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The Development of a Curriculum for Renewable Energy: A Case Study of Charcoal Briquettes from Agricultural Residues for Environmental Literacy of Secondary School Students at Samaki Wittaya Municipality School

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Abstract

This research aimed to (1) design a curriculum on Production of Charcoal Briquettes from Agricultural Residues, (2) implement the designed curriculum, and (3) study and compare the learning achievements of Matthayomsuksa 3 students at Samakee Wittaya Municipality School in terms of knowledge, learning skills, and participation in the production of charcoal briquettes from agricultural residues. The sample group consisting of 26 Matthayomsuksa 3 students was selected by the purposive sampling techniques. The research tools included a survey, interviews, a curriculum on charcoal briquette production, a knowledge test, a learning skill assessment questionnaire, and a participation assessment questionnaire. This research study was conducted in three phases. In phase 1, a survey and interviews were employed to gather initial data for curriculum development. A curriculum on charcoal briquette production was developed in phase 2 using the initial data gained from phase 1. The designed curriculum was implemented with the sample group in phase 3. The data were analyzed by mean and standard deviation, and the research hypotheses were tested by paired samples t-test and F-test (One-way MANCOVA and One-way ANCOVA). As assessed by the experts, the quality and content validity of the curriculum was at the average level ($\bar{X}$ = 0.80-1.00), and the suitability of the curriculum was at the high level ($\bar{X}$ = 3.60-4.40). Besides, it was found that after the implementation of the curriculum the students' mean scores, both in each and all aspects, for knowledge, learning skills and participation in charcoal briquette production were higher than those before the implementation of the curriculum at the significance level of 0.05. The one-way MANCOVA results showed that students of different genders had different knowledge, learning skills and participation in charcoal briquette production, statistically significant at the level of 0.05. The univariate tests also revealed a significant difference in two dimensions of environmental knowledge of the students—knowledge on renewable energy and participation in renewable energy production, at the significance level of 0.09.

Keywords: development of renewable energy curriculum, production of charcoal briquettes from agricultural residues, environmental literacy, learning skills, participation

1. Introduction

Thailand's energy consumption in the first four months of 2015 has recently reached to 26,401 thousand TOE-4.2 percent increase compared to the same period of time last year (Energy Statistics and Information, 2015). The final energy consumption of the country in 2014 was 73,316 thousand TOE. It is estimated that energy consumption growth in Thailand for the next coming 20 years (2010-2030) is likely to be 3.9 percent per year, according to Office of Natural Resources and Environmental Policy and Planning (2015, p. 4). 90 percent of its electricity is generated by different energy sources such as oil, coal, natural gas. However, Thailand has currently depended on renewable energy sources as alternative energy for electricity production to help lower oil and natural gas consumption. This is also regarded as one of the ways to reduce global warming caused by greenhouse gas emissions (Homwan, 2012, pp. 100-104).

Kaltschmitt et al. (2007) state that renewable energy includes solar radiation, geothermal energy, wind energy, run-of-river and reservoir water supply, and photosynthetically fixed energy. The transportation sector is the largest consumer of petroleum-based fuels in Thailand, followed by the industrial sector and the residential, respectively (Tanatvanit, Limmeechokchai, & Chungpaibulpatana, 2003, pp. 367-395). Department of Alternative Energy Development and Efficiency (2013) reported that Thailand alternative energy consumption in 2013 was or 8,232 thousand TOE, up 12.9 percent from last year or 10.9 percent of final energy consumption. (Prasertsan et al., 2006, pp. 599-610) mentioned that "Biomass has been traditional energy source in rural Thailand for decades. Country modernization, instead of reducing the biomass energy consumption, has continuously increased its utilization for both households and production of modern energy". Biomass has been used as alternative energy source through both thermal processes and biological processes, followed by a serious shortage of energy sources, namely forest, coal and wood. So, effective development of biomass energy is an underlying mechanism for a sustainable energy future (Biomass: Website). This notion has led to a number of projects in sustainable biomass production in Thailand (Sajjakulnukit & Verapong, 2003, pp. 557-570).

There has been an increasing demand in charcoals and charcoal briquettes in Thailand. Moreover, raw materials for charcoal production are commonly found in agricultural sites. The characteristics of charcoal briquettes include heating value greater than 6,300 kcl/kg, low smoke when burned, low amount of ashes, and not bursting when burned, according to local charcoal entrepreneurs (Lapanupat, 2010, abstract). Charcoal briquettes from agricultural residues can be used as alternative energy, effectively. Sophasop et al. (2007, abstract) indicated that charcoal briquettes help in reducing energy consumption, expenses and agricultural residues that may lead to pollutions and environmental problems. Moreover, they can be produced and consumed sustainably. Alternative energy is essential for human lives; therefore, environmental knowledge must be disseminated to students and the general public so that they will realize the importance of the environment and understand which energy consumption has a positive impact on the environment. Dissemination of environmental knowledge can be done in various ways such as training, class instruction or activities, as well as through media and other instruments and even through a learning curriculum. A curriculum can be regarded as a framework for developing learners' efficiency in response to standards or goals established in aspects such as knowledge, skills and desirable characteristics so that they can live happily in the society (Singseewo, 2014, pp. 17-18). Therefore, the learning content concerning alternative energy should be put in the education system through curriculum development processes—may it be put in a curriculum or in a training program.

Curriculum development is viewed as a process of or a step in combining certain methods or activates into a system which can be practiced in real-life situations, according to (Singseewo, 2015, p. 26). The Basic Education Core Curriculum B.E. 2551 (2008) is an educational reform and is also as an expansion of the National Education Act B.E. 2542 (1999) that strives to promote student centeredness under the notion that different people have different learning capacity depending on their interest, proficiency and individual differences (Ministry of Education, 2001, 2008; Singseewo, 2011, p. 94). Numerous areas must be taken into consideration when one has to develop a curriculum, e.g., interdisciplinary approaches to technology curriculum development, and importance of collaboration to creative curriculum development (Barlex, 2012, pp. 197-230).

Environmental literacy is one of the ultimate goals of environmental education (UNESCO—UNEP, 1989). Environmental literacy, trapped in educational paradigms, can be defined as knowledge, skills and motivation to appropriately deal with environmental problems (Simona & Ioana, 2014, pp. 586-591). Environmental literacy is also related to environmental education processes that place an emphasis on enabling individuals to realize the value of natural resources and environments and to clearly understand the relationship between humans and environments. These are the foundation to improving attitudes, awareness, decision skills in environmental issues, environmental ethics, and participation in the conservation and preservation of environments (Singseewo, 2011, p. 41). In this study, environmental literacy refers to the following three aspects: knowledge on alternative energy, learning skills and participation in the production of charcoal briquettes from agricultural residues.

Realizing the importance of environmental literacy as a goal of environmental education, the researcher desired to design an alternative energy curriculum on production of charcoal briquettes from agricultural residues, which can be integrated into regular class instruction to improve student achievements in environmental studies.

2. Objectives

1) To design an alternative energy curriculum on "Production of Charcoal Briquettes form Agricultural Residues".

2) To implement the alternative energy curriculum on "Production of Charcoal Briquettes form Agricultural Residues".

3) To study and compare environmental literacy of Matthayomsuksa 3 students at Samakee Wittaya Municipality School in terms of knowledge on alternative energy, learning skills, and participation in the production of charcoal briquettes from agricultural residues.

3. Material and Method

3.1 Population and Samples

The population in this study included 68 lower secondary students from Samakee Wittaya Municipality School under Maha Sarakham Municipality, Maha Sarakham Province.

The samples comprising 26 lower secondary students from Samakee Wittaya Municipality School under Maha Sarakham Municipality were selected through the purposive sampling method (Brown, 2010, pp. 142-146).

4. Research Instruments

4.1 Teaching and Learning Tool

A curriculum on alternative energy under the topic “Production of Charcoal Briquettes from Agricultural Residues” whose learning content consists of energy, alternative energy, and production of charcoal briquettes.

4.2 Tools for Measuring Environmental Literacy

1) A knowledge test on alternative energy comprising 20 questions each with 4 answers (a, b, c, d) each correct response earns 1 point, and each incorrect response earns 0.

2) A learning skill assessment questionnaire composed of 15 questions with five answers to select from namely highest, high, moderate, low and lowest—the score level are described as 5 = highest, 4 = high, 3 = moderate, 2 = low and 1 = lowest.

3) An assessment questionnaire on participation in Alternative Energy: Producing Charcoal Briquettes from Agricultural Residues comprising 15 questions with five answers to choose from namely highest, high, moderate, low and lowest—the score level are described as 5 = highest, 4 = high, 3 = moderate, 2 = low and 1 = lowest.

5. Collection of Data

Data were collected as initial information for the development of an alternative energy curriculum on the production of charcoal briquettes from agricultural residues, by knowledge transferring tools and assessment instruments in three phases as follows:

Phase 1: Conducting a survey for curriculum development, regarding causes of environmental problems and environmental literacy in schools

Phase 2: Designing an alternative energy curriculum through the seven steps of the Taba Model, whose learning content includes energy, alternative energy, and charcoal briquette production

Phase 3: Implementing the curriculum; this phase is divided into 2 sessions: theory and practice, each lasting one hour once a week for 10 weeks.

6. The Statistics Used

1) Basic statistics included mean and standard deviation (Srisa-ad, 2000, pp. 102-104).

2) Statistics used for testing the hypotheses consisted of Paired samples t-test and F-test (One-way MANCOVA and One-way ANCOVA) (Snijders, 2015, pp. 494-499).

7. Results

1) Designing an alternative energy curriculum on Production of Charcoal Briquettes from Agricultural Residues. The curriculum was designed based upon the 7 steps of Taba’s curriculum development model (Taba, 1962). The quality and content validity of the curriculum were assessed by experts both of which were found to be in acceptable criteria ($\bar{X}$ = 0.80-1.00), and the suitability of the curriculum was also rated at the high level ($\bar{X}$ = 3.60-4.40) (Aaron Kaplan et al., 2014).

2) The students’ mean score in Knowledge both in each and all aspects after the implementation of the curriculum was higher than that before the implementation of the curriculum at the significant level of 0.05 (see Table 1) (Wongchantra et al., 2008, pp. 941-944).

3) The students’ mean score in Learning Skills both in each and all aspects after the implementation of the curriculum was significantly higher at the 0.05 level (see Table 2) (Fortuin et al., 2013).

4) The students' mean score in Participation for both overall and in each aspect was higher significantly at the 0.05 level (see Table 3) (Sachiyo et al., 2011).

5) Overall knowledge, learning skills and participation of the students with different genders differed significantly at the 0.05 level (p = .012) as can be seen in Table 4. Moreover, the univariate tests revealed differences in the two dimensions of environmental literacy of the students with different genders—knowledge about alternative energy and participation in alternative energy, statistically significant at the level of. 009 (p < .001) as can be shown in Table 5 (Klongyut et al., 2015).

Table 1. A comparison of knowledge before and after the implementation of the curriculum on the topic "Alternative Energy: Production of Charcoal Briquettes from Agricultural Residues"

Alternative energy: Charcoal briquettes produced from agricultural residues	Total score	Before		After		df	t	p-value
n = 26		$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Energy	6	2.30	1.12	4.19	1.09	25	-7.72	0.00*
Alternative energy	9	3.11	1.63	7.53	0.98	25	-12.27	0.00*
Charcoal briquette	5	1.53	1.33	3.57	1.60	25	-5.39	0.00*
Total	20	6.96	3.19	15.30	2.67	25	-11.50	0.00*

*At a significance level of 0.05

Table 2. A comparison of learning skills before and after the implementation of the curriculum on the topic "Alternative Energy: Production of Charcoal Briquettes from Agricultural Residues"

Alternative energy: Charcoal briquettes produced from agricultural residues	Before		Level of skill	After		Level of skill	df	t	p-value
n = 26	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Knowledge	3.05	1.03	moderate	4.53	0.68	highest	25	-5.058	0.00*
Analytical thinking	3.31	0.98	moderate	4.43	0.66	high	25	-4.050	0.00*
Practice	3.15	0.94	moderate	4.57	0.51	highest	25	-5.662	0.00*
Total	3.17	0.91	moderate	4.51	0.59	highest	25	-5.116	0.00*

*At a significance level of 0.05

Table 3. A comparison of participation before and after the implementation of the curriculum on the topic "Alternative Energy: Production of Charcoal Briquettes from Agricultural Residues"

Alternative energy: Charcoal briquettes produced from agricultural residues	Before		Level of participatio n	After		Level of participation	df	t	p-value
n = 26	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Planning	3.19	0.96	moderate	4.53	0.55	highest	25	-5.091	0.00*
Practice	3.14	0.97	moderate	4.64	0.44	highest	25	-6.578	0.00*
Implementation	3.25	0.79	moderate	4.63	0.50	highest	25	-6.710	0.00*
Total	3.19	0.84	moderate	4.60	0.42	highest	25	-6.526	0.00*

*At a significance level of 0.05

Table 4. A comparison knowledge, learning skills and participation on the topic "Alternative Energy: Production of Charcoal Briquettes from Agricultural Residues" of the students with different genders (One way MANOVA)

Source of Variation	Statistic used	Value	F	Hypothesis df	Error df	p-value	Partial Eta Squared
Knowledge before learning	Pillai's Trace	.072	.489	3.000	19.000	.694	.072
	Wilks' Lambda	.928	.489	3.000	19.000	.694	.072
	Hotelling's Trace	.077	.489	3.000	19.000	.694	.072
	Roy's Largest Root	.077	.489	3.000	19.000	.694	.072
Skills before learning	Pillai's Trace	.066	.449	3.000	19.000	.721	.066
	Wilks' Lambda	.934	.449	3.000	19.000	.721	.066
	Hotelling's Trace	.071	.449	3.000	19.000	.721	.066
	Roy's Largest Root	.071	.449	3.000	19.000	.721	.066
Participation before learning	Pillai's Trace	.039	.258	3.000	19.000	.854	.039
	Wilks' Lambda	.961	.258	3.000	19.000	.854	.039
	Hotelling's Trace	.041	.258	3.000	19.000	.854	.039
	Roy's Largest Root	.041	.258	3.000	19.000	.854	.039
Gender	Pillai's Trace	.431	4.789	3.000	19.000	.012*	.431
	Wilks' Lambda	.569	4.789	3.000	19.000	.012*	.431
	Hotelling's Trace	.756	4.789	3.000	19.000	.012*	.431
	Roy's Largest Root	.756	4.789	3.000	19.000	.012*	.431

*At a significance level of 0.05

Table 5. A comparison knowledge, learning skills and participation on the topic "Alternative Energy: Production of Charcoal Briquettes from Agricultural Residues" of the students with different genders (Univariate Test)

Dependent Variable	Source of Variation	SS	df	MS	F	p-value	Partial Eta Squared
Knowledge	Before learning	3.225	1	3.225	.587	.452	.025
	Gender	44.661	1	44.661	8.122	.009*	.261
	S.D.	126.467	23	5.499			
Skills	Before learning	.932	1	.932	4.055	.056	.150
	Gender	1.083	1	1.083	4.713	.041*	.170
	S.D.	5.285	23	.230			
Participation	Before learning	.211	1	.211	1.836	.189	.074
	Gender	1.010	1	1.010	8.786	.007*	.276
	S.D.	2.644	23	.115			

*At a significance level of 0.017

8. Conclusion

This research attempted to study and compare environmental literacy of the students through the implementation of an alternative energy curriculum on Production of Charcoal Briquettes form Agricultural Residues in three aspects, namely knowledge about alternative energy, learning skills, and participation in alternative energy. When comparing the students' knowledge before and after the implementation of the curriculum, it was found that the students, mean score for both overall and in each aspect was higher statistically significant at the 0.05 level. The learning activities were organized based upon the environmental education processes. It is obvious that the research tools comprising an alternative energy curriculum, a knowledge test and questionnaires along with other instructional media had contributed greatly to the improvement of students' knowledge. Therefore, it can be said that environmental education processes are key factors in designing appropriate learning activities for students. The findings of this study are consistent with a research study entitled "Developing Environmental Education Activities to Strengthen Knowledge, Attitudes, and Environmental Conservation Behaviors of Children and Youths at Udon Thani Juvenile Observation and Protection Center" conducted by (Punprasart et al., 2013) which indicates that environmental education activities enhance knowledge, attitudes and behaviors in environmental conservation in terms of electricity and water conservation, garbage management and cleanliness, at the 0.5 significance level. This study is consistent with the findings of (Liarakou et al., 2013) from the study "Secondary School Teachers' Knowledge and Attitudes Towards Renewable Energy Sources" in which they discovered that despite having knowledge about renewable energy sources those teachers were still unable to express clear positions on environmental issues, e.g., solar energy, wind energy, technologies for farming. The present study is also consistent with the findings presented by (Ladawan et al., 2015) who conducted research on "Development of environmental knowledge, team working skills and desirable behaviors on environmental conservation of Matthayomsuksa 6 students using good science thinking moves method with metacognition techniques" which found that the teaching plans designed obtained the effectiveness index of 0.7290, and the students had better environmental knowledge after learning ($p = 0.001$).

The students' learning skills improved after the implementation of the curriculum at the 0.05 level for both overall and in each aspect. Three skills relevant to environmental education processes: knowledge, analytical thinking and practice had been employed during the tryout process of the curriculum. This finding is consistent with the previous study that has demonstrated the contribution of systems analysis to training students in cognitive interdisciplinary skills in environmental science education (K. P. J. (Karen) Fortuin et al., 2013, pp. 139-152). Fortuin el al. (2013) define three components of cognitive interdisciplinary skills: (1) the ability to understand environmental issues in a holistic way, taking into account the interplay of social and biophysical dynamics, (2) the ability to connect both the analysis of environmental problems and the devising of solutions with relevant disciplinary knowledge and methodologies, and (3) the ability to reflect on the role of scientific research in solving social problems. The findings of the present study are also consistent with a study conducted in 2009 by (Appamaraka et al., 2009) that was attempted to investigate "Effects of Learning Environmental Education Using the 5Es-Learning Cycle Approach with the Metacognitive Moves and the Teacher Handbook Approach on Learning Achievement, Integrated Science Process Skills and Critical Thinking of High School (Grade 9) Students". The results revealed that, in overall, the students had better learning achievement, critical thinking, and science process skills ($p < 0.05$), and gender difference did not affect the outcomes mentioned earlier ($p > 0.05$).

The students' mean score in participation increased both in each and overall aspect after the implementation of the curriculum, statistically significant at the 0.05 level. To enhance their participation in the production of charcoal briquettes, the students were asked to work in groups in which they got to learn and share ideas with each of their peer and the whole group. At this point, such participation of the students was enhanced through three aspects—planning, practice, and implementation all of which were gained from both theory and practice. This finding is consistent with the study of (Sachiyo et al., 2011) who carried out research on "The Participation Management of Children and Youth by Environmental Education Principle" and the findings revealed 1) the Participation Management (PM) was found to be at the high level, 2) PM based on the principles of EE is a form of participation in the HORA model, 3) the participants' mean scores in three aspects: learning, knowledge and awareness, were higher than those before research intervention. Besides, Wanlu et al. (2014) conducted a study on "The development of knowledge and awareness of environmental laws and participation in environmental conservation of probationers", which suggested that the training manual used obtained an effectiveness index of 0.2889, and after the intervention the experimental group showed gains in knowledge, awareness about environmental laws, and participation in environmental conservation ($p < .001$). Additionally, the experimental group had more knowledge on environmental laws and better participation in environmental conservation than the controlled group ($p < .001$).

A Multivariate Analysis of Variance was used to test a significant difference between the male students and the female students. The number of male students is equal to the female students. The findings revealed that the students with different genders had different knowledge about alternative energy, learning skills, and participation in the production of charcoal briquettes from agricultural residues at the significance level of 0.05. One reason to explain such difference is that the researcher had designed a wide range of learning activities and also used environmental education processes in those activities in which both male and female students were urged participate in equally, and then the MACOVA was employ to test if the two genders differ. After that a univariate test was conducted to determine whether the initial decision was correct, and the results showed that the students with different genders had different knowledge, learning skills and participation ($p < .017$). The study results are consistent with the work by (Fraune, 2015) which indicates that gender matters in renewable energy and citizen participation in Germany, but some findings on gender differences in the amount of capital assets invested per capita are inconclusive. Moreover, Fraune (Fraune, 2015, pp. 55-65) concluded that individual preferences, investment attitudes as well as social and political factors have an influence on an individual's agency to participate in RES-E operated by citizens' associations. The present study is also consistent with the results of the study "Effects of Learning Environmental Education Using the 5E-Learning Cycle with Multiple Intelligences and Teacher's Handbook Approaches on Learning Achievement, Basic Science Process Skills and Critical Thinking of Grade 9 Students" conducted by (Budprom et al., 2010) that indicated no difference in basic science process skills of the students with different genders; however, the male students outperformed the female students in learning achievement and critical thinking ($p < 0.05$). The findings of the present study are also consistent with a research study titled "A development of participation of primary school students in conservation of school environments" carried out by (Klongyut et al., 2015), which suggested that the students, taking both their GPA and proficiency levels into account, showed gains in attitudes, knowledge and behaviors before participating in the training session. That is, the female students had better knowledge than the male student in 3 aspects: water conservation, garbage/waste disposal, and chemical usage. The Grade 6 students had higher knowledge on energy conservation than the Grade 5 ones, but the two groups showed no significant difference in attitudes and behaviors. Besides, it was found that sex and level of education had a significant impact on knowledge and behaviors of the students.

References

Aaron, K., Ágnes, S., Thomas, S., & Angela, V. (2014). *Finding Quality: A Multilingual Search Engine for Educational Research*. Indicators and Approaches.

Appamaraka, S., Suksringam P., & Singseewo, A. (2009). Effects of Learning Environmental Education Using the 5Es-Learning Cycle Approach with the Metacognitive Moves and the Teacher Handbook Approach on Learning Achievement, Integrated Science Process Skills and Critical Thinking of High School (Grade 9) Students. *Pakistan Journal of Social Sciences*, *6*(5), 287-291.

Biomass Energy. (2015). Retrieved January 30, 2015, from http://www.eppo.go.th

Brown, R. S. (2010). Sampling. *International Encyclopedia of Education*, *3*, 142-146. http://dx.doi.org/10.1016/B978-0-08-044894-7.00294-3

Budprom, W., Suksringam, P., & Singsriwo, A. (2010). Effects of Learning Environmental Education Using the 5E-Learning Cycle with Multiple Intelligences and Teacher's Handbook Approaches on Learning Achievement, Basic Science Process Skills and Critical Thinking of Grade 9 Students. *Pakistan Journal of Social Sciences*, *7*(3), 200-204. http://dx.doi.org/10.3923/pjssci.2010.200.204

Cornelia, F. (2015). Gender matters: Women, renewable energy, and citizen participation in Germany. *Energy Research & Social Science*, 55-65.

David, B. (2012). CURRICULUM DEVELOPMENT. Technology Education for Teachers. *International Technology Education Studies*, 197-230. http://dx.doi.org/10.1007/978-94-6209-161-0_9

Department of Alternative Energy Development and Efficiency. (2015). *Thailand Alternative Energy Situation 2013 Report*. Retrieved May 15, 2015, from http://www.dede.go.th

Energy Statistics and Information Department of Alternative Energy Development and Efficiency. (2015). *Thailand Energy Situation January-April 2015*. Retrieved May 15, 2015, from http:// www.dede.go.th

Fortuin, K. P. J., van Koppen, C. S. A., & Kroeze, C. (2013). The contribution of systems analysis to training students in cognitive interdisciplinary skills in environmental science education. *Journal of Environmental Studies and Sciences*, *3*, 139-152. http://dx.doi.org/10.1007/s13412-013-0106-3

Georgia, L., Costas, G., & Eleni, F. (2009). Secondary School Teachers' Knowledge and Attitudes Towards Renewable Energy Sources. *J Sci Educ Technol*, *18*, 120-129. http://dx.doi.org/10.1007/s10956-008-9137-z

Homwan, M. (2012). Renewable Energy: A New Way to Save Our Environment. *Executive Journal Bangkok University*, *32*(1).

Klongyut, S., Singseewo, A., & Suksringam, P. (2015). A development of participation of primary school students in conservation of school environments. *Academic Journals of Educational Research and Reviews*, *10*(18), 2599-2605.

Ladawan, C., Singseewo, A., & Suksringarm, P. (2015). Development of environmental knowledge, team working skills and desirable behaviors on environmental conservation of Matthayomsuksa 6 students using good science thinking moves method with metacognition techniques. *Academic Journals of Educational Research and Reviews*, *10*(13), 1846-1850.

Lapanupat, P. (2010). *A Feasibility study for investment in corn core charcoal briquettes production in Amphoe Long, Changwat Phrae* (M.B.A Thesis). Chiang Mai University.

Martin, K., Wolfgang, S., & Andreas, W. (2007). *Renewable Energy*. Technology, Economics and Environment. Integra Software Services Pvt. Ltd., India.

Ministry of Education. (2001). *Basic Education Curriculum B.E. 2544*. Bangkok: The Teachers Council of Thailand, Ladprao.

Ministry of Education. (2008). *The Basic Education Core Curriculum B.E. 2551*. Bangkok: The Teachers Council of Thailand, Ladprao.

Office of Natural Resources and Environmental Policy and Planning. (2015). *State of Environment 2009 Report* (1st ed.). Text and Journal Publication Co., Ltd.

Prasertsan, S., & Sajjakulnukit, B. (2003). Sustainable biomass production for energy in Thailand. *Biomass and Bioenergy*, *25*, 557-570. http://dx.doi.org/10.1016/S0961-9534(03)00091-6

Prasertsan, S., & Sajjakulnukit, B. (2006). Biomass and biogas energy in Thailand: Potential, opportunity and barriers. *Renewable Energy*, *31*, 599-610. http://dx.doi.org/10.1016/j.renene.2005.08.005

Punprasert, P., Wongchantra, P., & Salee, B. (2013). Developing Environmental Education Activities to Strengthen Knowledge, Attitudes, and Environmental Conservation Behaviors of Children and Youths at Udon Thani Juvenile Observation and Protection Center. *European Journal of Scientific Research*, *96*(4), 546-552.

Sachiyo, M., Wongchantra, P., & Salee, B. (2011). The Participation Management of Children and Youth by Environmental Education Principle. *European Journal of Social Sciences*, *23*(2).

Simona, E. T., & Ioana, T. (2014). Why do we need to change the educational paradigms? *Procedia-Social and Behavioral Sciences*, *142*, 586-591. http://dx.doi.org/10.1016/j.sbspro.2014.07.670

Singseewo, A. (2011). *Foundations of Environmental Education*. Maha Sarakham: Mahasakham University.

Singseewo, A. (2014). *Environmental Education Curriculum Development*. Maha Sarakham: Mahasarkahm University.

Snijders, T. A. B. (2015). Hypothesis Testing: Methodology and Limitations. *International Encyclopedia of the Social & Behavioral Sciences*, *2*, 494-499. http://dx.doi.org/10.1016/B978-0-08-097086-8.44031-6

Sophasop, W. (2007). *Production of charcoal briquettes form Residues as renewable energy* (M.S. Thesis). Naresuan University.

Srisa-ard, B. (2002). *Introduction to Research* (7th ed.). Bangkok: Suweeriyasarn.

Taba, H. (1962). *Curriculum Development: Theory and Practice*. New York: Harcourt Brace & World.

Tanatvanit, S., Limmeechokchai, B., & Chungpaibulpatana, S. (2003). Sustainable energy development strategies: Implications of energy demand management and renewable energy in Thailand. *Renewable and Sustainable Energy Reviews*, *7*, 367-395. http://dx.doi.org/10.1016/S1364-0321(03)00066-2

The United Nations Education, Scientific, and Cultural Organization-United Nations Environmental Program (UNESCO-UNEP). (1989). Environmental literacy for all. *Connect*, *XIV*(2).

Wanlu, S., Singseewo, A., & Suksringarm, P. (2015). The development of knowledge and awareness of environmental laws and participation in environmental conservation of probationers. *Academic Journals of Educational Research and Reviews*, *10*(12), 1646-1650.

Wongchantra, P., Boujai, P., Sata, W., & Nuangchalerm, P. (2008). A Development of Environmental Education Teaching Process by Using Ethics Infusion for Undergraduate Students. *Journal of Social Sciences*, *5*(9), 941-944.