
Public literacy on sustainable development

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Abstract: Public literacy on sustainability, knowledge about sustainability and competence to act sustainably, is assessed with a 20-question questionnaire as a function of participants' gender, age, education and annual income by surveying 353 randomly selected typical, non-expert citizens. Exploratory factor analysis reduced the number of independent variables, questions, from 20 to five, which were used for analysis and interpretation. Public sustainability literacy explains more of the total variance than any other latent factor, yet high proportions of 'Don't Know' responses to all theme questions are evident. However, subject responses show a noteworthy level of knowledge and willingness to contribute to sustainable development. Assuming that typical citizens are not passive receptors of decisions made by sustainable development experts, an individual domain of responsibility is introduced to turn policies/regulations and technical advances into knowledge-based actions. The recommended bottom-up approach complements the top-down approach practiced presently and requires national campaigns to teach non-experts specific actions to achieve and maintain sustainability.

Keywords: sustainable development; sustainability responsibility domains; survey questionnaire design; bottom-up approach for sustainable development.

Reference to this paper should be made as follows: Panchal, A.P. and Moschandreas, D.J. (2015) 'Public literacy on sustainable development', *Int. J. Environment and Sustainable Development*, Vol. 14, No. 1, pp.71–88.

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1 Introduction

In this paper sustainability stands for the outcome of sustainable development, which assures that “we have and will continue to have the water, materials, and resources to protect human health and our environment” (US EPA, 2012). Similarly, sustainability signifies “policies and strategies that meet society’s present needs without compromising the ability of future generations to meet their own needs” (UN, 1999). While both definitions assign responsibilities for achieving sustainable development, the United Nations (UN) draws attention on policies and strategies while EPA directs its attention on ‘we’, that includes individuals who must carry out regulations and practices formulated by experts and must assure a rewarding life for present and future generations. A similar point of view defines sustainability as a complex process that creates, maintains and promotes conditions for harmonious and productive coexistence among humans and the natural environment. This coexistence signifies social, environmental and economic endurance and promotes the need for technical awareness supported by principled responsibility by *all* (Bonevac, 2010; Goodland and Daly, 1996; Ratner, 2004). Again this point of view shares pertinent sustainable development responsibilities among regulators, scientists and non-expert citizens.

This study identifies three responsibility domains of sustainability:

- a the *global responsibility domain* stands for the duties of national governments to assure sustainability by establishing policies and strategies
- b the *local responsibility domain* denotes the duties of state/province, city or other municipality governments, pertinent non-government organizations (NGO) and commercial organisations, which operate and act on smaller scale of influence than the global scale
- c the *individual responsibility domain* assigns duties to typical citizens, non-experts, who must contribute toward attaining sustainability.

In this paper, the individual responsibility domain broadens Geddes’ (1915) well known maxim on sustainable development “think globally, act locally”.

Turning policy and regulation into action requires participation of all stakeholders and leads to the individual domain of responsibility, which should be perceived in terms of dynamics that affect action by individuals. In this paper the term *individual* does not refer to active and concerned non-expert citizens, such individuals belong to the second domain of responsibility and are assumed to have ties and influence with institutional perspectives. Consequently, in this paper an individual is the typical citizen, a non-expert citizen, who is not actively involved in the other two responsibility domains of sustainability and may or may not be concerned with sustainable development. By recognising such an individual, the paper advocates the following:

- 1 sustainability is not all about technology and regulations, or that regulators and scientists *alone* cannot achieve global sustainability, non-expert individuals, the majority of citizens, must be drawn in to understand their responsibilities and act accordingly
- 2 technology and regulation evolve to serve people, yet the non-expert individual is not and should not be treated as a passive receptor of decisions made by experts.

Typical citizens must assume responsibility and act to implement policies and strategies as they affect the individual in his/her home, family, travel, lifestyle and global concerns.

The art of transforming knowledge into action, often referred to as knowledge- action system, has been studied extensively and specifically for sustainability. The concept behind “linking knowledge with action” focuses on “the urgency of sustainability challenges requires that research priorities defined by scientists be complemented with research priorities defined by managers and other decision makers if the potential concerns of S&T [Science and Technology] are to be realized in a timely fashion”. The National Academy, NAS, task force hypothesis is “Successful programs linking knowledge with action require dialogue and collaboration between the scientists who produce knowledge (producers) and the decision makers who use it (users)” (NAS, 2006). Clearly, this focus is on the global and local domains of responsibility for sustainable development and the individual domain of responsibility is not addressed. A knowledge-action system integrates all that is required to act efficiently on any given challenge. Such systems are complex, subject-specific and outside the scope of this paper. For the purposes of this paper, the relationship between knowledge and an individual’s action becomes lucid by the following: “Without knowledge action is useless and knowledge without action is futile” by Abu Bark (570–634.) and “Knowing is not enough; we must apply. Willing is not enough; we must do” by Goethe (1749–1832). If non-expert individuals were to change from passive receptors to willing contributors and if willing is not sufficient and knowledge without action is futile, the following question is posed: do non-expert individuals know enough to make their contribution and help achieve a sustainable community? This question leads to this paper’s central research theme, which explores whether typical, non-expert; citizens possess the necessary knowledge to act responsibly and effectively.

Most surveys conducted to study individual knowledge of sustainability are based on opinions of expert individuals who work in the government, academia, corporations or not-for-profit organisations. Expert concerns include

- 1 the predicted population growth from 6.9 billion to about 9.5 billion by 2050 (US Census Bureau, 2010) and the associated resource consumption at unsustainable rates
- 2 economic advancement alone does not justify degradation of the environment and social, ecological and fiscal domains should be integrated (Mirshojaeian Hosseini and Kaneko, 2010)
- 3 sustainability is a multidimensional performance concern that encompasses energy consumption, the food chain complex, water quality and distribution systems, waste management, disposal of toxic substances, use of materials and resources, indoor environmental quality, conservation of sustainable sites, awareness and education, (U.S. Green Building Council, 2012).

Sustainability surveys abound online for volunteers to assess their understanding of sustainable development. Analysis of such studies is not always clear and is not reported widely and comprehensively. Importantly their subjects are not selected randomly. In fact, to the best of the authors’ knowledge, there are no studies that select subjects randomly to evaluate their sustainability literacy, which is defined as subjects’ knowledge about sustainability and competence to act sustainably.

The public outlook towards the overall concept of sustainable development has not been assessed, although research is available for public perception of individual sustainability elements (Singh et al., 2009). For instance, since 1986, the Department for Environment, Food and Rural Affairs (DEFRA) of the United Kingdom conducts surveys every few years to track the public mind-set and activities towards the environment (DEFRA, 2009), but such surveys overlook economics, population growth and environmental quality. The American Association for Public Opinion Research (AAPOR) conducted a study to recognise the public perception of sustainable foods only (Lyon, 2004). Scientists have studied public knowledge on global warming to conclude that while most people are peripherally aware of the threat, they are also uninformed about actions required to manage global warming (Leiserowitz et al., 2010; Pigeon, 2006; Brechin, 2003; and others). An additional survey is performed annually to determine business concerns regarding sustainability (Leonard Academy, 2009). An interesting survey asked its subjects, individuals with professional interest in sustainability, to arrange in order of importance profit (economic development) and planet environmental protection (Gallup, 2011). While the order is of importance, it is essential to note that this work endeavours to decompose the triad of 'people, planet, and profit' that establishes sustainability as one entity.

Public knowledge and social behaviour has been studied by series of studies described by McLoughlin (2004) and references within this paper that describe research on understanding sustainability and associated concepts and efforts to separate a community into segments based on 'environmental knowledge, attitudes and behaviour'. This and similar studies worked with focus groups and are related to but different from the study described in this paper, which explores similar issues utilising randomly selected subjects.

The scientific hypothesis of the present paper explores the level of public sustainability awareness evaluated with a survey of individuals in Chicago, one of the leading US sustainable cities according to 2008 U.S. City Rankings US Small Business Administration, 2011; SustainLane, 2011). This hypothesis is based on the notion that if a typical citizen does not understand the fundamental concepts and practices of sustainable development, then sustainability will not be achieved within the required time interval of about 50 years (Flannery, 2005). Moreover, this scientific hypothesis asserts that public knowledge and understanding and associated actions constitute a prerequisite for sustainable development because typical individuals implement practical applications of expert knowledge.

Accordingly, the explicit study objective is to assess public literacy, knowledge of and competence in, sustainable development as a function of gender, age, education and annual income by conducting a survey of non-expert typical citizens. The surveyed subjects responded to 20 questions related to sustainable development. These questions do not require specific scientific knowledge, address issues that individuals would know if they had a general, though not clearly defined, concern about sustainability and an equally general aspiration to act toward achieving sustainable development. The term survey question is used interchangeably with observed variable and/or statement.

2 Material and methods

2.1 The questionnaire

A pre-survey questionnaire was tested on several subjects. The feedback received led to reducing the number of questions in the pre-survey questionnaire and to rephrasing a few among those that were retained. The final version included 20 sustainability questions based on energy, water, air quality, materials and site sustainable development issues and four demographic questions: gender, age, education, annual income in categorical scales. Survey subjects were selected randomly and responded in the vicinity of randomly selected churches, shopping malls, stores, public transportation stations, school and office buildings, business centres and other areas of public gatherings but not inside such buildings.

The final questionnaire, see Table 1, includes 20 questions or variables; 15 are designated as factual questions, or questions for which the literature provides an explicit and unambiguous answer; the remaining five questions are designated as opinion questions because the literature does not provide a single accurate/acceptable answer but provides public opinion. Two questions are considered as quality control questions, because they are paired and seek responses of the same concept expressed differently. The response scale of each question is a minor variation of the five point Likert scale; in this paper the conventional response ‘neutral’ is replaced by ‘don’t know’. Consequently, the response to each question has five levels: strongly agree, agree, don’t know, disagree and strongly disagree. When asked, potential subjects who declared that are working on projects or volunteering in activities related with sustainable development were excluded from responding to the questionnaire.

Table 1 The questionnaire

<i>Demographics</i>				
1	<i>Gender</i>	Male	Female	
2	<i>Age (years)?</i>	Below 17	17–29	30–50 Above 50
3	<i>Education level?</i>	High School	Some College	Undergrad Post graduate
4	<i>Annual income</i>	Less than 25,000	30,000–70,000	More than 70,000
<i>Directions</i>				
1	Based on your knowledge, you need to select an option for every statement asked in the survey.			
2	In order to assist you with the response options, follow the guidelines:			
	<ul style="list-style-type: none"> Strongly agree is like hearing music and being able to recognise the lyrics, the singer and the beats. Being sure about the song you are hearing. Agree is like hearing some familiar music, but being unable to recognise the exact song. Disagree is like hearing something (a sound) and being unable to determine if it is a car horn, a telephone bell or a song. Strongly disagree is like not hearing anything. 			

Table 1 The questionnaire (continued)

<i>Questions on sustainable development</i>		<i>Strongly agree</i>	<i>Agree</i>	<i>Don't know</i>	<i>Disagree</i>	<i>Strongly disagree</i>
1	Energy conservation and sustainability describe the same concept					
2	The initial investment of a green building construction increases in cost with respect to a conventional construction by 12%					
3	Activities associated with 'green washing' are sustainable					
4	Consumption of beef increases green house gases					
5	Human activities cause global warming					
6	Dishwashers operated on FULL LOAD are more energy efficient than washing dishes by hand					
7	The current trend of increasing global population hinders Sustainable Development					
8	'Xeriscape' indicates employment of drought resistant plants to conserve resources, especially water					
9	I will pay an extra \$2 per month to support a new Sustainable programme fee in my city					
10	Energy conservation is to sustainability what a tire is to a car					
11	Smoking affects Sustainable Development					
12	'People, planet and profit' define sustainable development					
13	The present rate of sustainable progress is not sufficient to avert irreversible climate change					
14	Certified sustainable buildings increase productivity at work					
15	The government, the scientific and the engineering communities will solve all concerns and assure sustainability within the next ten years					
16	Sustainability limits development					
17	Brownfield remediation is an important aspect of sustainable development					
18	Economic consideration is an important element of sustainable development					
19	Wearing a sweater in winter contributes to sustainable development					
20	Bottle water protects the ecosystem					

When asked, a large majority of the potential respondents who declined to participate in the survey, responded with variations of 'I do not care' or 'I do not know'. Such responses indicate that non-responding individuals have minimal knowledge of or

competence in sustainable development issues. The data analysis is based on information obtained from the 353 randomly selected individuals who responded to the survey questionnaire.

The subjects responded to the questionnaire in the presence of one of the authors; each individual was shown the University Institutional Review Board (IRB) approval and given a consent form. The consent form, shown to each potential survey participant stated that their participation was voluntary and they could withdraw at any point while answering the survey statements. The process of responding to the questionnaire took a maximum of 15 minutes per individual.

The generated database, responses to both demographic and sustainability questions, is in the categorical format, on either nominal scale, (gender of the subject) or ordinal scale (age, education, annual income and responses to the survey statements). Statistical analyses for this research were carried out using SPSS (formerly, Statistical Package for the Social Sciences).

Descriptive statistics summarised the sample database and described its basic features. Factor analysis may be either exploratory factor analysis (EFA) or confirmatory factor analysis (CFA). The EFA method used in this study is a technique that explores if subject responses, observed variables, reveal an underlying pattern of structure, which identifies specific variables of a set to form a small number of coherent subsets or factors that are nearly independent of one another. The EFA determines the number of factors by performing a principal component analysis while the CFA requires that investigators specify the number of factors a priori. Multinomial logistic regression (MLR), a logistic regression that permits more than two discrete outcomes, may lead to a significant likelihood ratio test, which enables investigators to reject the null hypothesis of no association between independent variables and the outcome. In this paper, contingency tables and Pearson chi-square tests are employed to examine the relationship between every question and each demographic category and multiple logistic regression is used to investigate potential relationships among all factors and each demographic category.

2.2 Justification of survey questions

Each question posed was justified by a review of the literature. The literature reviewed was not exhaustive and publications selected are more likely to be read by non-expert citizens rather than scientists, engineers and regulators. The justification of each question states the rationale for asking the question, proceeds by assessing the literature and ends by providing the authors' a conclusion on the response level. The response scale reflects literature conclusions for factual questions and the authors' judgment on opinion questions when the literature is inconclusive. In this paper summaries of the justification for three questions/statements, one for each type of question, are provided to illustrate the process.

One of the survey statements is "Dishwashers operated on FULL LOAD are more energy efficient than washing dishes by hand" This statement is justified by a commonly held notion that hot water is conserved by manually washing the household dishes or, conversely, by failing to notice that, an automatic dishwasher operated on full-load is energy-efficient when compared to manual dishwashing. This question tests the public knowledge on sustainability with respect to domestic tasks where typical citizens may contribute to sustainability. The literature establishes that the appropriate response is at the *agree level* because all pertinent publications reviewed declare that water is conserved

but the consumer must learn to use dishwashers fully loaded, otherwise frequent use of dishwashers wastes both energy and water (U.S. Department of Energy, 2009; Stamminger et al., 2007; Emmel et al., 2003).

The opinion statement “The current trend of increasing global population hinders Sustainable Development” investigates a widely discussed concern. The world human population is projected to grow from 6.9 billion to about 9.5 billion by 2050, and along this growth the rate of consuming limited natural resources is growing substantially (US Census Bureau, 2010). The population growth the earth can endure without ecological harm is defined as the earth’s ‘carrying capacity’. There is ambiguity in terms of environmental systems and while reduction of the rate of population growth could lead to ecological restitution, studies demonstrate that reaching equilibrium in population at present could reduce the replacement rate by 2043 leading to a decrease in work-age people. In all likelihood such a trend will jeopardise the economic and ecological sustainability from 2050 onwards. For an overall sustainable development, a growing work-age population is necessary and it is imperative that individuals realise the finite amount of resources and avoid over consumption. The literature supports a well-planned strategy and a systematic course of action to attain economic and environmental sustainable development under rising and falling world population. Such plan does not exist at the present time. The literature supports an *agree level* (Daily and Ehrlich, 1992; Bartlett, 1998; McNicoll, 2005; Engelmann, 2009; and others).

“Energy conservation and sustainability describe the same concept” and “Energy conservation is to sustainability what a tire is to a car” are two statements that serve as control of each other. A common misconception is the use of sustainability and energy conservation interchangeably, without realising that one is a subset of the other. Therefore, these questions explore whether participants understand the fundamental notion of sustainable development. The literature clearly establishes that energy conservation and environmental stewardship are closely related and energy conservation conventionally promotes environmental quality. However, research reveals that energy conservation policy may not prevent public health concerns and an economic downfall and therefore an overall sustainable policy is required. Thus, energy conservation and sustainability are not the same concept and *strongly disagree* is the correct response to this statement. The second statement addresses the same concept by declaring that energy conservation is a component of sustainability. Consequently the literature supports the notion that energy and sustainability are not synonymous and the correct response is *strongly agree* (Prindle et al., 2007; US EPA, 2012; Seligman et al., 1978; Hannon, 1975; Blumstein et al., 1979; Sutherland, 1996).

3 Results

The survey response rate was 68% for a total of 353 subjects. Descriptive statistics illustrate that 56.4% of the survey subjects are females compared to 51.3%, which is the female population of Chicago according to the US Census Bureau (2010). The slightly larger portion of female respondents indicates that females are easier to approach for a survey when compared with males. The age distribution of the subjects is similar to that of the US Census Bureau (2010) with a notable exception: the proportion of subjects less than 19 year old was much smaller than that of the Chicago population. The level of education of survey subjects was markedly different from that of Chicago citizens, for

81%, of survey respondents had at least a college degree. The discrepancy between respondents' and Chicagoans' education may be attributed to individuals who refused to participate in the survey and stated that the questions were beyond the scope of their interests and knowledge. Most survey participants' income falls in the income group of USD 30,000 to 70,000 and those below and above this income group are evenly distributed. It is difficult to compare this information with that of the Census because the census provides family income and the study requested individual income.

Table 2 illustrates the acceptable responses to the factual questions and identifies the opinion questions interspersed among the factual questions.

Table 2 Acceptable/correct answers to survey questions

<i>Question description</i>	<i>Acceptable answer*</i>
1 Energy conservation and Sustainability describe the same concept	S.D.
2 The initial investment of a Green Building construction increases in cost with respect to a conventional construction by 12%	A
3 Activities associated with 'Green washing' are sustainable	S.D.
4 Consumption of beef increases green house gases	S.A.
5 Human activities cause Global Warming	O.Q.
6 Dishwashers operated on FULL LOAD are more energy efficient than washing dishes by hand	A
7 The current trend of increasing global population hinders sustainable development	O.Q.
8 'Xeriscape' indicates employment of drought resistant plants to conserve resources, especially water	S.A.
9 I will pay an extra \$2 per month to support a new sustainable programme fee in my city	S.A.
10 Energy Conservation is to Sustainability what a Tire is to a Car	S.A.
11 Smoking affects sustainable development	S.A.
12 'People, planet and profit' define Sustainable Development	A
13 The present rate of sustainable progress is not sufficient to avert irreversible climate change	O.Q.
14 Certified sustainable buildings increase productivity at work	A
15 The government, the scientific and the engineering communities will solve all concerns and assure Sustainability within the next ten years	O.Q.
16 Sustainability limits development	D
17 Brownfield remediation is an important aspect of sustainable development	A
18 Economic consideration is an important element of sustainable development	S.A.
19 Wearing a sweater in winter contributes to sustainable development	A
20 Bottle water protects the ecosystem	S.A.

Contingency tables illustrate that large segments of typical citizens do not know the meaning of such relevant to sustainability terms or issues as xeriscape, 54%, brownfield, 46%, green washing, 38%. One may suggest that these relatively large segments should be expected because these terms are used mostly by specialists. Should this be the case,

typical individuals must be educated to encourage water conservation by xeriscape landscaping support and promote brownfield elimination, and avoid green washing and consequently encourage sustainable development. Moreover, proper education would lead to a better decision making process and improve the surprising 8% of subjects who did not know if they would be willing to contribute two dollars per month toward a city sustainable project and the equally surprising 18% of subjects who did not know that 'people, planet and profit' is a widely held characterisation of sustainable development, which reveals the continuum of values associated with sustainable development (Elkington, 1994).

Subjects are more likely to agree or disagree with a statement than strongly agree or strongly disagree indicating that their confidence is not very strong. Interesting inferences can be made on additional findings: a statistically significant portion of subjects, 61%, does not differentiate between energy and sustainability; another statistically significant portion of subjects is not aware of the fact that our eating habits affect sustainability. The two control questions have consistent trend; corresponding correct response portions were very low, below 9%, but their difference was statistically significant. This difference is attributed to the large percentage of subjects who did not know or did not recognise the energy conservation-sustainable development relationship when it was given as an analogy; 21% of the subjects did not know or had a response when the analogy was used as opposed to 9% when the declarative sentence was used to express the same concept. When the responses of strongly disagree and Disagree were normalised by the ratio of don't know, the agreement between the two questions improved markedly.

Pearson chi-square tests led to one expected and one unexpected conclusion. The expected conclusion establishes that a potential association is question dependent. The unexpected and most intriguing finding is that education has a statistically significant association with only three variables while each of the other three demographic variables associate with at least seven variables.

Requirements for carrying out EFA, (small correlation coefficient values, smaller than 0.9, in the correlation matrix of the questions and its determinant value 0.08) reveal that multicollinearity is not an issue with the database generated. The sample size satisfies the rule of thumb of 10–15 subjects per variable, which is further supported by the value of Kaiser-Meyer-Olkin measure of sampling adequacy, 0.749, which indicates an adequate sample size and suggests that correlations are compact and that EFA would effectively produce factors or latent variables. Finally, the significance of the Bartlett's test of sphericity confirms that factor analysis is suitable for this database (Field, 2005).

This study retains factors with eigenvalues greater than one. Another criterion for eigenvalue retention is the scree test, which plots eigenvalues against component number and retains factors with eigenvalues in the descent segment of the plot just before the inflexion point after which eigenvalue values stabilise and result in a straight line. After extraction the factor solution is rotated to assure that only one factor is maximally loaded and to make interpretation easier. In the conclusion of the above processes, five factors were retained by factor analysis. Eigenvalues linked with each extracted, by EFA, factor indicate the importance of that factor by estimating the variance explained by that specific linear model or component, see Table 3. Variables that load, or correlate, within the same factor have a common theme, which is conventionally used to name the factor, see Table 4.

Table 3 Fifteen total variance explained via eigenvalues

Component	Initial Eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.521	1.956E1	19.559	3.521	19.559	19.559	2.093	11.630	11.630
2	1.497	8.315	27.875	1.497	8.315	27.875	1.767	9.819	21.450
3	1.337	7.430	35.305	1.337	7.430	35.305	1.567	8.707	30.156
4	1.240	6.891	42.196	1.240	6.891	42.196	1.557	8.649	38.805
5	1.077	5.981	48.176	1.077	5.981	48.176	1.394	7.746	46.551
6	1.051	5.838	54.014	1.051	5.838	54.014	1.343	7.463	54.014
7	.959	5.326	59.341						
8	.913	5.075	64.415						
9	.905	5.030	69.445						

Notes: Extraction method: principal component analysis; initial eigenvalues for components 9–20 not shown

Table 4 Latent sustainability factors

<i>Latent factor</i>	<i>QS. #</i>	<i>Questions/major themes</i>
1 Public sustainability literacy	Q.17	Brownfield remediation is an important aspect of sustainable development
	Q.2.	The initial investment of a green building construction increases in cost with respect to a conventional construction by 12%
	Q.3.	Activities associated with 'green washing' are sustainable
	Q.8.	'Xeriscape' indicates employment of drought resistant plants to conserve resources especially water
2 Individual activities	Q.11.	Smoking affects sustainable development
	Q.7.	The current trend of increasing global population hinders sustainable development
	Q.19.	Wearing a sweater in winter contributes to sustainable development
	Q.4.	Consumption of beef increases green house gases
3 Community issues	Q.14.	Certified sustainable buildings increase productivity at work
	Q.13.	The present rate of sustainable progress is not sufficient to avert irreversible climate change
4 Contributions	Q.9.	I will pay an extra \$2 per month to support a new sustainable programme fee in my city
	Q.5.	Human activities cause Global Warming
	Q.1.	Energy Conservation and Sustainability describe the same concept
5 Economic concerns	Q.16.	Sustainability limits development
	Q.6.	Dishwashers operated on FULL LOAD are more energy efficient than washing dishes by hand
	Q.12.	'People, planet and profit' define sustainable development

Variables of the first latent factor, public sustainability literacy, are concepts and terms of sustainability; according to descriptive statistics the majority of the response to these variables was 'don't know'. The second factor includes variables reflecting individual activities that may affect sustainability; the maximum number of subject responses to this factor is 'agree'. The third latent factor relates to community issues regarding future perspectives of sustainability and also has the maximum number of 'agree' as their response. The next latent factor consists of variables on individual contribution to sustainable development and ecological concerns. The majority of responses are on the 'agree' level. The final latent factor reflects economic concerns as an element of sustainable development. Subject responses are distributed evenly among 'agree' and 'disagree' or 'don't know'.

The cumulative percent of total variance explained by the five retained factors is 48.18%, see Table 3, and that public sustainability literacy explains 19.56% of total variance followed by individual activities (8.32%) community issues (7.45%), individual concerns (6.9%) and economic concerns (5.98%). After rotation, the cumulative percent of total variance explained is 46.55%; the variance explained by the public sustainability acuity factor is 11.6% followed by individual activities (9.98%), community issues (8.9%), individual concerns (8.05) and economic concerns (7.75). The sixth factor with eigenvalue larger than 1.0 was not retained because

- 1 the scree plot did not justify its retention
- 2 no common theme could be identified.

MLR analyses the relationship among factor scores obtained from EFA and the demographic categories. The factor scores are independent variables, while the demographic categories are dependent variables. Five factor scores are recorded for each of the 353 individuals depending on how they responded to sustainability questions. The relationship between factor scores and the respondents' gender is significant, for the gender relates with factor 3 (community issues, $p = 0.018$) and factor 4 (individual concerns, $p = 0.020$). Similarly, the relationship between the factor scores and the participants' age is significant because age relates with latent factor 1 (sustainability literacy, $p = 0.000$), factor 2 (individual activities, $p = 0.000$) and possibly factor 3 (community issues, $p = 0.095$). Finally, the dependent variable annual income relates significantly with latent factor 1 (sustainability literacy, $p = 0.002$). The relationship between education and factor scores is not significant; a similar conclusion was reached with the contingency table analysis.

4 Discussion

The above results are put in perspective and discussed in this section. Table 5 examines the proportion of correct responses to Factual questions... The responses at the 'don't know' level range between 9 and 54%; the average equals 21% and the standard deviation equals 3.8%. The portion of responses to factual questions answered correctly ranges between 25 and 76%; the average equals 50.9% and the standard deviation 3.8%. In this paper 'correctly' stands for the author's assessment of the prevailing response in the literature. The percent of correct responses is classified into three groups. The first category of low percentage of correct responses is the one on green washing; it was answered correctly by 25% of the subjects and 33% did know the response to this question. The second category reflects a range of correct responses between 36 and 59% with an average value of don't know of 24.7% (standard deviation 5.06%) The third category contains questions that were answered correctly by more than 60% of the subjects; the average of don't know responses was 11.82% (standard deviation 3.05%) The maximum correct response portion of 76% is the statement associated with "Economic consideration is an important element of Sustainable Development".

The summary of opinion variables, Table 6, combines the percent of responses strongly agree and agree into one portion denoted by agree and, similarly responses strongly disagree and disagree are combined into one disagree proportion. Responses to opinion questions illustrate that individuals are willing to contribute towards sustainable development, mindful of human activities responsible for global warming, fearful of reaching irreversible effects on climate, and cognisant of potential problems with the increasing global population. Moreover, typical individuals are willing to assert that the government and the scientific and engineering communities alone cannot resolve all sustainability concerns. This is a positive finding, leading to an expectation that non-experts are enthusiastic to promote sustainability, provided they are given more information. It is also interesting that the proportion of 'Don't know' responses to the opinion questions is consistently less than 16% with a mean value of 11.6% (standard

deviation of 1.7) while the corresponding ‘don’t know’ average for factual questions is nearly twice as large at 21.7% (standard deviation of 3.8).

Table 5 Proportion of correct responses to factual questions

<i>Qs. #</i>	<i>Question description</i>	<i>% of correct responses</i>
1	Energy conservation and sustainability describe the same concept	39%
2	The initial investment of a green building construction increases in cost with respect to a conventional construction by 12%	40%
3	Activities associated with ‘Green washing’ are sustainable	25%
4	Consumption of beef increases green house gases	46%
6	Dishwashers operated on FULL LOAD are more energy efficient than washing dishes by hand	48.5%
8	‘Xeriscape’ indicates employment of drought resistant plants to conserve resources, especially water	36%
11	Smoking affects sustainable development	59%
12	‘People, planet and profit’ define sustainable development	50%
14	Certified sustainable buildings increase productivity at work	44%
16	Sustainability limits development	57%
17	Brownfield remediation is an important aspect of sustainable development	40%
10	Energy conservation is to sustainability what a tire is to a car	66%
18	Economic consideration is an important element of sustainable development	76%
19	Wearing a sweater in winter contributes to sustainable development	67.5%
20	Bottle water protects the ecosystem	69.5%

Table 6 Summary of responses to opinion questions

<i>Qs. #</i>	<i>Question description</i>	<i>Don’t know</i>	<i>Agree</i>	<i>Disagree</i>
5	Human activities cause global warming	8%	75%	17%
7	The current trend of increasing global population hinders sustainable development	11%	66%	23%
9	I will pay an extra \$2 per month to support a new sustainable program fee in my city	8%	68%	23%
13	The present rate of sustainable progress is not sufficient to avert irreversible climate change	16%	63%	21%
15	The government, the scientific and the engineering communities will solve all concerns and assure sustainability within the next ten years	15%	25%	60%

This paper introduces the individual responsibility domain, in addition to the conventional global and local responsibility domains for sustainable development. The very existence of the individual responsibility domain establishes the notion that non-expert typical citizens, the public, have an undeniable interest and investment in sustainable development and must

- a become active contributors to the sustainable development decision making process
- b engage attentively in the practice of collective decisions.

In the absence of an explicit responsibility domain for typical citizens, they will continue their present role of passive receptors of decisions made by policy experts, regulators and scientists. The study objective of this work explores and assesses public sustainability literacy, which requires both knowledge of pertinent concepts and competence to apply this knowledge in daily endeavours toward achieving sustainable development. It is recognised that sustainable development is a complex task that does not depend merely on knowledge or respond linearly to knowledge because additional personal attitudes affect an individual's actions. In this paper it is assumed that independently of personal attitudes to sustainable development knowledge is necessary to correctly respond to sustainability requirements.

EFA reduced the number of independent variables from 20 to 5, a more manageable size that preserves the initially accumulated information and evaluates public sustainable literacy by studying collinear factors. The general conclusions reached by factor analysis are similar to those reached by other analysis methods, Education does not relate to any of the latent factors while the other demographic variables relate significantly with at least one factor. This unexpected finding reflects the fact that only educated and motivated, but not actively engaged in the practice of sustainability, typical citizens were willing to be surveyed. Each of the remaining demographic variables, gender, age and annual income relate significantly with either one factor by way of a simple linear regression, or more than one factors via multiple linear regression.

5 Conclusions

Four general response types resonate with the analysis of the survey database: Firstly, public sustainability literacy explains more of the total variance than any other individual factor; the underlying characteristic of this factor is lack of subject knowledge. Secondly, the other factors, taken together, show a certain level of knowledge and willingness to assist on individual, community and economic concerns related to sustainability. Thirdly, the relatively large proportion of 'Don't Know' responses and the justification given by those who declined to be surveyed, I don't know or care, leads to the conclusion that the non-expert must be educated and inspired to learn both the terms and actions that will assist in achieving sustainable development. Finally, given the high level of subjects' education, responses to this questionnaire may reflect opinions of well educated non-experts *and not* of the population of Chicago.

The literature indicates that experts write for experts, volunteers talk to volunteers and the general public is concerned but too busy to act. This approach may be appropriate for a few scientific and social activities but it is not a correct approach for sustainability because, in our opinion, sustainable development is achieved jointly when all stakeholders work together and those in the individual responsibility domain become educated and inspired to put in practice decrees or suggestions made by those in the other two responsibility domains. If public literacy denotes individuals' ability to analyse, synthesise and apply information, results from this study demonstrate that an attitude adjustment is required to assure that regulators and scientist work actively and competently with the general public. If this partnership does not come to pass, non-expert

individuals, even well educated non-expert individuals, become passive receptors of information and, by definition, passive receptors do not put into action information they receive.

Turning policy and knowledge into action, the essence of the suggested attitude adjustment, requires that regulators and scientists continue to focus on their important work and add an equally important task: they must teach teachers to teach students and the general public *specific* daily activities that, taken together, will lead to effective sustainable development. This task is presently left to volunteers who are, regrettably, ignored by many. Like personal hygiene care, sustainable development must become an integral element of the early and continuing education for all. The teaching the teachers to teach sustainable practice is, we believe, an effective approach because benefits are likely to exceed costs substantively. The proposed approach of teaching non-experts to put into practice specific sustainable ideas is a bottom-up approach that reinforces efforts to achieve and maintain sustainability and complements the presently practiced top-down strategies. The large proportion of 'Don't Know' responses to questions posed by this study must not be tolerated by those in the global and local responsibility domains.

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