to rate their desire to be involved in improving the environment/community. They were also asked to rate their skills and knowledge to bring about environmental/community improvements. Table 6 shows that there is little difference between the IT students and the total sample. There is considerable variation between departments. 62% of Veterinary nursing students reported a strong or very strong desire to contribute as did 60% of Social Service students, and 55% of both Engineering and Hospitality students. At the other end of the scale, only 28% of Business students and 33% of IT students wished to contribute. This desire to contribute is correlated with the NEP (0.404).

**Table 6:** Desire and skills to contribute to improving environment/community

Desire to be involved	Very Strong	Strong	Medium	Weak	Very weak
Total	15.57	26.02	45.8	9.24	3.26
ICT	15.00%	18.33%	45.00%	15.00%	5.00%
Skills and knowledge					
Total	15.57	26.02	45.8	9.24	3.26
ICT	15.00%	18.33%	45.00%	15.00%	5.00%

There is no clear relationship between the desire to contribute and a self reported rating of skills and knowledge. 27% of IT students rate themselves as having high or very high skills suited to sustainability (the highest is Occupational Therapy with 30%, the lowest self assessment is Nursing with 12%). 33% of IT students report low or very low sustainability skills (about the average).

IT students have a low desire to be involved and but are split as to their level of skills to contribute.

### 3.5 Actions

Respondents were asked whether they had undertaken a range of sustainability related actions and whether they would (or would not) consider doing them. Again there is considerable variation in responses to these questions (Table 7). Although “I have done” summed for each person, has a 0.4198 correlation (Pearson-product moment correlation) with single value NEP, different actions have quite different patterns. Some actions, such as “take part in litter campaign” have a low participation rate for the whole sample but a high “I would do”. Within this, IT has a high 19% “have done” but also second highest refusal rate.

### 3.6 Scenario

A scenario has previously been described to aid in the articulation of what it means to be a sustainable practitioner for a given discipline (Mann and Smith 2008). Such a scenario was explored here. Respondents were prompted with this brief scenario:

*“If in your first position/job after you graduate you are asked by your supervisor to perform a task that you consider to be unsustainable practice, what would you do?”.*

“Refuse to do it”, and “Say no!” were given by 8% of IT students. Some of this group recognised potential consequences of this “Resign”, and “Not do it, even if I got fired”. A few added some explanation to this: “Explain my reasons for not wanting to do it”.

27% of students responded that they would do the task without qualification: “Do it anyway” being the most common answer. Several respondents gave reasons for this, usually ones of authority:

*“Are you kidding? I’m going to smart mouth or say anything to this person??”, “*

*“Do it anyway, being stubborn towards an employer is foolish”, “It is not my place to question my supervisor, I am there to do a job, and you wonder why unemployment is high”.*

51% of students responded that they would do the task, but would talk to their supervisor about it. Some (5%) would do the task first and bring it up later “Do it then complain about it later”. Variations on this include “

*Depends on what it was probably do it and maybe make a comment to him after work or after the job about it”*

and

*“Bring it up but if the employer wanted it done I would get them to sign a document so it would be the companies fault not mine”.*

The majority of students responded that they would do the task but would talk about it “Tell my supervisor my issues with the task”. Some put the responsibility onto the supervisor: “Ask if there was another way of achieving this “, or added the question of the worth of the task: “Discuss the reasons for needing to do the task & ask if there are ways to make it more environmentally friendly”, others saw it more of a discussion “Bring it up as an open topic with the supervisor” and “Consult them as to what needed to be done”, one saw that they should personally suggest alternatives (this much more frequent in health).

The apparent non responses are also useful. 35% either didn’t answer this question or wrote variations on “I have no idea”. One respondent wrote something irrelevant. These non answers are useful as benchmarks – hopefully on graduation these students will have something useful to contribute.

The qualitative responses were independently coded (distribution shown in Table 8). IT is significantly from the total intake in the higher proportion who would “Do it, say nothing”.

### 3.7 Relevance

The respondents were asked “How relevant is sustainability to your programme of study?” shows that responses to this question are well distributed and are only weakly influenced by the NEP (.23). We interpret this as indicating that people with strong pro-ecological world views either see a strong role for their discipline or they are reporting that it is not currently relevant.

**Table 7: Sustainability related actions**

	I have done in the last 12 months		I would consider doing		I would not consider doing		Commentary
	IT	OP	IT	OP	IT	OP	
Choosing household products that are better for the environment	42	48	44	45	14	6	Veterinary, Social services and Midwifery above 60% do.
Writing a letter, or signed a petition, or attended a meeting etc, with the aim of protecting or improving the environment	10	19	51	57	37	25	Foundation 92% do or would do (all health above 80%), down to Engineering 55% do or would
Deciding for environmental reasons to re-use or recycle something instead of throwing it away	69	79	25	17	5	3	Vet 94% do. Seven depts above 80% do, 11/13 depts do or would above 90%. Only FOL and HSS have 10% would not
Trying to encourage someone else to change an activity or practice that you thought was harmful to the environment.	39	45	36	41	25	13	Veterinary 69% do, all others below 50%. Engineering lowest do with 31. Only IT and Regions below 80% do/would
Taking part in a clean-up campaign or anti-litter scheme of some kind	19	12	46	67	36	22	Only Social services reaches 20% do. Normally green Veterinary has only 6% active but 80% saying they will in next year.
Making a report or complaint about something that you thought was bad for the environment	10	7	56	63	32	29	Only 7% have done, highest dept Veterinary 19%. Several depts 40%+ "would not do" (Engineering, Business).
Making an effort, for environmental reasons, to reduce water consumption	31	41	37	47	32	12	All health above 90% "do or would do", IT, Social services and Engineering "would not do"
Trying to get information for your own interest on some topic that you thought was relevant to protecting the environment	17	21	64	57	19	22	Only 5% of Engineering do, and 30% would not giving 70% "do or would". Veterinary has highest "do" (38%),
Taking part in a tree-planting scheme	19	15	59	67	22	18	Low activity. Wide spread: eg "would not do". 6% Veterinary to 32% in Business
Making a gift or donation to an environmental or conservation group	15	16	42	56	42	28	All departments under 25% "do". Wide range in "do/would" from low of 60% in engineering to 85% in Hospitality and 94% in Veterinary. IT highest "wouldn't do".
Growing food in your own garden	47	54	39	38	14	9	35% of Engineering do, Midwifery and Occupational Therapy above 65% "do". Most departments below 10% "would not do" except Sports, Eng and IT.

**Table 8:** Frequency of coded responses to scenario (combined Health shown for comparison)

Answer code	OP total	IT	Health
Don't do it	0.08	0.10	0.07
No idea	0.31	0.17	0.35
Do it say nothing	0.11	0.27	0.05
talk and do it	0.06	0.07	0.05
first talk alternatives	0.41	0.38	0.46

**Table 9:** Responses to “How relevant is sustainability to your programme of study?”

	Frequency	NEP
Very high	11%	2.33
High	27%	2.44
Medium	42%	2.51
Low	14%	2.55
Very low	6%	2.51

**Table 10:** By department average responses to “How relevant is sustainability to your programme of study?”

	Relevance	NEP	Desire (%)
Engineering	2.28	2.7	55
Occupational Therapy	2.32	2.41	50
Hospitality	2.50	2.67	54
Design	2.51	2.39	35
Veterinary	2.54	2.12	62
IT	2.78	2.58	33
Nursing	2.97	2.46	42
Social Services	3.00	2.57	60
Business	3.02	2.59	28
Midwifery	3.08	2.35	48

These responses also vary by department (Table 10). Perhaps surprisingly Engineering has the strongest positive relevance (2.28).

Respondents were asked to explain their answer about the relevance of sustainability to their discipline. Some IT students saw that it had a very low relevance:

*“IT is about humans and technology, not humans and the environment.”*

*“We are studying IT! The complete opposite of nature”*

*“We only use paper and computers”*

Others saw a little more relevance:

*“It is something worth considering but not relevant enough to warrant drastic action”*

Those who described a medium relevance came from two camps. Some had self interest motives *“It'll put food on my table in the future”*. Others saw the need to reduce IT's own impact *“IT consumes a lot of natural resources”* while others

saw potential for a wider impact: *“doesn't directly influence environment but can create media to raise awareness”*.

Those who saw high relevance also described two aspects. Some described computing's impact: *“computing has a high carbon footprint”* while others could see an impact on computing: *“the resources needed in the industry might run out i.e. for building the p.c. and internals”*. Some looked past these considerations to a wider statement: *“No matter what field we go into if the environment is disrupted enough to cause flooding eg sea level rise and greenhouse gases to grow then it is important to recognise the implications”*. Similar reasons were given by those who argued for very high relevance:

*“because everything in this world is relevant to sustainability”*

*“I regard it as high in my chosen field as if there were no sustainability, I would have no career”*.

#### 4. DISCUSSION

This survey was undertaken in the first weeks of the first semester – before students had learnt much at a tertiary level. They had, however, chosen their fields of learning-computing, engineering, nursing and so on. This study has examined the differences in the sustainability worldviews of students who have made that career path decision, but not yet been formally influenced by teaching in that discipline. Little is known about the affective learning status of students at this stage but this survey begins to give a baseline of who we, as educators, are working with.

Some findings can be summarized as they relate to computing (IT) students on intake. These findings provide useful pointers to computer science education in implementing computer education for sustainability policies and agenda (Mann *et al.* 2008).

On average IT students are slightly pro-ecological but with a wide variation in worldviews. They are much less pro-ecological in worldview than students in other disciplines, health in particular.

Within this worldview, IT students are more anthropocentric in not agreeing with a belief that nature provides limited resources (ie they would not have a high “a tendency to recycle”). They are also anthropocentric in their negative response towards the notion that humans are subject to the laws of nature (they would not have “a tendency to be precautionous” with regards to the environment).

There is a strong gender effect on worldview (females significantly more pro-ecological) but this is not the whole story. Much more work needs to be done on understanding the complexity of these relationships.

Priorities for IT students are largely the same as the total intake. Protecting environment is the highest priority. IT students are more concerned about strengthening the economy (p=0.02) and limiting population growth (p=0.07) and less concerned about creating a fairer society (p=0.03) than the total intake.

While respondents were familiar with general and popularly known concepts – renewable resources, greenhouse effect etc – they were less confident with ecological concepts and specific principles such as carrying capacity, the precautionary principle. Specific environmental science concepts would have to be taught to enable students to

undertake an essay “along the lines of discuss the impacts for computing as described in the Millennium reports (2003).

Incoming students from across the institution reported limited understanding of indigenous concepts of sustainability.

IT students have a particularly low desire to be involved in improving the environment/community and but are split as to their level of skills to contribute. This is an area that needs more work in understanding factors at play here. Despite having a low pro-ecological worldview, engineering students reported high desire yet similarly anthropocentric business students had a low desire.

There is much variety in the extent to which people undertake (or are prepared to undertake) sustainability related actions. Surprisingly few students reported seeking information for example, and a surprisingly high number of students would not make a report regarding unsustainable activity. IT students report a high resistance to trying to encourage someone else to change an activity or practice that you thought was harmful to the environment. This is of concern as we try to move beyond our own footprint to using computing as an enabler for a wider sustainability.

In response to a scenario, incoming IT students seem to be particularly strident that they would follow instructions even if a task is unsustainable. This seems at odds with the characterisation of our students as independently thinking geeks. Instead, a substantial number of them suggest they would do an unsustainable task on basis of disempowerment with a power relationship. Fortunately, a reassuring 50% would at least talk about it. There is no right answer to this scenario, but articulating appropriate responses should be part of education that hopes to produce sustainable practitioners.

While the majority of IT students see the relevance of sustainability to their study, those that don't are quite vociferous in their incredulity at the suggestion. Other disciplines have similar percentages of “not relevant” but none showed the strength of feeling IT students demonstrated. This could be explained by the worldview – a pro-ecological student may simply have not made the connection (Health fields for example, have people with strongest pro-ecological worldviews, but don't make the connection between this and their careers). Engineers (anthropocentric) see sustainability as strongly relevant yet similarly anthropocentric business see much less relevance. These patterns are complex and not well understood but clearly, different pedagogical strategies would be needed for these different groups (Vartianen 2003).

Many authors have identified gender issues in computing and computing education (Bair and Cohoon 2004). Gender differences in environmental attitudes have been extensively researched and reviewed (Zelezny *et al.* 2000). Research since 2000 suggests that women report more environmental concern than men and greater participation in pro-environmental activity. The introduction of sustainability concepts into IT curricula could help to address the traditional gender imbalance in IT intakes by making the IT world more appealing to women. Gender differences in pro-environmental stance in the Otago Polytechnic are marked and no doubt contribute greatly to departmental/programme differences in student characteristics.

The combined NEP for IT is not distinguishable from the overall male NEP – the 17% female students are not making a substantial impact in this regard.

This paper describes a survey of a single institution. A multi-institutional and multinational survey is underway to extend

these findings. Changes over the eight years from Fien's study suggest an impact of societal changes. Further work will need to separate changes as a result of education and societal/age effects.

The crucial sentence in computing education for sustainability is “*Our goal is that every graduate may think and act as a “sustainable practitioner”*”. This sustainable practitioner means more than technical skills but means we have to come to terms with worldviews, affective learning and action competence (Jensen and Schnack 1997, Shephard 2008). This paper has made a start in these understandings as they relate to computing students.

## 5. CONCLUSION

To effectively gauge the impact of education for sustainability, it is important to establish baseline measurements. The survey described here captures the understandings of a cohort of students at one institution on entry to their chosen field of study. The responses indicate a wide range of understandings, but clear differences emerge across disciplines. Computing students demonstrate low levels of awareness in many sustainability issues. This approach provides useful pointers to computer science education in implementing education for sustainability within the computing curriculum.

### *Acknowledgements*

We are grateful to Paula Petley and Stuart Terry for administering the survey and to Patricia Haden for statistical advice. This research was conducted under Category B ethics approval.

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