Identifying Energy Literacy for
the Upper-secondary Students in Taiwan

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Abstract: In order to have a set of energy literacy to become the basis for further curriculum development, instructional design and so forth in an energy literacy education project conducted in Taiwan and led by the author, nominal group technique (NGT) was employed to identify energy literacy for the upper-secondary students. As a result, an energy literacy list was successfully identified and the following three conclusions are drawn: (1) The literacy regarding energy conservation is more important than the literacy related to new energy development for upper-secondary students; (2) The literacy identified may serve as a performance guide to design curriculum, instruction and assessment; and (3) Further verification should be conducted to justify the literacy identified.

Key-Words: Competency identification, Energy technology, Nominal group technique, Taiwan, Technological literacy, Upper-secondary education

1Introduction
Taiwan is a densely populated island with lacking in energy resources in which 98% depend on imports [1]. Thus, to tap new energy sources and conserve energy consumption is very important and leans on quality talent. The talent education can be categorized into energy literacy education and energy professional education. The energy literacy education, a study of energy and a realm of technological literacy education, aims to prepare all students to have capability to use, manage, assess, and understand energy. For example, Standards for Technological Literacy (STL), developed and published by International Technology Education Association (now called International Technology and Engineering Educators Association) offer a common set of expectations for what students should learn in the study of technology. The standard entitled Energy and Power Technologies is one of the 20 standards in STL. The benchmark topics of Energy and Power Technologies for grades K-12 are shown as Table 1.
Table 1. The benchmark topics of Energy and Power Technologies for grades K-12 [2]

<table>
<thead>
<tr>
<th>Standards</th>
<th>Benchmark Topics Grades K-2</th>
<th>Benchmark Topics Grades 3-5</th>
<th>Benchmark Topics Grades 6-8</th>
<th>Benchmark Topics Grades 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Power Technologies</td>
<td>● Energy comes in many forms</td>
<td>● Energy comes in different forms</td>
<td>● Energy is the capacity to do work</td>
<td>● Law of Conversion of Energy</td>
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<tr>
<td></td>
<td>● Energy should not be wasted</td>
<td>● Tools, machines, products, and systems use energy to do work</td>
<td>● Energy can be used to do work using many processes</td>
<td>● Energy sources</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>● Power is the rate at which energy is converted from one form to another</td>
<td>● Second Law of Thermodynamics</td>
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<td></td>
<td></td>
<td></td>
<td>● Power systems</td>
<td>● Renewable and non renewable forms of energy</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>● Efficiency and conversion</td>
<td>● Power systems are a source, a process, and a load</td>
</tr>
</tbody>
</table>

In order to promote both energy literacy education and energy professional education, Ministry of Education, Taiwan, launched a three-year-and-four-month Energy Education project in 2010. Aiming to promote K-12 graders’ energy literacy, Energy Literacy Education Project (ELEP) is one of its two subprojects and is led by the author.

2 Problem Formulation

There is a saying “Never build a tall tower on the quicksand.” Competency-based performance is a widely-accepted concept to guide talent preparation, selection, and application in Taiwan. Competency is a set of related knowledge, skills, and attitudes that affects a major part of one’s role (or responsibility, job), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via education, training and development [3]. Literacy, originally expanded from 3R’s--reading, writing and arithmetic, is basic competency necessary for all. Lacking of energy literacy for grades K-12 will lead the problem that conducting further teacher training, curriculum development, instructional design and so forth in ELEP will be like “building a tall tower on the quicksand.”

3 Problem Solution

In order to solve the problem of lacking of energy literacy, the taskforce of ELEP, employed a nominal group technique (NGT) to identify energy literacy for the upper-secondary (grades 10-12) students in Taiwan. NGT is a type of structured and small-group discussion to reach consensus. NGT gathers information by asking individuals to respond to questions posed by a moderator, and then asking participants to prioritize the ideas or suggestions of all group members [4].

Eleven panelists in the field of energy education or energy technology, including six university faculty members and five upper-secondary school teachers, participated in a NGT panel discussion held in March 2011. The moderator (i.e., the author) presented guidelines for developing energy literacy to the group in written form and asked everyone to write literacy in brief phrases or statements silently and independently. Then, the
recorder typed and projected literacy from every group member on a screen that was visible to the entire group. Each recorded literacy was then discussed to determine clarity and importance. Finally, group members voted to prioritize the literacy.

As a result of the NGT meeting, the following energy literacy is obtained:

Knowledge Domain
1. Compare different forms of energy
   1.1 Conversion of energy
   1.2 Forms of energy
      1.2.1 Primary energy
         1.2.1.1 Renewable energy
         1.2.1.2 Non renewable energy
      1.2.2 Secondary energy
   1.3 Energy situation in Taiwan
      1.3.1 Forms, advantages and disadvantages of electricity generation
      1.3.2 Main sources of energy fuels and energy share of Taiwan
   1.4 Impacts caused by different energy sources
      1.4.1 Economic benefits
      1.4.2 Environmental contamination
2. Criticize Green energy (GE)
   2.1 Definition of GE
   2.2 Production of GE
   2.3 Advantages of GE
   2.4 Disadvantages of GE
3. Explain applications of energy
   3.1 Operating principles of daily electric appliances
   3.2 Operating principles of internal combustion engines
   3.3 Relationship between energy uses and carbon footprint
   3.4 Techniques and status of renewable energy
4. Justify fundamental concept of 3E’s (Energy, Environment and Economy)
   4.1 Environmental and social impacts caused by energy uses
   4.2 Domestic and global issues related to energy

Skills Domain
1. Collect information to conduct experiments and designs related to energy
2. Apply data collection and recording methods to analyze energy consumption in school and at home
3. Follow energy conservation instructions to use daily electric appliances

Attitudes Domain
1. Behave energy conservation habits
2. Tell individual opinions on controversial domestic and global energy-related issues
4 Conclusion

To sum up, the following conclusions can be drawn:

1. Literacy regarding energy conservation is more important than literacy related to new energy development for upper-secondary students
   It is found that energy conservation, not new energy development, is highly valued in the literacy list.

2. The literacy identified may serve as a performance guide to design curriculum, instruction and assessment
   The literacy identified may be applied to further energy literacy curriculum development, instructional design and so on.

3. Further verification should be conducted to justify the literacy identified
   In order to justify the literacy identified, the taskforce of ELEP is working on a verification process.

References: