A STUDY ON EDUCATION OF SUSTAINABLE DEVELOPMENT IN TAIWAN– USING ENERGY RESOURCE CENTRES IN PUBLIC MIDDLE AND ELEMENTARY SCHOOLS AS AN EXAMPLE

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Abstract. In order to respond to idle school space caused by a lower birth rate, Taiwan has sought to enhance schools’ building lifecycles and transform them into bases for environmental education. This study uses 32 Taiwanese middle and elementary schools, to assist in transforming idle space into energy-resource learning centres and implementing energy-resource teaching. According to each school’s needs, idle space was transformed into “Energy-Resource Education Centres” with a focus on energy-saving. This provided schools with locations for achievement displays, and an expert consultation team was established to assist them in drafting, implementation, and performance review and achievements sharing of a resource transformation plan. The increase in students’ energy-resource education cognition and attainment levels was understood through questionnaires. Renovation categories included renewable resource applications, energy-saving designs, improvement of the indoor environment, healthy and natural construction materials and reclaimed rainwater re-usage. The renovations provided a 13.4% energy use decrease and many schools’ water and electricity use also exhibited a decline. Schools had a yearly increase in their building life-cycle maintenance and management evaluation, and enhanced the effectiveness of teaching by allowing students to participate in operation of the facilities. During renovation, schools were able to choose the best plan for their particular geographic, climatic and human characteristics. This allowed renovation to have concrete results and educational significance, and also to be able to be incorporated into daily life and teaching, which will enable students to cultivate a philosophy of “energy-saving and carbon reduction” from early on. Energy-resource education can also be promoted to the community, effectively creating links in the energy-resource education network, and striving towards a low-carbon school goal.

1 INTRODUCTION

In order to respond to idle school space caused by a lower birth rate, Taiwan has sought to enhance schools’ building lifecycles and transform them into bases for environmental education that accord with sustainable development. The above is in accordance with the viewpoints of Chen N.T., Liu K.S., Chiang C.M., Tsai Y.H., and Hsieh M.C. (2010). This study uses 32 Taiwanese middle and elementary schools as research subjects, to assist in transforming idle space into energy-resource learning centres and implementing energy-resource teaching.
The target structure of the energy-resource educational centre plan is shown in Figure 1 below:

Figure 1. Plan target structure

2 METHODS

According to each school’s needs, idle space was transformed into “Energy-Resource Education Centres” with a focus on energy-saving. This provided schools with locations for achievement displays in resource and eco-education, and an expert consultation team was established to assist them in drafting, implementation, and performance review and achievements sharing of a resource transformation plan. The increase in students’ energy-resource education cognition and attainment levels was understood through questionnaires.

2.1 Expert consulting team

According to research by Chen N.T., Liu K.S., and Chiang C.M. (2011), the following steps can be used in the creation of an expert consulting team: establish a consulting team mechanism; work with administrative implementation and professional technical guidance from the MOE (Ministry of Education); assist schools with design and implementation, as well as carrying out examination of results and benefit analysis etc.; conform to plan implementation. This can achieve superior results in the consulting process.

2.2 Physical hardware

(1) “Energy-resource educational centre construction and renovation project”: indicates that when idle school space is being renovated into an energy-resource centre, the facilities must act as a normal physical building construction project.

(2) “Energy-resource display equipment and educational tools”: indicates the development of building facilities and educational equipment that possess educational display capacity, with sustainable education as a goal. The proposals for energy-resource educational centres are shown in Figure 2.
2.3 Software component

The software component must be able to conform to the development of sustainable education with local characteristics. Every school should develop special energy-resource classes and energy-resource creative educational activities according to the “Energy-resource educational centre” plan targets.

Ex.:

(1) Classes on energy-resource characteristics

Goals should be planned according to the “Energy-resource educational centre”, with each school’s unique characteristics as a prerequisite. This can lead to the development of thematic energy-resource educational courses such as: partnering the fields of nature and life technologies (Physics, chemistry, biology or earth science), social education fields (geography, history or civics), and important topics in environmental education etc., to implement issues-immersion teaching.

(2) Energy-resource creative teaching activities

Should suit the energy-resource characteristics classes, and with each school’s unique characteristics as a prerequisite, energy-resource educational activities should be held, such as: jointly organising school water quality monitoring activities with post-secondary institutions in neighbouring regions, and holding energy-resource promotion experience camps etc.

In the future it will be able to conform even better to different neighbourhood special educational institutions and be more able to develop into a close-knit sustainable-development education contact network.

3 RESULTS

Renovation categories included renewable resource applications, energy-saving designs, improvement of the indoor environment, healthy and natural construction materials and
reclaimed rainwater re-usage. The renovations provided a 13.4% energy consumption decrease and many schools’ water and electricity usage also exhibited a general decline. Schools had a year-on-year increase in their building life-cycle maintenance and management evaluation, and as indicated by Shih Y.L. (2010), this also can enhance the effectiveness of teaching by allowing students to participate in actual operation of the facilities.

3.1 Recycling of reclaimed rain water

In 2008, there were 10 schools that applied for this category. The project contents mostly involved recycled rain water educational display equipment. In 2010, the rain water reclamation equipment usage continued to expand, with a portion of the schools applying for newly added educational equipment. From the completion of installing at the end of 2009 until the end of November 2011, statistics show that the southern region reclaimed 607 tonnes of rain water while the northern region reclaimed 8,808 tonnes, for a total of 9,415 tonnes of rain water (see Table 1). If converted into carbon reduction amounts, approximately 1,949 kilograms of carbon dioxide emissions were saved. The northern region’s reclaimed amount was significantly higher than the southern region which indicates differences due to location and climate. Due to reasons of actual environmental conditions and choice of project, the difference between the southern and northern regions was quite substantial.

<table>
<thead>
<tr>
<th>Item</th>
<th>2009 (tonnes)</th>
<th>2010 (tonnes)</th>
<th>Total (tonnes)</th>
<th>CO2 emission reduction (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Taiwan</td>
<td>3,571</td>
<td>5,238</td>
<td>8,809</td>
<td>1,823</td>
</tr>
<tr>
<td>Southern Taiwan</td>
<td>91</td>
<td>516</td>
<td>607</td>
<td>126</td>
</tr>
<tr>
<td>Total</td>
<td>3,662</td>
<td>5,754</td>
<td>9,416</td>
<td>1,949</td>
</tr>
</tbody>
</table>

Table 1. 2008-2010 Rainwater collection amounts and CO2 emission reduction equivalents

3.2 Application of renewable resources

This item was the one that the largest number of schools applied for in both 2008 and 2010. Compiling results from the completion of the project plan in 2008 up until November 2010, the total reclaimed amount (power generated) was 23,484 kWh in the southern region and 13,460 kWh in the northern region, for a total of 36,944 kWh (see Figure 3). If converted into carbon dioxide emissions saved (1 kWh equal to 0.625 kilograms of carbon emitted), this is equivalent to a reduction of 23,090 kilograms of carbon dioxide emissions. This works out to a saving of between $77,582 Taiwan Yuan (approximately £1700) at a non-summer electricity rate of 2.1 Yuan per kWh below 110 kWh, to $188,413 (approx. £4140) Taiwan Yuan at a summer rate of 5.1 Yuan per kWh above 710 kWh.

Similar to “Recycling of reclaimed rain water”, this category showed large differences between the northern and southern regions. The main reason for this is the effects of geography and climate that influenced the implementation of the project in each locality. According to Chiang C.M., Chen H.H., and Huang C.Y. (2004), it can be understood how important “building locally” is. That is to say, the local environment and climate must be
taken into account when designing project contents. Only then can the goal and meaning of energy-resource education be effectively achieved.

![Figure 3. 2009-2010 Renewable energy production amounts](image)

### 3.3 Benefits of water and energy savings

Calculating statistics for 2 years of average per-person school water and electricity usage, while excluding new building construction and renovation, the majority of schools showed a downward trend in water and electricity usage. In 2008, this amounted to 89,882 kWh, 2009 was 85,178 kWh, and 2010 was 77,870 kWh. Comparing 2010 and 2008, there was a total saving of 13.36% of electricity (see Figure 4).

![Figure 4. 2009-2010 Energy saving design features post-installation efficiency](image)

As the European Commission indicates (http://ec.europa.eu/environment/eussd/ retrieved May 10, 2013), through the creation of sustainable communities it is possible to manage and use resources efficiently, tap the ecological and social innovation potential of the economy and in the end ensure prosperity, environmental protection and social cohesion.
Each school considered differences in local climatic and environmental conditions to allow construction items and their contents to conform with particular local characteristics. Below is an introduction of this study’s more unique cases, with the hope that case sharing can be provided to other schools and groups with interest in energy-resource education, and also to be able to produce innovation in developing energy-resource transformation according to local characteristics such as different environmental and climatic regions:

Northern Region: In Yilan County’s Yueming Elementary School complied by setting up an environmental and energy-resource monitoring system which can be used to carry out teaching about greenhouse gas inventory and reduction. This allows students to learn how to use numbers for analysis from a scientific perspective. Students also were able to grow and take care of climbing plants, thereby giving further thought to how to reduce behaviour that leaves a burden on the environment (Figure 5).

Southern Region: Yong’an Elementary School in Houpi District, Tainan City started implementation of a three-year “Yong’an Green Villa – Global Children’s Centre” plan in 2007. This plan’s goal was to take space designated as “unusable” and transform it into “usable” and then again into “useful” space. This was by using a “point, line, area” model to create this school’s very unique energy-resource education centre, as well as effectively integrating educational classes and promoting this idea to community residents allowing a basic local energy-resource education centre to start to take shape (Figure 6).

After the invigoration of environment and space, not only did they have energy-resource efficiency and educational capability, but also showed vitality and helped to stimulate students’ learning. From teaching materials and class design aspects, each school worked hard in planning and diligently designing, which inspired quite a lot of creativity, such as: Tianzi Elementary School in Gaoshu Township, Pingdong County used naturally-cleaned water circulation educational display facilities and interpretive signs combined with a concept towards healthy and natural building materials to transform and beautify the original ugly water tower. This has now become an optimal location for student learning (Figure 7).
4. CONCLUSIONS

During renovation, schools were able to choose the best plan for their particular geographic, climatic and human characteristics. This allowed renovation to have concrete results and educational significance, and also to be able to be incorporated into daily life and teaching (Pictures 8). Each school used its capital account for hardware transformation, and as indicated in Shih Y.L. (2004) used its current account for planning corresponding teaching activities or relevant educational literature. This allowed the meaning of energy-resource education to be more easily promoted through incorporation in routine classes, holding relevant practice activities, educational visits, workshops and experience camps, etc.

As well, the model through which each school actively trained “Young Commentators” is very much worth other schools to refer to and learn from (Picture 9). For the children, this is not only a nice teaching method, but also allows children to use their own creative explanations to allow energy-resource education to become even more diversified and interesting.

As for schools receiving subsidies for planning activities with their current account, educational literature was the main item of focus, followed by educational visits and then holding training camps. Through multi-faceted implementation of current account planning, the schools’ students and teachers were able to have more opportunities to learn about energy-resources. As well, as Chen Z. D. and Tzeng C. T. (2011) pointed out, schools can reach out to neighbourhood residents and technical support teams to effectively create links to the energy-resource education network, to work towards the low-carbon school plan assisted by innovative energy-resource education methods, to effectively implement the mission of sustainable development.

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Figure 8: Energy-Saving Lamp Observation and Comparison

Figure 9: Results of the Young Commentators Programme
Student Mr. Colin Sawatzky and for assistance from the principal and applicable colleagues from Kaohsiung City Hsiaokang Municipal High School.

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Research Projects


Internet Resources