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The effects of an Environmental Conservation Camp based on Transformative Learning Theory

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Abstract

Although environmental education aims to transform learners' behavior and practices of environmental conservation, many environmental education programs have concentrated on merely transmitting related knowledge. For this reason, transformative learning theory has recently attracted the attention of scholars, because perspective transformation explains how the meaning structures that learners have acquired over a lifetime become transformed. In this study, a camp program for environmental conservation was designed and developed, based on transformative learning theory to change the behavior of middle school students, and then the effects of a two-day camp were investigated. Leadership, environmental attitude and behavioral intention were postulated as dependent variables since they have been known as generators of performing transcendent ideas and actions beyond one's short-sighted interests. The 226 middle school students who participated in this study were assigned to an experimental group (123 participants) or a control group (103 non-participants). An independent sample *t*-test was used to compare the effects of three variables between two groups. The results showed that the scores of leadership, environmental attitude and behavior intention of the participant group were significantly higher than those of the non-participant group. The findings show that the camp based on transformative learning theory could be effective in transforming students' leadership, attitude, and behavioral intention in environmental conservation. Several guidelines and strategies for designing and developing learning programs based on transformative learning theory have been suggested.

Keywords: *Transformative learning, leadership, environmental attitude, environmental behavioral intention*

Introduction

As the global environment changes rapidly with the development of industrial economies, attention to environmental issues has increased globally and pressed us to take firm steps to conserve the environment in our daily lives. Due to the delayed effects of destructive environmental attitudes and actions, people can be extremely insensitive and apathetic in their current attitudes and behavior. It is, therefore, important for environmental education to cultivate a person who can take concrete action right now. Education has to go beyond

the simple accumulation of related knowledge. Besides, adolescents and college students are more important target audiences than older generations in fostering proper environmental attitudes and behavior (Cheong, 2004). Proper environmental behavior is difficult to encourage, since it requires uneconomical and irrational decision making that contradicts one's natural desires (Yi, 2009). Internal and unconscious factors related to the pursuit of individual interest may prevent environmental behavior from becoming a habit. So, environmental education should take an approach not in terms of knowledge transmission but of transforming one's perspective.

According to transformative learning theory, more experienced persons are likely to accept new information. That is, one is much likely to form a frame based on the references reflecting one's own habit of mind and point of view. Transformation, therefore, is requires a change of the frame of reference for sustainable and developmental growth. Accordingly, transformative learning aims at supporting release from one's own discriminative prejudices so that individuals can experience and accept the transformation by taking different perspectives. Though it originated from adult learning, transformative learning should now be extended to adolescents.

For this study, an environmental conservation camp was developed based on transformative learning theory and environmental issues in terms of leadership, attitude, and habits. Leadership of the middle school students was an important issue. The camp designers' intention was for our students to become leaders to solve environmental problems actively at home, school and society beyond the individual's mere participation in camp. The entire context of the camp was designed based on the 10 phases of Mezirow's Transformative Learning Process.

This study postulated the environmental behavior intention as the outcome of the transformative learning-based environmental conservation camp. According to previous research, behavioral intention could replace environmental behavior which is the final goal of the environmental conservation camp (Aragóon-Correa & Liorens-Montes, 1997; Chan, 2001; Powell & Ham, 2008). Besides, environmental leadership and attitude were also selected as dependent variables since they are considered to have a strong relationship with behavioral intention.

This research investigated the effects of transformative learning theory applied in designing the environmental conservation camp and suggested guidelines for designing and developing learning programs. To pursue the purposes of the research, the questions were formed as follows. "Is there a difference in the scores of leadership, environmental attitude, and environmental behavior intention between the camp participant group and non-participant group?"

Theoretical Background

Transformative learning

Transformative learning is learning understood as a process to infer a new or revised interpretation of individual experience using the previous interpretation to derive future behavior (Mezirow, 1996). The core of transformative learning is self-changing, a shifting method by which the individual sees oneself and the world. For learners to change "meaning schemes" (specific beliefs and attitudes), they must engage in critical reflection on their experiences, which in turn leads to a perspective transformation (Mezirow, 1991). Rather than knowledge acquisition or information accumulation we experience in conventional education, it means that the learner comes to be a subject, and has to experience and recognize that his perspective has transformed and changed. Mezirow's transformative learning includes the process of perspective transformation and it emphasizes recognition in individuals that the subject of learning is the learner himself.

One of the characteristics of transformative learning is practical discipline. Based on transformative learning theory, Lee and Nam (2012) conducted a qualitative analysis on the learning experiences of newly-appointed elementary teachers and Pugh (2002) examined the effectiveness of instructional elements in cultivating transformative learning like encouragement and apprenticeship in a high school zoology class using Dewey's concept of transformative experience. Han and Choi (2007) examined transformative experience related to gender equality, social and vocational awareness in a leadership development course of 7 women. Such domestic and foreign practical studies show that educational programs based on transformative learning theory may facilitate participants' internal and external changes.

Leadership

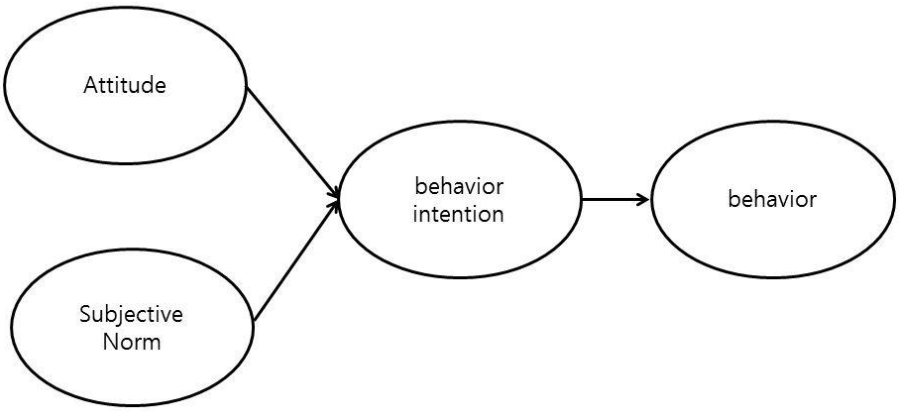
Leadership allows one to influence team members and help them achieve a goal in a certain situation. Leadership theory originally applied to adults, but nowadays is expanding to adolescents with the change in theoretical research on ideal leadership for a given age group. In this study, as sub-factors of leadership, firstly there are intra-and inter-individual characteristics, and secondly, intra-individual characteristics include vision, morality and self-management ability. Inter-individual characteristics include consideration for others and community and organization management (Chun, Yoo & Yoo, 2013). Baek and Kim (2010) found out the effects of undergraduates' leadership strategy on attitude. Hong, Kim, and Chang (2005) also identified that self-leadership has a significant effect on the attitude of workers, suggesting that autonomy-respecting leadership is required to improve workers' attitudes. Shim and Lee (2012) found out that self-leadership of undergraduates has a significant effect on career exploration. Also, Choi (2012) mentioned that self-leadership has significance for innovative behavior in research on college students.

Environmental attitude

Concepts of attitude could vary according to researchers. In psychology, attitude is defined as a disposition to respond to a certain object with a favorable or unfavorable mode." (Im,1991). Environmental attitudes refer to a psychological tendency to respond favorably or unfavorably to the natural environment (Milfont, 2007). In environmental research, environmental attitude is regarded as an important variable in improving environmental behavior (Keum, 2011b). According to Kim and Park (2006), high school students who have a strong interest in environmental issues perform more interactive behaviors, including persuading others to modify environmental behaviors. Oerke and Bogner (2013) found that the general behavior of children was predicted by attitude, social desirability, and the interaction between both. Sia (1986) stated that the level of environmental sensitivity, which is a sub-factor of environmental attitude, is one of the major predictors of environmental behavior. Through these related studies, environmental attitude was discussed as a predictor of environmental behaviors.

Environmental behavior intention

Researchers use various terms like pro-environmental behavior, pro-environmental action or eco-friendly behavior to describe environmental behavior. Environmental behavior may be a useful tool for understanding people's psychological and behavioral changes vis-à-vis the environment. Also it works as an important measurement for setting objects with contents and evaluating effects of environmental education (Keum, 2011a). The Theory of Reasoned Action (TRA) by Ajzen and Fishbein is the representative theory for explaining an individual behavior, regarding behavioral intention as the most direct and powerful variable to determine a behavior (Ajzen, 1988). As such, environmental behavior intention is regarded as the most persuasive variable for predicting personal behavior (Aragóon-Correa & Liorens-Montes, 1997; Chan, 2001; Powell & Ham, 2008).



[Figure 1] The Model of Reasoned Action

Sourced from: Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall, Englewood Cliffs: N J.

Method

Participants

A total of 226 middle school students participated in this research. The participant group consisted with 123 students from 49 schools participated in the environmental conservation camp, and the non-participant group consisted of 103 middle school students from 5 schools were not attending the camp. The participant group was consisted with 43.9% male students (*n* = 54) and 56.1% female students (*n* = 69), and their average age was 14.0 years old. And the non-participant group was consisted with 47.6% male students (*n* = 49) and 52.4% female students (*n* = 54), and their average age was 14.7 years old.

Development & implementation of education program

Educational program was developed by 4 instruction designers including the researcher with 5 contents professionals and conducted for 3 months from March to May, 2014. This educational program aimed at identifying pro-environmental habits and cultivating environmental behavior intention of middle school students across the country who participated in the camp of one night and two days.

Needs analysis for designing the camp was conducted to identify the contents and strategies.. As the result, we found out that target audiences had high level of prior knowledge and instructional strategies were suggested to induce interest of the participant including the true-false quiz or games, through minimizing lecture type program. Besides, if necessary, they were made to have direct experience. Contents were organized to induce internal motivation of the participants using workbooks to facilitate them to find out the answer to the critical issues such as why should we have to change our habits? Transformative learning approach was applied to the program based on Mezirow's (1991) 10 phases on <Table 1>.

Measurement

As for the leadership diagnostic tool, 'KEDI Leadership Inventory (Simplified) by Korean Educational Development Institute was used. In this research, 16 items were used excepting 1 item reducing reliability by the reversed item and 3 items having high contents similarity with questions of other variables. 5-point scale was used, with sub-variables of organization management (7 items) and self-management (9 items). Cronbach's α is .822 and .866, respectively.

A scale by Cheong (2007) was taken for measuring the environmental attitude. In this research, 14 items were used excepting 4 items reducing reliability by the reversed item and 5 items having high contents similarity with questions of other variables. 5-point scale was used, with sub-variables of environment awareness (6 items), environment sensibility (5 items) and personal environment tendency (3 items). Cronbach's α is .819, .763, and .768,

respectively.

As for the environmental behavior intention, a corrected environmental behavior scale by Keum (2011a) was used. In this research, 14 items were used excepting 2 items having high contents similarity with questions of other variables from original 16 items. 5-point scale was used, with sub-variables of consumption learning (10 items) and environment management (4 items). Cronbach's α is 928 and .823 respectively.

<Table 1> Transformative Learning Theory into 10 phases

Step		Main Content	Activity Content
1	Intro Activity	Confusing dilemma	Future Earth Experience
2		Self-checking(reflection)	Collective intelligence formation through discussion
3		Critical evaluation on implied assumptions	
4		Recognition that other learners had a similar process	
5	Main Activity	Alternative exploration for a new role, relation & behavior	Habit training
6		Establishment of practice planning	
7		Acquisition of knowledge & skill for plan implementation	
8	Concluding Activity	Attempt of a new role	UCC production
9		Enhancement of capability & confidence in new roles & relations	
10		Reintegration of the life based on conditions of a new perspective	

<Table 2> Measurement tools

Variable	Source	# of items	Degree	Reliability	
				participant	Non-participant
Leadership					
Organization management	Chun, Yoo, & Yoo (2013)	7		.881	.719
Self-management		9		.904	.786
Environment attitude					
Environment awareness	Cheong (2007)	6	5 point	.874	.726
Environment sensibility		5		.777	.735
Personal tendency		3		.821	.712
Environment behavior intension					
Consumption learning	Keum (2011a)	10		.912	.910
Environment management		4		.855	.787

Data analysis

As for the collected data, descriptive statistics and correlation analysis were conducted. Then a comparison was done by using independent sample *t*-test for the mean difference in leadership, environmental attitude and environmental behavior intention between participant group and non-participant group of the transformative learning based environmental resource conservation camp.

Results

The result of descriptive statistics and correlation analysis of seven sub variables of three main variables were shown in <Table 3>. For participation, the means of sub variables of leadership, organization management and self-management, were 4.093 and 3.940, respectively. The means of sub variables of environment attitude, environment awareness, environment sensibility and personal tendency were 4.043, 3.389, and 4.062, respectively. The means of sub variables of environment behavior intention, consumption learning and environment management, were 3.699 and 4.195, respectively. The absolute skewedness of all variables was between .384 and 1.011, and the absolute kurtosis was between .441 and 3.400. For non-participation group who did not participate in the camp the means of sub variables of leadership, organization management and self-management, were 3.896 and 3.646, respectively. The means of sub variables of environment attitude, environment awareness, environment sensibility and personal tendency were 3.937, 3.115, and 3.916, respectively. The means of sub variables of environment behavior intention, consumption learning and environment management, were 2.945 and 4.000, respectively. The absolute skewedness of all variables was between .030 and 1.233, and the absolute kurtosis was between .052 and 2.906.

<Table 3> Descriptive statistics and correlation analysis

Variables		Participant (n_1 = 123)		Non-participant (n_2 = 103)	
		M	*SD*	*M*	*SD*
Leadership					
	Organization management	4.093	.629	3.896	.529
	Self-management	3.940	.663	3.646	.555
Environment attitude					
	Environment awareness	4.043	.715	3.937	.573
	Environment sensibility	3.389	.774	3.115	.767
	Personal tendency	4.062	.784	3.916	.790
Environment behavior intention					
	Consumption learning	3.699	.717	2.945	.796
	Environment management	4.195	.744	4.000	.781

An independent-samples *t*-test was conducted to compare leadership, environment attitude and environment behavior intension in participant group and non-participant group. There was a significant difference in all variables for participant and non-participant group ($p < .05$), and the scores of variables in participant group are higher than non- participant group. For leadership, there was a significant effect for environment conservation camp, with participation group receiving higher organization management ($\Delta M = .197$, $t(224) = 2.516$, $p < .001$) and self-management ($\Delta M = .294$, $t(224) = 3.576$, $p < .001$) than non-participant group. For environment attitude, there was also a significant effect for environment conservation camp, with participant group receiving higher environment awareness ($\Delta M = .106$, $t(224) = 1.219$, $p < .001$), environment sensibility ($\Delta M = .274$, $t(224) = 2.661$, $p < .001$), and personal tendency ($\Delta M = .146$, $t(224) = 1.394$, $p < .001$) than non-participant group. For environment behavior intention, there was a significant effect for environment conservation camp, with participant group accommodating more of consumption learning ($\Delta M = .754$, $t(224) = 7.495$, $p < .001$) and environment management ($\Delta M = .195$, $t(224) = 1.919$, $p < .001$) than non- participant group.

<Table 4> *t*-test for equity of means between two groups

Variables	*T*	*df*	*p*	Δ*M* (participant – non-participant)	effect size (Cohen's *d*)
Leadership					
Organization management	2.516*	224	.013	.197	.34
Self-management	3.576*	224	.000	.294	.48
Environment attitude					
Environment awareness	1.219	224	.224	.106	.16
Environment sensibility	2.661*	224	.008	.274	.36
Personal tendency	1.394	224	.165	.146	.19
Environment behavior intention					
Consumption learning	7.495*	224	.000	.754	1.00
Environment management	1.919	224	.056	.195	.26

*$p < .05$

The result shows that all comparisons of variables are highly statistically significant; participation group had a higher mean score than non-participation group. We also examined the magnitude of differences in mean scores and in score variability by considering the effect size (Cohen's *d*). Following Cohen (1977), in psychological research,

0.2 is considered a small effect, 0.5 is considered medium, and effect sizes above 0.80 are considered large. Thus, the effect size of difference in consumption learning, sub variable of learning behavior intention, is considered large. While the effect sizes of difference of the other variables are considered small or under medium.

Discussion

In this study, we compared leadership, environmental attitude and behavioral intention of participation and non-participant groups to examine the effects of an environmental conservation camp based on transformative learning. The results of this study are as follows. First, the score of leadership including two sub variables, organization management and self-management, of the participant group was higher than that of the non-participant group. Second, the score of environmental attitude including three sub variables, environment awareness, environment sensibility and personal tendency, of the participant group was higher than that of the non-participant group. Third, the score of environmental behavior intention including two sub variables, consumption learning and environment management, of the participant group was higher than that of the non-participant group. Especially, consumption learning showed a larger effect size than any other variables. This result verifies that the learning program designed by transformative learning was derived from internal change of participation, and it is supported by related research studies (Lee & Na, 2009; Lee & Nam, 2012; Shim, 2004).

Particularly, since leadership was shown as more effective in camp participation than environmental attitude, it may be inferred that the experience-centered camp program with its team activities enhanced participants' participation and immersion in the camp program and contributed to the improvement of leadership. Besides, consumption learning, a sub-factor of environmental behavior intention, was most effective. It means that participating in various activities in conserving energy may have facilitated the actual intent to practice.

The suggestions based on this study are as follows. Firstly, it verified empirically that transformative learning theory has an effect on learners' leadership, attitude and behavior for adolescents. Particularly, learning outcome was identified through comparison with the non-participant group of the camp. Given that the ultimate aim of learning is a behavioral change in real life from environment-related learning, living a pro-environmental life may be realized by specific efforts to apply transformative learning theory to the environmental education field.

Despite such suggestions above, every variable of this study was measured in a self-report manner. So, it is possible to induce biased responses so that there may be more proper ones than those of an individual. Hence, it is necessary to enhance objectivity including thorough observation of an external evaluator in future research. Furthermore, it is necessary to identify additionally if the mean difference between the participant group and

non-participant group resulted purely from the transformative learning. For instance, additional research is needed with strict consideration and control over learners' characteristics and learning environment. Lastly, this study suggests measuring environmental behavior to identify clearly if "education for the environment" was done for making a precise decision on the utilization of the present and future environment. Such utilization was made possible through exploration of the relationship between the environment and personal reactions to environmental issues beyond knowledge cultivation and environmental experience. Future studies could examine relationships among variables including environmental behavior through measuring it at least one month after the end of the camp.

Notwithstanding these constraints, it was empirically proven that a camp program based on transformative learning has a positive influence on affective and social features of the person, such as leadership as well as attitude and behavioral intention in this work. It is meaningful that it provided the theoretical basis for the application of transformative learning for which personal fulfillment is a prerequisite.

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Integrating renewable energy modules with conventional technical programmes for sustainable development and enhancing employability

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Abstract

Global warming and its undesired effects, increased pollutions levels, Spiraling oil prices, lack of trained manpower to maintain renewable energy equipment etc, call for alternative solutions for meeting the energy needs of the developing nations. Technical education can be the driver for change in the future, by integrating renewable energy modules with conventional technical programmes. This paper discusses the need for such programmes in wind energy and Jatropha Biofuel both renewable energies of the future.

Keywords: *Global Warming, Renewable Energy Modules, Conventional Technical Programmes, Jatropha Biofuel, Wind Energy, MNRE (Ministry Of New And Renewable Energy), GEDA (Goa Energy Development Authority), AICTE (All India Council Of Technical Education).*

Introduction

Emissions of carbon dioxide as the main greenhouse gas are the highest from coal combustion among all fossil fuels. As long as we continue to cover our energy needs primarily by combustion of fossil fuels or nuclear reactions, we are going to have the problems, the environmental impacts, social and sustainability problems. What we really need are energy sources that will last forever and can be used without pollution of the environment. Due to the sharp increases of oil and gas prices coal became cost effective fuel. This development seems to be very dangerous from the perspective of global warming. Emissions of carbon dioxide as the main greenhouse gas are the highest from coal combustion among all fossil fuels. As long as we continue to cover our energy needs primarily by combustion of fossil fuels or nuclear reactions, we are going to have the problems, the environmental impacts, social and sustainability problems. What we really need are energy sources that will last forever and can be used without pollution of the environment.

The generic skill gaps identified in the RE industry are – Planning & co-ordination Skills in project management, erection, commissioning and grid integration of large scale RE projects, installation and commissioning skills and techno commercial marketing skills. Design skills to match wind speeds and capacity of turbines, installation of large scale Turbines, operation and maintenance & failure analysis of turbine gear boxes.

Out of the 910 students who graduate in Energy Management with RE electives, majority of them take up jobs in IT and manufacturing sector as the salaries are higher. Also the infrastructure at the Universities is not adequate and the industry finds it difficult to employ the graduates passing out of the Universities as well the ITI's, as they do not have the requisite skills. Hence there is a need to fine-tune and improve the curricula, improve the infrastructure at the Universities so that they meet the future HR requirements of the industry (AICTE 2006-7) [19]

The commercial energy consumption in developing countries has been increasing at an alarming rate. Emissions from the fossil fuels used for electricity and heating are supposed to have an adverse impact on human health. It is found that investment in energy efficiency and renewable energy produce substantially higher levels of employment than equivalent levels of investment in conventional energy supply [1]. However one of the barriers towards spread of renewables is the lack of technical education programs in renewable energy in the developing world that this paper intends to investigate.

Table No.1.1: The world energy World Energy Consumption in 2000

	World Mtoe	**USA %**	**EU-15 %**	**Japan %**	**Russia %**	**China* %**	**India %**
All Fuels	9977,7	23,1	14,9	5,3	6,2	11,4	5,2
Solid fuels	2336,0	23,2	9,4	4,1	4,7	28,1	7,5
Oil	3482,7	25,6	17,2	7,5	3,7	6,4	3,2
Natural gas	2112,4	26,0	16,3	3,1	15,1	1,3	1,1
Nuclear	680,4	30,6	33,8	12,3	5,1	0,6	0,6
Renewables	1367,1	8,0	6,7	1,2	1,5	17,1	15,2
Hydro	227,4	9,6	12,8	3,3	6,2	8,4	2,8
Geothermal	43,5	30,1	7,9	6,6	0,1	0,0	0,0
Wind/Solar	7,2	27,4	37,8	12,6	0,0	0,0	1,9
Biomass	1089,0	6,7	5,2	0,5	0,6	19,7	18,5
Source: Commission services, Organisation for Economic Co-operation and Development						* Includes Hong Kong	

The need for the development of alternative fuels based on renewable sources is growing due to environmental concerns and fears that the production of oil will no longer be able to cover the demand. Such fuels are already available today (biofuels). In contrary to electricity or hydrogen (fuel cells) biofuels does not need large changes in infrastructure, engine equipment and can easily be accommodated by recent fleet of cars on the streets. Biofuels have the potential to reduce greenhouse gas (carbon dioxide) emissions by almost 100 percent relative to oil based petroleum. Kalam Abdul in his address at the inauguration of the South Asian conference on renewable energy which was held at New Delhi on18th April 2006, on energy independence has mentioned that "*The most significant aspect, however would be that the power generated through renewable energy technologies has to be increased to 25% against the present 5%. It would be evident that for true Energy Independence, a major shift in the structure of energy sources from fossil to renewable energy sources is mandated.*"[3]

Need for Technical education programs in renewable energy

Benchikh, Osman, Director of renewable energy implementation programs from UNESCO, in year 2005/2006, while addressing challenges in the area of global renewable energy education and training clearly mentioned that, "*Presently no specific degree granting university and education programme exists in the field of renewable energy". [2]*

If American higher education does not embrace sustainability, then it is likely that another country's universities will and thereby gain competitive advantage. Higher Education plays a profound and pivotal, but often overlooked, role in making this vision of a sustainable future a reality '[7]

The Renewable Energy Technologies Diploma Series is a non-credit, continuing education program providing professional training in the field of renewable energy. The program provides students with technical information and the theory behind the technology, as well as policies, codes and standards, exam preparation exercises, and business management strategies. Currently, five technologies are covered in the series: photovoltaic, wind power, biomass/biofuels, solar thermal and residential green building practices.

The Solar Centre has been very successful in pursuing market transformation and advocacy programs for renewable energy and energy efficiency. With the growing market demand for renewables came a need to develop a capable and knowledgeable workforce. This program has attracted individuals pursuing a new career in the renewables industry, as well as current professionals who need a diploma to authenticate and augment their existing knowledge. The Diploma Series is the only one that is

interdisciplinary by giving the choice of integrating the knowledge of photovoltaic, wind, solar thermal systems, biomass and green buildings into one service package that best meets their needs.[3]

Although the underlying principles of all renewable energy technologies are rooted in traditional scientific and engineering subjects, their hardware requirements and deployment strategies are considerably different from centralized energy sources (e.g. large-scale hydro, fossil and nuclear plants). Therefore, clear and forward looking policies are needed to ensure that technicians, technologists and engineers that possess firm technical training in renewable energy technologies are properly and timely trained. To meet these essential needs, educational organizations must plan for the initiation, development and evolution of renewable energy training programs that provide content specifically tailored to the requirements of existing renewable energy deployment plans and targets [4]

Since energy plays an essential role in people's lives, the study of energy and energy issues should be emphasized in education. Some curriculum developers and teachers in Wisconsin include energy-related activities in education curricula. However, many people believe more needs to be done if energy education is to be widely and consistently instituted throughout Wisconsin in a manner that effectively promotes lifelong learning and links students to the world around them. The creation of a K–12 energy education program has helped meet this need. This program utilizes and encourages school-to-career skills and the use of a rich set of community resources including professionals representing Wisconsin's investor-owned, municipal, and cooperative utilities, as well as businesses, environmental organizations, and institutions of higher education [5]

Renewable Energy and the Employment Front

On the employment generating front, Osman Benchik mentions that "I*n only a few years, figures have passed from 1.5 to 5.6 jobs per installed megawatt and renewable energies will remain an important source for job creation compared to classical energy sources".[2]*

In a 1997 study for Environment Canada, the Pembina Institute found that investment in energy efficiency and renewable energy produce substantially higher levels of employment than equivalent levels of investment in conventional energy supply.

The report found that for every million dollars invested, an average of 36.3 jobs are created in the energy efficiency sector or 12.2 in the renewable energy sector. For every million dollars invested in conventional energy, an average of only 7.3 jobs are created.

Based on this information, the measures identified in this document would result in a total net increase of more than 100,000 person years of employment [9]

Hans, Josef et al state in Human Capacity Building *"In Germany, the renewable energy industry with over 1,30,000 employers provides more jobs than coal, gas, oil and nuclear industries put together". [8]*

2.0 **METHODOLOGY**:

To Study the existing technical education programmes in the area of renewable energy in the region; a thorough literature review was undertaken. Questionnaire 1 was designed by the undersigned at the 'Wind Power Management Program' in Sweden in 2006 September in consultations with the undersigned's Supervisor and senior faculty of Gotland University Sweden and visiting industry professionals who were present over there. It was designed to elicit the type of renewable energy programmes in technical education in their respective countries including the expected competencies from the graduates for the programs (if any). It consisted of two parts Part-1 and Part-2.

a) Part -1: This part contained questions related to name of the respondent, country, qualifications, designation and years of experience of the respondent. These questions were asked so that content of responses could be analysed.
b) Part-2: In this part the respondents were asked their areas of specialization in renewable energy, whether their country has a specialised full time diploma/degree in renewable energy. What were their opinions about having specialized diploma/degree programs in the area of renewable energy?

Additionally, discussions were held with academics in India, Ministry officials of MNRE, survey of AICTE and other websites of other prominent engineering institutes of national repute working in the area of renewable energy about existing technical education programs in the area of renewable energy.

2.1 Target Group

Participants from eighteen different countries, who were attending the Wind Power Management Programme' in Sweden in 2006 September

2.2 Administering Questionnaire No.1

The questionnaire was administered on the target group of participants from eighteen different countries. Here the mode to administer the questionnaire was personal contact and interview. The 3-year engineering diploma level of technical education and 4-year undergraduate degree programmes of India was made clear to all the respondents by the researcher. Questions related to qualifications and availability of the technicians to be

recruited at different levels for working in the area of renewable energy was asked. The competencies in renewable energy suggested by the respondents were also recorded.

3.0 RESEARCH INSTRUMENT No. 2 – QUESTIONNAIRE No.2

This research instrument i.e. Questionnaire-2 consists several sub-parts designed to fulfil some of the following objectives:

3.1 Part-A of Questionnaire No.2

'Part A' of Questionnaire 2 was designed to get the requisite data for achieving the Objective-2 of this research i.e. Identify existing career pathways in the field of renewable energy. Therefore, Part-A of Questionnaire-2 tries to understand the broad areas (nature) of jobs of a mechanical and electrical engineering diploma, graduate engineer and post graduate engineer with specialisation in wind is called upon and the career growth of diploma/UG degree holders in the industry and about different no of wind engineers required were also asked. A 5-point rating scale was used for this part of the instrument. Respondents were supposed to give their opinions on different statements in questionnaire on five point rating scale ranging from highly important to not so important'

3.2 The Initial Sections of 'Part B' of Questionnaire-2 - B1, B2 and B3

The initial part of 'Part B' of Questionnaire 2 i.e. Section number B1, B2 and B3 were designed to elicit data regarding the job profile of the conventional Mechanical and Electrical Engineering diploma/undergraduate degree/postgraduate degree holders for the necessity of specialisation in wind engineering as perceived by the industry. This part is therefore concerned with the career growth of all the three levels of technical persons - engineering diploma, undergraduate degree and postgraduate degree holders.

4.0 WHY THE RENEWABLE ENERGY SOURCES - WIND ENERGY AND JATROPHA BIOFUEL - CHOSEN FOR THIS STUDY

David, Jones [15] CEO of Allianz Specialised Investments says "*wind power has become cheaper and more widespread than most other renewable energy sources"* Wind power also has an edge over other renewable energy sources like hydropower for the following reasons:

- Greatly reduced environmental impacts per unit of energy produced, compared with conventional power plants. Environmental costs are becoming an increasingly important factor in utility resource planning decisions.
- More jobs per unit of energy produced than other forms of energy.
- Long-term income to ranchers and farmers who own the land on which wind farms are built.

Windmills may have been around for almost 1500 years, but it was not imagined that wind power would become affordable enough to compete with fossil fuels. In fact, many utility services around the world offer wind-generated electricity at a premium of 2 to 3 cents per kWh. If a household uses wind power for 25% of its needs, it would spend only $4 or $5 dollars per month for it and the price is still dropping.

Compare this to 4.8 to 5.5 cents per kWh for coal or 11.1 to 14.5 cents per kWh for nuclear power. Wind energy is therefore "cheaper than any other new electric generation except natural gas. Which emits one pound of greenhouse gases for every kilowatt-hour of electricity it generates." The success of this energy is in part due to the fact that its costs have gone "down by more than 80% since the early 1980s." Even lower prices are expected, as "industry analysts see the cost dropping by an additional 20 percent to 40 percent [16].

In India, wind is the fastest growing renewable energy source that is being tapped by the industry in India. But university system in India has yet to rise up seriously to come to the aid of the wind industry by including wind power technology in a big way to provide competent manpower, as compared to other renewable and conventional energy technologies. The gross potential of wind power is 48,561 MW and a total of only about 11,807 MW of commercial projects have been established until March 31, 2010 [17]. There is obviously a huge potential for tapping wind power.

As continuous wind assessment is being undertaken by different agencies and private developers, certain reports like Indian Wind Energy Association (InWEA) states that the on-shore technical potential of India is almost 1,00,000 MW [18]. The grid penetration of India is very poor because of poor evacuation problems. The utility companies are quite slow in strengthening the grid and hence the grid penetration is also very poor. As thumb rule 20% wind power penetrations is considered a technical limit for most grids [11].

Why Jatropha (Biofuel Renewable Resource) Chosen for this Research

In the bioenergy area among the various biofuels, Jatropha (Biodiesel) is another clean and green energy, which is also commercially viable as an alternative to conventional diesel. It was chosen by the researcher as a subject for Mechanical diploma and Mechanical degree students for the following reasons:

Jatropha oil is a vegetable oil produced from the seeds of the Jatropha curcas, a plant that can grow in wasteland. Jatropha curcas grows almost anywhere, even on gravel, sandy and saline soils. It can thrive on the poorest stony soil and grow in the crevices of

rocks. When Jatropha seeds are crushed, the resulting Jatropha oil can be processed to produce a high-quality biodiesel that can be used in a standard diesel car, while the residue can also be processed into biomass to power electricity plants [10].

The cost of selling a litre of Jatropha biodiesel is approx Rs.32 around eight rupees less then conventional diesel, which costs about Rs. 40 and is always increasing [10]. Since Jatropha is not going to replace traditional food crops given the fact it grows on waste land and further more since the vehicles engines do not have to be modified it will be an ideal alternative clean green Biofuel choice for our country saving huge amounts of foreign exchange. At the same time it can also used in remote villages not connected to the grid along with wind power in a hybrid system.

Why the Focus on other Renewable Resources is Limited in this Study?

Markets will generally exploit the lowest-cost resource options first, and thus the costs of renewables may not decline in a smooth trajectory over time. For example, in the case of wind power, the lowest-cost resources are generally available at the most accessible sites in the highest wind class areas. Development of these prime resources will thus entail significant resource cost shifts as markets adjust to exploit resources. At present, onshore wind is an economically favoured option relative to other (non-hydroelectric) renewable resources and hence wind power is expected to continue to grow rapidly if recent policy initiatives continue into the future [14].

Regarding solar energy, even now the production cost of solar PV for every kWH varies in the range from Rs.15 to 18. Moreover, the solar PV has lower efficiencies and is commercially still not viable as wind power.

Ocean energy has various consists of various technologies related to wave energy, tidal energy, ocean current energy and ocean thermal energy conversion (OTEC) technologies and they are highly varied. Hence the industry is yet to use them widely, as the technologies are yet to be competitively commercialised.

Geothermal energy is available only in a very few places in India and yet to be harnessed for commercial use.

Bio energy also has a number of technologies, therefore, the most commercially viable one Jatropha discussed above is considered in this study.

Hydropower has a high level of environmental impact and also has longer gestation period and higher capital cost.

It can thus be concluded that given that wind energy is commercially viable and India is making fast progress in the area of wind power development its curriculum need to scientifically designed and implemented for further systematic progress and development. So is the case with Jatropha as a Biofuel, which is also commercially viable.

5.0 SAMPLE SIZE

The criteria for determining the sample size for the different categories of respondents used in this research was by using Macorr's research calculator. As based on the confidence level, confidence interval and population it can determine the sample size [13].

6.0 UTILITY OF THIS STUDY

Technical Education has been making significant contribution to India's economic development. However the sustainable development through technical education programmes in renewable energy is an area, which has yet to be explored. Rapid advancement of technology is making every sphere of the renewable energy more and more sophisticated, requiring especially skilled engineers, supervisors, and artisans manages etc, to manage the programme at various levels. The technical knowledge, acquired from universities engineering colleges, polytechnics, industrial training institutes needs to be supplemented with applied scientific, engineering and managerial skills. These skills are to be regularly updated to cope with the ever progressing and rapidly advancing technologies being introduced in the renewable energy sector where the speed of obsolescence often overtakes the pace of acquisition of a particular skill. In addition renewable power has an interface with the grid utilities that have numerous technical issues to grapple with. Trained manpower is required at every stage of the above mentioned tasks [12]. Undersecretary B.K. Trikha on June 2nd 2009 in national circular [12] mentions the urgent need for developing curricula in renewable energy for ITI, polytechnics, undergraduate programmes, etc. and there is a national budgetary allocation for the same.

7.0 DATA RELATED TO Study the existing technical education programs in the area of renewable energy

From the Literature review it can be clearly seen that although there are several programmes at Masters level in renewable energy conducted by IITs, TERI and various other Universities there are no technical education programmes with specialisation in renewable energy (wind and Jatropha biofuels) at the diploma or under graduate and post graduate level anywhere in India.

The Questionnaire No.1 was used to. *Study the existing technical education programs in the area of renewable energy.* This questionnaire was administered to a group of energy representatives from eighteen countries who attended the 'Advanced Wind Power Management Programme' conducted by SIDA, Sweden in 2006 September. The responses are presented in Table 1.2. This questionnaire is indirectly related to this objective as the researcher used this opportunity, when undergoing training in Sweden, to ascertain the extent of renewable energy programmes being offered in the technical education systems of other countries.

Table: 1.2 Renewable Energy Programmes in Different Countries

Country	Level			Renewable Energy Programmers in Different Countries
	Diploma	Undergraduate	Postgraduate	Area in which Competencies are Required
Tanzania	None	None	None	Hybrid systems, Medium sized wind power, environmental impacts of wind power
Vietnam	One	None	None	Site selection, economics of wind power,
Sweden	Two	Three	None	Solar, Biofuel, hybrid, wind power
Nigeria	None	Two	None	Use of wind pro software, Design wind turbines
Colombia	One	None	None	Research on wind turbines
Ghana	None	One	None	Installation and operation of wind turbines
Sweden	None	None	None	Installing solar systems
China	None	None	None	Installing wind and solar systems
Mozambique	Two		None	Installing wind and solar pv Hybrid systems
Sri Lanka	None		None	
Argentina			None	Develop Computer skills for wind data analysis. Use of Statistics in wind power analysis
Cote D Ivories	None	One	None	
Kenya	Two	One Only	None	Environmental studies
Brazil	Three	Three	None	Design wind power plants make Project Proposals for renewable
Zambia			None	
Cambodia	None	None	None	Knowledge of Wind, hydro and biomass
Indonesia	None	Very less	None	

8.0 Interpretation of Results

From the above it can be seen that except for Colombia and Vietnam which have a diploma programme in renewable energy, Sweden, Ghana, Nigeria, Corte d ivories, Kenya, Brazil have degree programme, all the remaining countries had no renewable energy diploma or undergraduate programme. North Korea for reasons of internal security were not willing to respond in writing but orally informed that they too have no programmes in renewable energy at its diploma and under graduate level. Besides, mechanical, civil and