Malaysian Journal of Distance Education 16(2), 39–57 (2014)

The Effect of Online Project-Based Learning on Students' Attitudes towards Renewable Energy

Mohd Ali Samsudin[1*], Abdul Hadi Harun[2], Norfarah Nordin[3], Noor Hasyimah Haniza[4] and Corrienna Abdul-Talib[5]
[1,2,4]School of Educational Studies, Universiti Sains Malaysia
[3]National Higher Education Research Institute (IPPTN)
[5]Southeast Asian Ministers of Education Organisation-Regional Centre for Education in Science & Mathematics (SEAMEO RECSAM)
[*]alisamsudin@usm.my

Abstract

This study examined the effect of online project-based learning (e-PBL) on Form Four science students' attitudes towards renewable energy (RE). The study applied a quasi-experimental method with "A Design Group Pre- and Post-Test" The sample experimental group consisted of 48 Form Four students who received the e-PBL treatment. The impact of e-PBL on the students' attitudes towards RE was measured three times with a pre-test, post-test and follow-up test. Repeated measures analysis of variances (ANOVA) were used for quantitative data analysis. The findings indicate that the use of e-PBL had a significant impact on improving students' attitudes towards RE. The content analyses of e-PBL's impact on the synchrony and asynchrony of online communication show that students are more comfortable using the social interaction sites that are provided through e-PBL to more flexibly perform collaborative group work outside of school hours. Students also acquired new learning experiences and were able to share information about RE issues. This study suggests that project-based learning for RE study is suitable for online implementation because students can more easily interact without the limitations of time and space.

Keywords: online project-based learning, students' attitudes, renewable energy

Introduction

As a basic resource, energy is instrumental in a country's socioscientific development. Energy-related knowledge, such as power transmission, energy consumption, energy maintenance, and energy conservation, is important for economic development areas (Hinrichs and Kleinbach, 2006; Papadouris, Constantinou and Kyratsi, 2008). Underlining the importance of energy, Mohd Yusof and Kamaruzzaman (2006) state that "without energy there will be no activity in daily life, especially in this modern lifestyle, and without fundamental knowledge in the natural sciences related to energy, people will not be developing and growing" In every activity, humans consume energy, and energy that is mindfully consumed closely relates to the sustainability of our planet. Energy-related knowledge is therefore one of the key areas to be nurtured and understood by school children. If energy-related knowledge is neglected, the advancement of science and technology knowledge could stall.

Many researchers (e.g., Liarakou, Gavrilakis and Flouri, 2009; Halder et al., 2010; DeWaters, 2011; Hilal, 2011) have conducted studies about students' and the public's awareness and level of energy-related knowledge. These studies have assessed the level of energy-related knowledge and awareness among students and workers in the community. The empirical findings show that students and workers have a less-than-positive attitude about energy knowledge, specifically renewable energy (RE) (Bittle et al., 2009; Curry et al., 2007; DeWaters, 2011a; Hilal, 2011; Lawrenz, 1985; NEETF, 2002; Howcast, 2005; Manville, 2008). In a study conducted by the National Environmental Education and Training Foundation (NEETF) in 2002, knowledge of energy conservation and RE was very low. In a survey on RE, Bittle, Rochkind and Ott (2009) also found that 40% of respondents were unable to state the source of fossil fuels and RE sources. Hence, there is a need for education measures that improve energy literacy by impacting student attitudes, values and behaviours, as well as broad content knowledge (DeWaters and Powers, 2011).

Notably, 66% of respondents could not identify any source of petroleum-derived energy, and 56% attributed the onset of global warming to nuclear energy only. In their study, Halder et al. (2010) found that 92% of ninth-grade student respondents had no knowledge of the source of biomass energy. From the low-knowledge student group, 60% stated that they had never heard of biomass energy. These unfavourable findings are in line with the findings of many other researchers in the field (Askew, 2006; Department of Business, Enterprise and Regulatory Reform (BERR), 2007).

According to Liarakou, Gavrilakis and Flouri (2009), formal education is a means to empower students with RE knowledge. In some countries, RE education has shaped positive attitudes and positive behaviours and provided students with knowledge about energy concepts and energy-related issues. This knowledge enables students to better analyse and interpret all energy-related information (Barrow and Morrisey, 1989; Farhar, 1996; Gambro and Switzky, 1999; Hofman, 1980; Solomon, 1992; Solomon, Pasqualetti and Luchsinger, 2003; Van Koevering and Sell, 1983). In the 21st century, teachers need to be creative and innovative to encourage students to learn and use alternative means for information searches (Norazah and Ngau, 2009).

Online Project-Based Learning

Twenty-first century learning approaches offer better learning opportunities that can expand on the classroom-learning situation by including the generation of knowledge and problem-solving skills in the real world. Through teachers' use of information and communications technology (ICT), students can be more engaged in learning activities, have one-to-one treatment through online discussion sessions, structure their knowledge through a self-testing process, and be supported regardless of time or place (Chang, 2001; Vonderwell and Turner, 2005).

Teachers must be skilled in the pedagogy of technology-enhanced learning (TEL) to teach through an online medium. To ensure effective teaching and learning, teachers must master content knowledge, acquire ICT expertise and support ICT literacy among students. In the 21st century, teachers and students face a similar challenge; they must acquire and apply knowledge in an era that requires learning skills, innovation skills, skills for information searches through alternative media and technology, life skills and career skills. To support 21st-century learners, an online project-based learning (e-PBL) module on RE was developed for Form Four pure-science stream students.

Online project-based learning supports the goals of the 21st-century learning (Thomas, 2000) and national curricula that encourage student-centred learning activities. The online module encourages students to master skills by exploring topics in real-life situations. In the online module, students can have access to information, regardless of their geographical location, which thus enables the students to have continuous access to the learning process (Yusup and Razmah, 2001). Students also have the flexibility to choose their time preferences and determine the content and direction of their learning. Students may repeat a poorly understood topic (Lim and Tan, 2001) to aid with their learning. The online learning environment creates opportunities for PBL synchronous and asynchronous interactions among students, students and teachers, students and experts outside or within their country of origin and beyond; hence, e-PBL promotes collaborative learning (Anderson, 2003; Lau and Fitri Suraya (2002). Other e-PBL features include seamless access to different types of information based on student ability; support for interaction with other individuals from within and outside the country; the ability to respond quickly to answer questions; the ease of locating and accessing information; and fast search capabilities (Kim et al., 2009).

In addition, Web 2.0 applications provide an environment for collaborative learning and information sharing, which is needed to support the active and socialising nature of learning (Sajjan and Hartshorne, 2008). The use of Web 2.0 applications, such as wikis and social networks, also enables the completion of studies in the classroom and creates an interactive learning experience and collaborative learning among students (Sajjan and Hartshorne, 2008). Collaborative learning can help students to better retain information compared with individual learning lessons (Sajjan and Hartshorne, 2008).

Implementation of Online Project-Based Learning

To begin the implementation of online project-based learning, students need to know about the basic concepts of RE. Teachers can introduce these concepts by exposing students to RE resources, the debate surrounding energy resource depletion and the environmental impact of energy shortages. After the students have acquired the basic RE-related information, their knowledge is examined in a test. This test is important in reinforcing the students' understanding before they apply their RE knowledge in their respective projects.

After they have reinforced their RE knowledge, students identify problems related to RE and then form their own groups. Savin-Baden (2007) suggests that a good project team includes four to six people (Savin-Baden, 2007). In the context of this study, a total of 48 students were divided into 12 groups of four. All of the group members' names were keyed into the e-PBL program. Students were then asked to complete an

RE e-portfolio with their respective groups. Students completed their e-portfolios to outline the principle issues surrounding their chosen situation and to identify the energy and environmental issue that they sought to resolve. This e-portfolio guided the students in finding a solution for their groups' problem; therefore, students were required to follow the design steps of online project-based learning. These steps enabled them to produce a solution in a project that was supported by online tools. When all project planning information was keyed into the e-portfolio, the teachers then reviewed the plans and any online social media interactions between the teacher and student groups. The main focus of students' projects related to RE and energy projects that grappled with existing problems in the local community. Projects could be classified in three ways—those related to photovoltaic, solar thermal or biomass energy. The teacher uploaded the project proposal to the wiki page. Therefore, students could download information for guidance and locate information on who should execute the RE project.

Teachers also act as facilitators in e-PBL spaces. According to Savin-Baden (2007), the facilitator works to guide students in solving problems and provides guidelines/measures and related problem-solving techniques. Therefore, in the process of implementing e-PBL, the teacher helped students to design RE projects according to the details that they provided in their e-portfolios. Next, students were asked to discuss in groups and present their views on the issues to be resolved through their projects. Teachers helped students by recommending particular activities that could resolve some of the problems associated with their energy problem. Students were required to access websites or refer to RE energy experts to find information about their group project. While students could refer to various online sources, they also needed to interact with the teacher to ensure that the projects were carried out appropriately and in accordance with the project title. To discuss the RE projects, students and other individuals used Web 2.0 technology for their online interactions and collaborative relationships. In addition to collaborative relationships between teachers and students, collaborative relationships among students or between students and experts also existed and progressed on an on-going basis, using Web 2.0, either synchronously and asynchronously as required. Using social media for discussions and interactions with others is the best choice, as this branch of communication can enhance students' knowledge and generate new ideas (Batchelder, 2010).

Through e-PBL, students can assess information relating to the project and to project implementation procedures, duration, level of performance and evaluation methods on the wiki page that is linked to their online project-based learning space. The teacher uploads this information to the wiki page. A wiki is a web site that can display the user's writing (Njuguna, 2005) and be loaded with video and audio (Hernandez-Ramos, 2004). Each affirmation and direction of the teacher (facilitator) will be uploaded to the wiki. The wiki simplifies the process of students or facilitators sharing their writing and functions as an adjunct to cognitive scaffolding when students receive feedback on their written work (Olson, 1994).

In addition, student-facilitator interactions through online forums support all partners in the project team (Sherer and Shea, 2002). In addition, the use of wiki pages supports facilitator feedback that can be delivered quickly (Ferdig and Trammel, 2004). Immediate facilitator comments can help the students to correct any mistakes and enhance their motivation to complete project work (Simsek, 2010).

In the next phase, students need to use the available information to formulate a solution. Based on the question design that drives the built-in online forums, students list their possible solutions in the e-portfolio, each of which is assumed to be able to help the students to build the project. Students are encouraged to use initiative in selecting the most effective solution. To help students perform these activities, teachers help students reframe the problem by building a sketch of the storyline that focuses on the project design. The storyline is based on local RE-related problems.

In the context of e-PBL, problem solving refers to the production of product designs. The products or artefacts generated are based on five design principles (Buck Institute for Education, 2003):

1. Set expectations so that the end product meets the specified standards and criteria.
2. Use questions that guide students to resolve any problems or issues.
3. Design assessments that are aligned with the specified standards and criteria.
4. Map project outcomes, thus providing a complete design for each project activity undertaken.

5. Carefully manage the implementation process of the project—from start to finish.

Based on the storyline of the local energy-related issues, each group of students will build their projects, as deemed appropriate, to resolve the problem. Each group should upload all project plans and related materials, such as study procedures, project plans and the framework of reference materials, to the wiki. The online wiki serves as a collaborative idea tool for each project. In addition, the wiki is also able to manage documents and resources from other partners in the group (Ras and Rech, 2009). After uploading all of the materials to the wiki page, students implement the RE project according to the schedule outlined by their respective groups. In addition, the student groups will use their skills to present the results of their virtual projects. The teacher's comments and feedback on student projects appear in the space available on the wiki page. The wiki essentially serves as a blog for students' project work that can be used to generate content for learning, share ideas, socialise and interact in a collaborative manner (Chong, 2010). In addition, the written work or comments on the wiki come from the real experiences of students and teachers, thus producing a more meaningful learning experience.

Interaction and collaboration between students and RE experts occurs through e-mail and chat. The use of e-mail is appropriate for such collaboration, as students and RE experts can communicate according to their own schedules. Sending a message through e-mail is therefore appropriate and enables asynchronous communication to take place between the two sides. Furthermore, student-teacher communication can be implemented using forums and chat messages that are integrated into the e-PBL space. Chatting and messaging are two unique communication tools on the discussion forum. The interaction through chats or messaging occurs in synchrony and requires the individual to interact spontaneously with a more in-depth discussion of the topic (Johnston, Anderson and DeMeulle, 1998; Suler, 2004).

Research Methodology

The main objective of this study is to investigate the effect of the e-PBL approach on the attitudes towards RE among form four students in the pure-science stream. Students' attitudes towards RE were measured using a questionnaire developed by DeWaters (2011). Items in the original version of the questionnaire were all in English; because the native language in Malaysia is Malay, the questionnaire was translated using the 'back-to-back' method, a reciprocal type of translation. The expertise of a lecturer with an English language, Malay language and physics education was utilised to crosscheck each translated scale and item. This step was taken to ensure that the meaning of each scale and item was translated in line with the scale of the original item. The instruments use a five-point Likert scale to assess the score of each item. As a pilot test, the attitude towards energy questionnaire was distributed among 33 students. The Cronbach's alpha value for the items' reliability in the attitude towards RE questionnaire is 0.80.

This study employed a quasi-experimental method with a pre-test-post-test, repeated measures group design for the dependent variables (Campbell and Stanley, 1963; Cohen, Manion and Morrison, 2001; Heward et al., 2005). Repeated measures were taken to rectify flaws in the study design, which did not include a control group (Best and Kahn, 2008). The design used is shown in Table 1. All students were required to answer the same pre- and post-test questionnaire to see the effect of e-PBL on their attitudes towards RE. The group then took a second post-test (a follow-up attitude towards RE questionnaire) to identify the impact of e-PBL on sustaining positive attitudes towards RE.

Table 1: Quasi-Experimental design group pre-test-post-test (Campbell and Stanley, 1963)

Group	Intervention
Treatment	O_1 X O_2 ....O_3

where;

X = Online Project-based Learning
O_1 = Pre Test (Pre Attitude Towards RE Questionnaire)
O_2 = Post Test (Post Attitude Towards RE Questionnaire)
O_3 = Second Post Test (Follow Up Post Attitude Towards RE Questionnaire)

Samples

In this study, using purposive sampling methods (Azizi et al., 2006; Best and Kahn, 2008, 48 students were selected for the experimental group, which met the minimum criteria for quasi-experimental methods (Krejcie and Morgan, 1970; Best and Kahn, 2008. The students were drawn from Form Four pure-science stream students, a classification that was based on aggregates obtained in the Lower Secondary Examination or Penilaian Menengah Rendah (PMR). The selection of students was based on their average scores in three subjects, namely, English, Mathematics and Science; to be selected, students had to obtain at least a grade B.

Results

To determine if the distribution of the data collected was normal, two methods were used, namely the descriptive statistics of the skewness and kurtosis slant and graphical analysis. Skewness values show a symmetrical distribution, while the kurtosis values indicate peakedness. Positively skewed values show scores that are clustered to the left of the low values in the graph. Meanwhile, the negative slant shows scores that are gathered on the right side of the values in the graph. Positive kurtosis indicates a relatively sharp distribution, which represents the scores gathered in the middle (Hayes et al., 2012). In this study, the data normality was checked by through graphical analysis of a Q-Q plot graph and an analysis of the kurtosis and skewness values.

Based on a range of values between –1 and +1 (George and Mallery, 2003), it is found that the skewness and kurtosis values are assumed to be zero, which leads to the conclusion that the distribution of the scores of pre-test attitude towards RE questionnaire, post-test attitude towards RE questionnaire and follow-up attitude towards RE questionnaire incline towards the normal shape. In fact, the results of the Shapiro-Wilk test are not significant ($p > 0.05$, Table 2), which shows that the scores are normally distributed.

Table 2: Normality test of Shapiro-Wilks based

RE Attitude	Shapiro-Wilk		
	Statistic	Degree of Freedom	*p*-value
Pre Questionnaire	0.940	48	0.062
Post Questionnaire	0.966	48	0.175
Follow-up Post Questionnaire	0.979	48	0.541

This finding is supported by research on the normal Q-Q plot of the score distribution of the pre-test, post-test and follow-up attitude towards RE questionnaires, with the points nearing the normal Q-Q plot straight line. It is found that the mean score of the post-test attitude towards RE questionnaire (M = 43.50, SD = 6.13) is higher than the mean score of the pre-test attitude towards RE questionnaire (M = 38.85, SD = 6.28) (Table 3). It is also found that the mean score of the follow-up attitude towards RE questionnaire (M = 48.39, SD = 5.76) is higher than the mean score of the post-test attitude towards RE questionnaire (M = 43.50, SD = 6.13) (Table 3).

Table 3: Descriptive statistics for the pre-, post- and follow-up attitude towards RE questionnaire

	Pre Questionnaire	Post Questionnaire	Follow-up Post Questionnaire
N	48	48	48
Mean	38.85	43.50	48.39
Standard Deviation	6.28	6.13	5.76
Minimum	26.00	31.00	36.10
Maximum	50.00	56.00	61.10

Next, a repeated measures analysis of variance (ANOVA) test at a significance level of $p = 0.05$ was conducted to detect whether there are significant differences in the mean scores of the pre-test questionnaire, the post-test questionnaire and the follow-up questionnaire. Overall, the repeated measures ANOVA test was conducted to determine the main effect of the test on the dependent variables for attitudes towards RE. The testing time is categorised as a within variable and is used to perform the repeated measures ANOVA. Based on the perspective of the repeated measures ANOVA (Hair et al., 2009), within variables are dependent variables that can be measured repeatedly on the same sample. In the context of this study, the testing time refers to the attitude towards RE, which is repeatedly measured in the samples. These testing times are the pre-treatment time (pre-test questionnaire), the time immediately after treatment (post-test questionnaire), and a certain period of time after the treatment was completed (follow-up questionnaire). Thus, the purpose of testing the main effects of the within variables is to determine whether there are significant changes in the mean scores of RE questionnaires based on repeated measurements of attitudes towards RE, which were carried out three times. Multivariate test results (Table 4) show the main effect of the testing time of attitudes towards RE was significant, Wilks' Lambda = 0.435, F (2, 46) = 29,859, p = 0.000, η2 = 0.565, and the power of observation value is 1.000. Multivariate test results support the findings of the univariate tests.

Table 4: Results of multivariate tests for the RE mean attitude scores

Effect		Value	F	Hypothesis Degree of Freedom	Error Degree of Freedom	Sig.	Partial Eta Squared	Power of Observation
RE Attitude	Wilks' Lambda	0.435	29.859	2.000	46.000	0.000	0.565	1.000

Table 5: Results of Mauchly Sphericity test RE attitude

Effects Within	Mauchy's W	Chi Squared	Degree of Freedom	Sig.	Epsilon
					Greenhouse-Geisser
RE Attitude	0.967	1.562	2	0.458	0.968

However, prior to selecting the appropriate univariate tests, Mauchly's sphericity test was performed as a sphericity assumption check, and the p-value obtained was 0.458, which is greater than 0.05 (Table 5). The values obtained show that the assumption of sphericity of the covariance matrix has been met (Howell, 2009). The results of the univariate tests are based on the assumption of sphericity (Table 5), and the main effect of testing time is found to be significant for attitudes towards RE, F = 35,965, p = 0.000, η2 = 0.433, with a power of observation value of 1.000. The multivariate (Table 4) and univariate test results (Table 6) are significant, which means that there are at least a couple of tests that have different mean scores on the attitude towards RE questionnaire, as shown in the pairs below.

Table 6: Test results univariate for mean scores of attitude towards RE questionnaire

Source		Sum of Squred Type III	Degree of Freedom	Squared Mean	F	Sig.	Partial Squared Eta	Squared Observation
Attitude TD	Spherical Assumption	2183.617	2	1091.809	35.965	0.000	0.433	1.000
	Green house-Geissser	2183.617	1.935	1128.26	35.965	0.000	0.433	1.000

1. The mean score of the pre-test attitude towards RE questionnaire and the mean score of the post-test attitude towards RE questionnaire
2. The mean score of the post-test attitude towards RE questionnaire and the mean score of the follow-up attitude towards RE questionnaire
3. The mean score of the pre-test attitude towards RE questionnaire and the mean score of the follow-up attitude towards RE questionnaire

In the Bonferroni test results (Table 7), there was a significant difference ($p < 0.05$) in the following pairs:

1. The mean score of the pre-test attitude towards RE questionnaire and the mean score of the post-test attitude towards RE questionnaire
2. The mean score of the post-test attitude towards RE questionnaire and the mean score of the follow-up attitude towards RE questionnaire
3. The mean score of the pre-test attitude towards RE questionnaire and the mean score of the follow-up attitude towards RE questionnaire

To see the pattern of these changes, the value of the estimated marginal means of attitudes towards RE was used to identify patterns of score changes for each test performed. The results show that the mean score of the pre-test attitude towards RE questionnaire is 38.85, while the mean score of the post-test attitude towards RE questionnaire is 43.50 (Table 8). There was an increase in mean scores of the pre-test attitude towards RE questionnaire and the post-test attitude towards RE questionnaire. This finding is supported by the findings in Table 7, which show that there are significant differences between the mean scores of the pre-test and post-test attitude towards RE questionnaires. Thus, e-PBL is found to have a significant impact on increasing students' positive attitudes towards RE.

Table 7: Results of Bonferroni test

RE Attitude		Mean Difference	Error Degree of Freedom	Sig.
Pre questionnaire	Post Questionniare	–4.646	1.086	0.000
	Follow-up Post Questionnire	–9.573	1.222	0.000
Post questionnaire	Pre-Questionnaire	4.646	1.086	0.000
	Follow-up Post Questionnaire	–4.892	1.059	0.000
Follow-up questionnaire	Pre-Questionnaire	9.537	1.222	0.000
	Post Questionniare	4.892	1.059	0.000

Table 8: Estimated marginal means test results for RE attitude

		95% Confidence interval	
Energy Attitude	Mean	Lower Limit	Upper Limit
Pre-test Questionnire	38.85	37.03	40.67
Post-test Questionniare	43.50	41.72	45.28
Follow-up post-test Questionnaire	48.39	46.72	50.07

Furthermore, these findings show that the estimated marginal mean score of the follow-up attitude towards RE questionnaire is 48.39, while the mean score of the post-test attitude towards RE questionnaire is 43.50 (Table 8). This finding is supported by the findings in Table 7, which show that there are significant differences between the mean scores for the post-test and follow-up attitude towards RE questionnaires. Thus, it can be concluded that e-PBL has a significant impact on sustaining students' positive attitudes towards RE.

Discussion and Conclusion

The analysis indicates that the mean scores of the attitude towards RE questionnaires increase after treatment. This finding indicates that e-PBL treatment has a significant effect on improving students' attitudes towards RE. The findings also show that e-PBL is able to sustain students' positive attitudes towards RE, given the increase in the mean score of the follow-up attitude towards RE questionnaire relative to the mean score of the post-test attitude towards RE questionnaire.

These findings suggest that an increase in positive attitudes towards learning is the result of structured, project-based learning activities. Throughout the project, students are nurtured to develop positive attitudes towards RE by solving authentic energy-related problems (DeWaters, 2011). The use of a project-based learning approach enables students to learn about RE and appreciate the importance of RE in real life.

With e-PBL, the students have the autonomy to make decisions, which falls in line with the constructivist approach that emphasises understanding, student-centred approaches and active student involvement in the learning process (Phillips, 2000). Students are free to discuss and share ideas and exchange information among groups at any time (Gray and Xiaoli, 2001). The online tools attract the students' attention, encourage feedback, help in the development of literacy, and hone higher-order thinking skills (Parker, 2008). These observed features of online learning are consistent with the findings of Lau and Lee (2010) who reported that the use of weblogs in education helped increase awareness and cultivated student interests, making students more sensitive to energy problems.

Learning culture in the form of social communication tools, such as Facebook, has changed the learning attitudes in schools (Mohamed Amin, 2011). The immediacy of hypertext and hypermedia in online learning makes the process of finding information faster, easier and more entertaining (Jonassen, 2000). The use of online resources from YouTube combines sound, video and images to make the learning process more interesting and effective. Based on the Glogster presentation of the final RE results, students upload a YouTube page that is similar to setting up the RE products that they design. This finding suggests that the use of multimedia technology can increase student interest and achievement.

Interesting and fun learning environments can support students' sustained interest in continuous learning.

In implementing e-PBL, teachers encourage students' active engagement, such as their involvement in hands-on activities, inquiry learning, cooperative learning and collaboration, which requires them to find information sources by questioning and investigating phenomena that occur in their surroundings. According to Harlen (1996), this approach requires students to have a desire to know and be open-minded critical thinkers who are honest and accurate in recording data. Students surf global RE-related webpages related to increase their knowledge. This exploration helps nurture positive attitudes and the desire to know in students, which instils attitudes of openness to creativity, patience and hard work. This authentic online learning environment improves students' attitudes towards learning and makes learning interesting (Bouillion and Gomez, 2001).

References

Ajjan, H. and R. Hartshorne. 2008. Investigating faculty decisions to adopt Web 2.0 technologies: Theory and empirical tests. *Internet and Higher Education* 11: 71–80.

Anderson, T. 2003. Modes of interaction in distance education: Recent developments and research questions. In *Handbook of distance education*, eds. M. Moore and G. Anderson, 129–144. Mahwah, NJ: Erlbaum.

Askew, M. F. 2006. European Union and Bioenergy-Biofuel. http://www.rice.edu/energy/publications/eventpres/biofuels/Biofuels_Askew%20_092506.pdf.

Azizi Yahya, Shahrin Hashim, Jamaludin Ramli, Yusof Boon, Abdul Rahim Hamdan and Syed Mohamed Shafeq Syed Mansur Al-Habshi. 2006. *Mastering research in education: Theory, analysis and data interpretation.* Kuala Lumpur: PTS Profesional Publishing Sdn. Bhd.

Babbie, E. R., F. S. Halley, W. E. Wagner and J. S. Zaino. 2012. *Adventures in social research: Data analysis using IBM, SPSS statistics.* 8th ed. USA: Sage Publications Inc.

Baker, T. R. and S. H. White. 2003. The effects of G.I.S. on students' attitudes, self-efficacy, and achievement in middle school science classrooms. *Journal of Geography* 102(6): 243–254. doi: 10.1080/00221340308978556.

Barrow, L. H. and J. T. Morrisey. 1989. Energy literacy of ninth-grade students: A comparison between Maine and New Brunswick. *Journal of Environmental Education* 20(2): 22–25.

Batchelder, C. W. 2010. Social software: Participants' experience using social networking for learning. PhD diss., Capella University. ProQuest. (UMI No. 3398679).

Best, J. W and J. V. Kahn. 2008. *Research in education.* 10th ed. New Delhi: Prentice Hall of India.

Bittle, S., J. Rochkind and A. Ott. 2009. The Energy learning curve: Public agenda. http://www.publicagenda.org/reports/energy (accessed 25 September 2011).

Boss, S. and J. Krauss. 2007. Reinventing project-based learning: Your field guide to real-world projects in the digital age. Washington, DC: International Society for Technology in Education.

Bouillion, L. M. and L. M. Gomez. 2001. Connecting school and community with science learning: Real world problems and school-community partnerships as contextual scaffolds. *Journal of Research in Science Teaching* 38(8): 878–898.

Buck Institute for Education. 2003. Project based learning handbook. Novato,CA.

Campbell, D. T. and J. C. Stanley. 1963. *Experimental and quasi-experimental design for research.* Chicago: Rand Menally.

Chang, C. C. 2001. A study on the evaluation and effectiveness analysis of webbased learning portfolio (WBLP). *British Journal of Educational Technology* 32(4): 435–459.

Chong, E. K. M. 2010. Using blogging to enhance the initation of students into academic research. *Computer and Education* 55: 798–807.

Church, W. 2005. The sidewalk project. *Science Teacher* 72(4): 32–33.

Cohen, L., L. Manion and K. Morrison. 2001. 5th ed. *Research Methods in Education,* London: RoutledgeFalmer.

Curry,T. E., S. Ansolabehere and H. Herzon. 2007. A survey of public attitudes towards climate change and climate change mitigation technologies in the United States: Analyses of 2006 result. MIT LFEE 2007-01WP.

Department for Business, Enterprise and Regulatory Reform (BERR). 2007. Renewable energy awareness and attitudes research. Management Summary, URN 07/706. http://www.berr.gov.uk/files/file41239.pdf.

DeWaters, J. E. and S. E. Powers. 2011. Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy* 39(3): 1699–1710.

DeWaters, J. E. 2011. Energy literacy and the broader impacts of energy education among secondary students in New York State. PhD diss., Clarkson University.

Farhar, B. C. 1996. Energy and the environment: The public view. *Renewable Energy Policy Project REPP* 3(1–11). College Park, MD: University of Maryland at College Park.

Ferdig, R. E. and K. D. Trammel. 2004. Content delivery in the blogosphere. *T.H.E Journal Online* 31(7): 12.

Gambro, J. S. and H. N. Switzky. 1999. Variables associated with American high school students' knowledge of environmental issues related to energy and pollution. *Journal of Environmental Education* 30(2): 15–22.

George, D. and P. Mallery. 2003. SPSS for Windows step by step: A simple guide and reference 11.0 update. 4th ed. Boston: Allyn & Bacon.

Gray, K. C. and H. C. Xiaoli. 2001. Computer and Internet usage in education: Theories, practices and research basics. *Journal of Educational Technology Systems* 29(1): 41–48.

Hair, J. F. H., R. E. Anderson, R. L. Tatham and W. C. Black. 2009. *Multivariate data analysis.*7th ed. New Jersey: Prentice Hall.

Halder, P., J. Pietarinen, S. H. Nutinen and P. Pelkonen. 2010. Young citizens' knowledge and perceptions of bioenergy and future policy implications. *Energy Policy* 38: 3058–3066.

Harlen, W. 1996. *The teaching of science in primary school*. London: David Fulton.

Hayes et al. 2012. A multicenter collaborative approach to reducing pediatric codes outside the ICU. *Pedriatics* 129(3): e785–e791.

Henderson, D., D. Fisher and B. J. Fraser. 2000. Interpersonal behavior, laboratory learning environments, and student outcomes in senior biology classes. *Journal of Research in Science Teaching* 37: 26–43.

Hernandez-Ramos, P. 2004. Web logs and online discussion as tools to promote reflective practice. *The Journal of Interactive Online Learning* 3(1): 1–16.

Heward, W. L., T. E. Heron, N. A. Neef, S. M. Peterson, D. M. Sainato, G. Cartledge, et al., eds. 2005. Focus on behaviour analysis in education: Achievements, challenges and opportunities. Upper Saddle River, NJ: Pearson.

Hilal Aktamis. 2011. Determining energy saving behaviour and energy awareness of secondary school student according to socio-demographic characteristic. *Educational Research and Reviews* 6(3): 243–250.

Hinrichs, R. and M. Kleinbach. 2006. *Energy: Its use and the environment.* New York: Thomas Learning.

Hofman, H. 1980. Energy crisis – school to the rescue. *School Science and Mathematics* 80(6): 467–478.

Howell, D. C. 2009. *Statistical methods for psychology*. International Edition. Belmont, CA: Wadsworth Publishing Company.

Johnston, J., R. S. Anderson and L. DeMeulle. 1998. Prospects for collaborative self-study on the internet. In *Reconceptualising teaching practice: Self-study in teacher education*, ed. M. L. Hamilton, 208–223. London: Falmer Press.

Jonassen, D. H. 2000. *Computer as mindtools for school: Engaging critical thinking.* 2nd ed. New Jersey: Merill-Prentice Hall.

Kim, D. J., K. B. Yue, S. P. Hall and T. Gates. 2009. Global diffusion of the Internet XV: Web 2.0 technologies, principles and applications: A conceptual framework from technology push and demand pull perspective. *Communications of the Association for Information Systems* 24(38). http://aisel.aisnet.org/cais/vol24/iss1/38.

Krejcie, R. V. and D. W. Morgan. 1970. Determining sample size for research activities. *Education and Psychological Measurement* 30: 607–617.

Lau B. Y. and C. H. Lee. 2010. Contextualising e-learning services and content for computing course in higher education based on learning style and competency level. *International Journal of Learning Technology* 5(3): 211–242.

Lau, S. and Fitri Suraya Mohamad. 2002. Online Learning: Is it meant for science courses? *Internet and Higher Education* 5: 109–118.

Liarakou, G., C. Gavrilakis and E. Flouri. 2009. Secondary school teachers' knowledge and attitudes towards renewable energy sources. *Journal Science of Education Technology* 18:120–129.

Lim, C. P. and S. C. Tan. 2001. Online discuss boards for focus group interviews. An exploratory study. *Journal of Educational Enquiry* 2(1): 50–60.

Mohamed Amin Embi. 2011. *Web 2.0 in teaching and learning.* Bangi*:* Centre for Academic Development, Universiti Kebangsaan Malaysia.

Mohd Yusof Othman and Kamaruzzaman Sopian. 2006. Alternative resource of environmental friendly energy: Prospects and problems. *Jurnal Kesturi* 16(1&2): 41–63.

Moursund, D. 2003. *Project–based learning using information technology*. 2nd ed. Eugene: International Society for Technology in Education.

National Environmental Education and Training Foundation (NEETF). 2002. NEETF and Roper ASW. Americans low "Energy Iq". National report card. Washington DC.

Njuguna, W. 2005. Blogs with strengths and weaknesses gain. 2005 ASNE Reporter. http://www.asne.org/index.cfm?id=592 (accessed 4 March 2012).

Norazah Mohd. Nordin and C. H. Ngau. 2009. Development and evaluation of web based teaching and learning material-webQuest for ICT lesson. *Jurnal Pendidikan Malaysia* 34(1): 111–129.

Olson, D. 1994. *The world on paper: The conceptual and cognitive implications of writing and reading*. New York: Cambridge University Press.

Papadouris, N., C. P. Constantinou and T. Kyratsi. 2008. Students' use of the energy model to account for changes in physical systems. *Journal of Research in Science Teaching* 45(4): 665–688.

Parker, L. L. 2008. Technology-mediated learning environments for young English learners. New York, NY: Lawrence Erlbaum

Phillips, D. C. 2000. *Constructivism in education: Opinions and second opinions controversial issues*. The ninety-ninth Yearbook of the National Society for the Study of Education. Part 1. Chicago, Illnois: University of Chicago Press.

Ras, E. and J. Rech. 2009. Using wikis to support the Net Generation in improving knowledge acquisition in capstone projects. *The Journal of Systems and Software* 82: 553–562.

Savin-Baden, M. 2007. *A practical guide to problem-based learning online*. London: Routledge.

Sherer, P. and T. Shea. 2002. Designing courses outside the classroom: New opportunities with the electronic delivery toolkit. *College Teaching* 50(1): 15–20.

Simsek, O. 2010. The effect of weblog (blog) students writing performance. *Procedia Social and Behavioral Sciences* 2: 953–958.

Solomon, B. D., M. J. Pasqualetti and D. A. Luchsinger. 2003. Energy geography. In. *Geography in America at the dawn of the 21st century*, eds. G. L. Gaile and C. J. Willmott, 302–313. New York: Oxford University Press.

Solomon, J. 1992. *Getting to know about energy: In school and society*. London: The Falmer Press.

Suler, J. 2004. Psychological dynamics of online synchronous conversation in text-driven chat environments. http:// www.rider.edu/users/suler/psycyber.html.

Thomas, J. W. 2000. A review of research on project-based learning. Report prepared for The Autodesk Foundation.

Van Koevering, T. E. and N. J. Sell. 1983. An analysis of the effectiveness of energy education workshops for teachers. *Science Education* 67(2): 151–158.

Van't Hooft, M. 2005. The effect of the "Ohio Schools Going Solar" project on student perceptions of the quality of learning in middle school science. *Journal of Research on Technology in Education* 37(3): 221–243.

Vonderwell, S. and S. Turner. 2005. Active online learning and student experiences in an online course: A case study. *Journal of Technology and Teacher Education* 13(1): 65–84.

Yusup Hashim and Razmah Man. 2001. An overview of instructional design and development model for electronic instruction and learning. *Malaysian Journal of Educational Technology* 1(1): 38–52.