Promoting Environmental Stewardship through Project-Based Learning (PBL)

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Abstract

Environmental stewardship is living responsibly as a caretaker of the environment for the benefit of present and future generations and is quickly becoming one of the most pressing public priorities for communities today. As stewards, we are personally responsible for the care and preservation of our fellow communities: human, plant or animal. It is grounded in an understanding of the importance of environmental quality and natural resources to the human race and the effects of human actions on the environment. Thus, it is important to provide relevant educational experiences that involve students and promote an understanding of their responsibility to care for the world and its resources. This paper presents the findings from a study conducted to investigate the effect of project-based learning on students' attitudes and behaviors towards the environment. A total of 173 pre-service teachers enrolled in a chemistry teaching methods course participated in this study. The pre-service teachers were in their third year of the teacher education program. Data were collected through questionnaires containing Likert-type items designed to assess the degree of environmental concern and readiness in pro-environmental behaviours. As part of the project, they were required to identify topics in the chemistry syllabus that are deemed relevant and suitable to teaching climate change and to design a Web-Quest lesson on global climate change. The topic was chosen as it is one of the growing threats to society caused by human activities and the complexity of the topic offers an opportunity to engage students in higher order thinking skills in addition to making learning relevant. For, in the end, as noted by one Senegalese ecologist, we will conserve only what we love, we will love only what we understand, we will understand only what we have been taught. Results indicated that adopting the PBL could enhance students' attitudes and behaviours towards environment.

Introduction

As the global population grows and standards of living improve, there will be increasing stress on the world's limited resources. This situation would require both present and future generations to use the earth's resources more efficiently and produce less waste. The proper use and management of the earth's resources are the responsibilities of every individual. There is a need for every individual to understand that the environment has an impact on lifestyle and quality of life. Similarly, their lifestyle has an impact on the environment. Each and every one of us will be responsible for making decisions that will shape the health of the environment. To prepare for such responsibilities, there is a need for sound Environmental Education (EE) as a foundation from which to make those decisions. Formal education is the most suitable medium to create an environmentally responsible citizen and to prepare for the challenges. The long term effects of increasing awareness will lead to a more informed citizenry that is well equipped to solve future challenges.

Stewardship is usually used to describe forms of "responsible" management where concerns such as sustainability and environmental quality are being promoted (Worrell & Appleby, 1999). In addition, Worrell and Appleby (1999) defined stewardship as the responsible use (including conservation) of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society. Environmental stewardship as defined by the Environmental Protection Agency (EPA, 2005) is the responsibility for environmental quality shared by all those whose actions affect the environment, reflected as both a value and a practice by individuals, companies, communities, and government organizations. Positive stewardship behaviour demonstrates acceptance of this responsibility through the continuous improvement of environmental performance to achieve measurable results and sustainable outcomes. Strong environmental stewardship is expressed in both values and practice. The values are: respect for the environmental, on which life depends; acceptance of personal and organizational responsibility for environmental quality; and recognition of the need to sustain the environment for future generations.

These values are consistent with one of the principles of Islam Hadhari or civilization and comprehensive Islam, i.e., citizens is urged to protect the environment (Bashir, 2005). This call is also consistent with the basic foundations of an environmental ethic in Islam, i.e. to use no more than is necessary, to respect the privileges of other species, and to preserve and protect creation in all its various forms (Chishti, 2003). EE is critically important in shaping values, perspectives, and understanding of the environment and how to interact with it. 'Environmental attitudes' deal with the affective domain while 'environmental behaviour' refers to the overt and observable actions taken by a student in response to the environment (Geok Chin et al., 1998). Research indicates that environmental knowledge and attitudes are factors identified to influence environmental behaviours (Dillon & Gayford 1997). Education plays an essential role in the formation of pupils' positive attitudes towards the environment, both social and natural. Fostering EE is critical because it helps in developing adults who understand and care about environmental stewardship. EE was formally introduced into the Malaysian school curriculum in 1983 but not as a subject (Arba`at, 2006). Teachers are required to integrate the concepts and components of EE across the curriculum at all levels, particularly in subjects like Science, Geography, History, Local Studies, Math, and languages.

To facilitate the tasks for teachers, EE Curriculum Guidelines that include the specific objectives, components and implementation strategies of EE at pre-school, primary, and secondary levels was provided. The goals of the EE in the Malaysian school curriculum are to educate children in order to create an environmentally aware and caring society whose members can act individually and collectively to overcome environmental problems; enable children to love and care for the environment so that they will think and act wisely to preserve it; and make children aware of the importance of sustainable development. The ultimate goal of EE is to sensitize the public towards environmental problems and lay the foundations for the citizens' active participation in the protection of the environment and the appropriate use of natural resources (Flogaiti, 2006). Even though EE is infused into the school curriculum, it is unfortunate that its importance is not stressed and so students do not really see the need to practice an environment-friendly life-style (Thiaga, 2005). Studies keep revealing that Malaysians in general and students specifically have not reached a certain desired level of commitments towards our environment (Komala Devi, 2009). EE research has tended to conclude that the problems associated with the implementation of environmental education are due to a perceived lack of adequate pre-service and in-service environmental education training.

Thus, the provision of further or restructured teacher education has been identified as the 'priority of priorities' for environmental education (Ballantyne, 1995). Project-based learning (PBL) is a well-known method for imparting thinking competencies and creating flexible learning environments. Students have a chance to learn by doing, enhancing their critical skills and shaping the learning process by being active participants. Students in a PBL environment deal with real-life problems, which may result in permanent knowledge. In PBL, projects are focused on questions or problems that "drive" student to encounter (and struggle with) the central concept and discipline and maybe build around thematic units (Blumenfeld, et al., 1991). An environmental topic which has been debated in various arenas, including among scientists themselves is global warming and climate change. Despite the scientific consensus on global warming, the issue is still controversial and confusing for the general public. With only superficial knowledge and unfounded ideas about climate change, citizens are not in a position to take the steps necessary to stem its progression. Inadequate information about climate change either from the news media and the curriculum has precluded an accurate assessment of the situation and what should be done about it.

From pedagogical perspective, climate change is a challenging topic to teach and to learn and the complexity of the topic offers an opportunity to engage students in higher order thinking skills in addition to making learning relevant. As climate change science rapidly advances, it is essential for educators to have up-to-date, relevant teaching materials that present the basic concepts in ways that stimulate student interest. Teaching environmental stewardship both by example and through concrete learning will ensure the students' contribution to a cleaner, sounder global environment. In recent years, technology has taken on a strong role in education and has become a common tool in the classroom. It has the potential to support student's ability to find and share updated information (Blumenfeld, et al., 1991). Technology can also supplement whole class instruction and give students the tools to reach more in-depth understandings. Hence, this study was conducted to investigate the effect of IT-enhanced PBL on students' attitudes and behaviour. As part of the course assignments, students were required to identify topics in the chemistry syllabus that are deemed relevant and suitable to teaching climate change. They were also required to work in teams for the development of a Web-Quest project on the topic of Global Climate Change.

Methodology

This study employed a one group pre-test-post-test design.

A total of 173 students enrolled in the chemistry teaching methods course were involved in the study. Of the respondents, 11.5% were males and 88.5% were females. The students were in their third of year of the Science with Education program. All the students were chemistry majors. Questionnaires were utilized to measure students' environmental attitudes and behaviour. The Environmental Concern Scale developed by Weigel and Weigel (1978) was used to measure students' attitudes towards environment (Appendix). The instrument contained 11 items and divided into two dimensions (Chan, 1996): 'personal sacrifice' and 'optimism/issue'. 'Personal sacrifice' consists of five items (Q1, Q3, Q6, Q7, and Q11) while 'optimism/issue' six items (Q2, Q4, Q5, Q8,Q9, and Q10). Personal sacrifices refer to the willingness of the respondents to act to protect the environments although this action will sacrifice their time and money. Optimism/Issue refers to the tendency of the respondents to believe that there are always solutions for environmental problems. For instance, they believe that contamination of rivers, oceans and air will soon return to normal by nature's purifying processes. The items used a four-point Likert-type scale ranging from Strongly Agree to Strongly Disagree. The Environmental Concern Scale has been demonstrated to exhibit adequate internal consistency and predictive validity and also had received evidence of reliability and validity in various studies in Western cities (Chan, 1996; Weigel & Weigel, 1978). The Cronbach's for the attitude questionnaire used in this study was 0.630.

Environmental behaviour was measured using 11 pro-environmental behaviour statements. The statements were taken from two different sources: Chan (1996) and Volk and McBeth (1997). The items also utilized a four-point Likert-type scale (1= strongly agreed and 4=strongly disagreed) which is use for the codification of the answers. The behaviour were selected on the basis that (1) the students would be familiar with them and that they were within their capabilities to participate, (2) the bahaviours were clearly related to the environmental issues and (3) the behaviours were different in nature and situations (Chan, 1996). The internal consistency of the behavioural intention score, as measure by the Cronbach's alpha was found to be very high (0.831). This indicates that the pro-environmental behaviours were selected from a consistent set of behavioral indicators. The score for the eleven items, after reversing, were summed to give an overall behavioural intention score. The impact of the project-based learning on, attitudes and behavioural intentions of pre-service teachers was evaluated using these questionnaires. The same pre- and post- questionnaires were administered at the beginning and last class sessions respectively. Data obtained through the questionnaires were analyzed using the Statistical Package for Social Science (SPSS) software version 11.5. Descriptive analysis, simple correlation and paired sample t-test analysis were utilized in analyzing the data. To analyze students` attitudes and behaviour, descriptive and inferential statistics were used while Pearson correlation coefficient was used to determine relationship between attitudes and behaviour.

Result and Discussions

The results of the study are discussed in three parts: students` environmental attitudes, students` willingness to participate in pro-environmental behaviours and the relationship between environmental attitudes and behaviour. Table 1 summarized the frequency distribution, mean score and standard deviation for each of the eleven item of the environmental concern scale with respect to pre- and post-test. The mean score for negatively worded items which are Q1, Q3, Q6, Q7 and Q11 were reversed so that high scores represent positive environmental attitudes.

Environmental Attitudes

Table 1 Frequency distribution, mean and standard deviation of environmental attitudes

Items	Pre - test						Post-test					
	SA (%)	A (%)	D (%)	SD (%)	Mean	SD	SA (%)	A (%)	D (%)	SD (%)	Mean	SD
Q1	34.3	58.7	5.8	1.2	3.26	.618	56.1	38.2	4.0	1.7	3.49	.661
Q2	1.2	1.7	23.7	73.4	3.69	.564	5.2	3.5	17.9	73.4	3.60	.791
Q3	20.2	0	69.9	9.8	3.10	.540	41.0	50.9	5.2	2.9	3.30	.700
Q4	1.2	5.2	35.8	57.8	3.50	.653	12.1	4.0	25.4	58.4	3.30	1.013
Q5	1.7	9.3	53.5	35.5	3.23	.685	4.6	6.4	33.5	55.5	3.40	.805
Q6	30.6	56.6	10.4	2.3	3.16	.694	50.3	41.6	7.5	.6	3.42	.656
Q7	64.2	34.1	.6	1.2	3.61	.566	83.2	15.6	.6	.6	3.82	.445
Q8	4.6	15.0	62.4	17.9	2.94	.717	4.6	12.1	52.0	31.2	3.10	.783
Q9	6.9	41.0	48.6	3.5	2.49	.679	13.3	42.8	35.3	8.7	2.39	.826
Q10	8.1	52.6	35.8	3.5	2.35	.679	19.7	51.4	23.7	5.2	2.14	.790
Q11	23.1	69.9	6.4	.6	3.16	.543	42.2	0	50.9	6.9	3.35	.608

SA= strongly agree; A=agree; D=disagree; SD=strongly disagree

The results indicated that the respondents showed overwhelmingly positive environmental attitudes. The mean scores range from 2.35 to 3.69 in the pre-test and 2.14 to 3.82 in the post-test.

They strongly advocate courses focusing on conservation of natural resources to be taught in school. The respondents were strongly in favor of conservation of wild animals and natural resources (Q2 and Q7 respectively). They strongly urged the government to tackle pollution problems by introducing harsh measures. Two items that garnered the lowest mean score are item 9: *The currently active anti-pollution organizations are really more interested in disrupting society then they are in fighting pollution* and item 10: *Industry is trying its best to develop effective anti-pollution technology.* The overall mean for both the pre-test and the post-test were calculated in order to ascertain the significant differences between the mean score by using paired sample t-test. The standard deviation for both pre-test (.540-.717) and post-test (.445-1.013) were relatively small and showed that students` environmental attitudes were relatively consistent and uniform. Table 2 summarized the mean scores of the pre- and post-test as well as the t-value for each of the construct and the whole environmental concern scale.

Table 2 Overall mean, standard deviation and t-value for pre- and post-test for each constructs of environmental attitudes

Construct	Pre-test		Post-test		*t*-value
	Mean	SD	Mean	SD	
Personal sacrifice	3.2581	.29471	3.4740	.37489	-5.809*
Optimism/Issue	3.0318	.33592	2.9884	.51639	.927
ECS (overall)	3.1346	.24131	3.2091	.34467	-2.268*

*Significant at .05.

The paired sample t-test analysis showed that there is a statistically significant difference between the mean scores of the pre-test and post-test for personal sacrifice ($F=-5.809$, $p<0.05$) and the overall Environmental Concern Scale ($F=-2.268$, $p<0.05$). However, there is no statistically significant difference between the mean scores of the pre-test and post-test for optimism/issue ($F=-.927$, $p>0.05$). The experiences in completing the tasks assigned in the PBL had perhaps showed them that it is still possible to save the planet by making personal sacrifices. The tasks had provided them with the knowledge and the steps that needed to be taken in order to fulfill their responsibility as stewards of the planet.

Environmental Behaviour

Behavioural intentions were also measured on a 4-point scale (1=strongly agree and 4=strongly disagree) in which students indicate their willingness to participate in 11 items which reflect pro-environmental behaviour. The scores for the eleven items, after reversing, were summed to give an overall behavioural intention score. The mean score for each item were reversed so that high score represents positive environmental behaviour. The mean scores for each item in the pre-test and the post-test were compared in order to find the difference between the two tests. Frequency distribution, mean and standard deviation of environmental behaviour are reported in Table 3. The mean scores range from 2.10 to 3.70 for the pre-test and 2.40 to 3.88 for the post-test. The results indicated that the students were very willing to actively participate in paper recycling, support environmental education in schools as well as plant more trees near house premises. Although most of the items show high mean scores which indicate their strong willingness to participate in pro-environmental behaviour, the low mean score was exhibited by questions asking respondents to support an increase on gasoline (petrol) prices and use public transportation more than they do now. They are less likely to adopt these behaviors which they considered could bring about direct, significant changes in their convenience and economic conditions (Fortner et al., 2000).

Table 3 : Frequency distribution, mean and standard deviation of environmental behaviour

Items	Pre - test						Post-test					
	SA (%)	A (%)	D (%)	SD (%)	Mean	SD	SA (%)	A (%)	D (%)	SD (%)	Mean	SD
Q1	59.5	38.7	1.7	0	3.58	.529	85.0	15.0	0	0	3.85	.358
Q2	53.8	45.7	.6	0	3.53	.512	82.1	17.9	0	0	3.82	.385
Q3	50.3	47.4	2.3	0	3.48	.545	71.7	27.2	1.2	0	3.71	.482
Q4	53.2	44.5	2.3	0	3.51	.546	75.1	24.3	.6	0	3.75	.450
Q5	69.9	30.1	0	0	3.70	.460	88.4	11.6	0	0	3.88	.321
Q6	39.3	55.5	5.2	0	3.34	.575	61.8	35.8	2.3	0	3.60	.537
Q7	46.8	52.6	.6	0	3.46	.512	78.6	20.8	.6	0	3.78	.429
Q8	45.7	54.3	0	0	3.46	.500	75.7	23.1	1.2	0	3.75	.463
Q9	39.0	58.7	1.7	.6	3.36	.550	70.5	28.9	.6	0	3.70	.472
Q10	31.8	55.5	11.0	1.7	3.17	.685	60.7	32.9	5.2	1.2	3.53	.652
Q11	6.9	20.8	48.0	24.3	2.10	.850	15.6	30.1	33.5	20.8	2.40	.987

SA=strongly agree; A=agree; D=disagree; SD=strongly disagree

The standard deviation for both the pre- and post-test were relatively small. It ranged from .460 to .850 for the pre-test and .321 to .987 for the post-test indicated that students` environmental behaviour were relatively small and uniform.

A paired sample t-test was conducted to determine if there is a significant difference in the mean scores between the pre-test and post-test. Table 4 provides a summary of the mean and standard deviation for both pre- and post-tests and the t-value. The paired sample t-test analysis showed that there was a statistically significant difference between the mean scores of the pre-test and the post-test ($F=-7.972$, $p<0.05$). High overall mean scores in the post-test indicate that respondents were more willing to participate in pro-environmental behaviours.

Table 4 Overall mean, standard deviation and t-value for pre- and post-test of environmental behaviour

Construct	Pre-test		Post-test		*t*-value
	Mean	SD	Mean	SD	
Environmental Behaviour	3.3357	.34671	3.6148	.32463	-7.972*

*Significant at .05

Attitude-Behaviour relationship

The relationship between attitudes/concerns and behaviour were measured using Pearson correlation (Table 5). There is no statistically significant relationship between behavioural intention with environmental concern ($r=.063$, $N=173$, $p>.01$) and Optimism/Issue ($r=-.066$, $N=173$, $p>.01$). However, there is a significant relationship between behavioural intentions and personal sacrifice. The correlation coefficient between behavioural intention and personal sacrifice can be described as small but positive correlation ($r=0.236$, $N=173$, $p<.01$). Previous studies investigating the relationship between environmental awareness/concern and behaviour also did not find very high correlations and some showed very low correlation (e.g. Hines et al., 1986). Vogel (1996) suggested that perhaps there is a need to employ highly complex models to analyze such relationships.

Table 5: The Pearson correlation matrix between environmental attitudes and students` pro-environmental behaviour

	Behavioural intention	Environmental Concern	Personal Sacrifice	Optimism/Issue
Behavioural intention	1.0	.063	.236**	-.066
Environmental Concern		1.0	.583**	.871**
Personal Sacrifice			1.0	.109
Optimism/Issue				1.0

** Correlation is significant at the 0.01 level (2-tailed).

Conclusion

Environmental stewardship is on the rise. Today, a growing number of people are making informed choices in their daily lives, work places, and communities that are good for the environment, for their finances, and for overall quality of life. These actions are inspiring and evidence of an emerging societal commitment to environmental stewardship. Our findings indicate that both the post-test mean score of environmental concern scale and environmental behaviour are significantly higher as compared to the pre-test mean score. Hence, incorporating IT-enhanced project-based learning perhaps can enhance students` environmental stewardship. The development of Web-Quest lessons on global climate change enhanced students` understanding of the concepts, theories and framework of climate change, one of the major environmental problems which is rapidly becoming the main issue being discussed worldwide. Engaging students in environmental learning provides opportunities to apply course material while contributing to improved environmental quality. Arbuthnot and Lingg (1975) stressed the importance of knowing attitudes and behaviour in order to design effective environmental programs. In creating programs which aims to enhance environmental awareness, programs should be designed to engage their target audience in not only increasing their environmental knowledge but their environmental skills, attitudes and behaviour as well (Grodzinska-Jurczak et al., 2003). Conscious efforts to teach these integrated elements in the classroom and outside the classroom have resulted in much greater awareness amongst students about the quality and state of the environment. Teachers can be a critical factor not only in developing the knowledge but also in shaping the behaviour of young children science in school (Basile and White, 2000). For educators in the classroom, environmental stewardship means practicing or applying what is taught in classroom. It means modeling and being actively involved as a participatory citizen and engaging children in similar activities.

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Appendix

Instruction: Tick (√) the appropriate column according to the following

Strongly agree=1, Agree=2, Disagree=3, Strongly disagree=4.

Environmental Concern Scale

No	Item	1	2	3	4
1.	The government will have to introduce harsh measures to halt pollution, since few people will regulate themselves.				
2.	We should not worry about killing many wild animals because in the long term run, things will balance out.				
3.	I would be willing to make personal sacrifices for the sake of slowing down pollution even though the immediate result may not seem significant.				
4.	Pollution is not personally affecting me.				
5.	The benefits of modern consumer products are more important than the pollution that results from their production and use.				
6.	We must prevent any types of animal become extinct, even it is mean scarifying something from ourselves.				
7.	Courses focusing on the conservation of the nature resources should be taught in schools.				
8.	Although there are continual contaminations of our rivers, oceans and airs, nature's purifying processes soon return them to normal.				
9.	The currently active anti-pollution organizations are really more interested in disrupting society then they are in fighting pollution.				
10.	Industry is trying its best to develop effective anti-pollution technology.				
11	If asked, I would contribute time and money to an organization that work to improve the quality of the environment.				

Student Readiness to Participate in Various Pro-Environmental Behaviors

No	Item	1	2	3	4
1.	If there is paper recycling program in university,I will try my best to participate.				
2.	Plant more trees near my house.				
3.	If there is a "use less tissue" campaign in my university, I will try my best to participate.				
4.	Now some shops and supermarkets are running a "use less plastic bag" campaign, I will try my best to participate.				
5.	Supports environmental education in schools.				
6.	Install save-energy bulb in my house.				
7.	If there is paper receptacle in the building I'm living in, I will try my best to use it.				
8.	Vote 'yes' on a ballot issue to reduce greenhouse gases.				
9.	Supports lawsuits against emitters of greenhouse gases.				
10.	Use public transportation more than I do now.				
11	Support an increase on gasoline (petrol) price.				