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Identification of the Essential Elements and Development of a Related Graphic Representation of Basic Concepts in Environmental Education in Taiwan

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ABSTRACT

The objectives of the study were: 1. to identify the essential elements of the basic concepts in environmental education for Taiwan; and 2. to develop an easily-understood graphic model to express the interrelationships among the identified essential elements. This study's target population (N=1398) consisted of the Society of Science Education, the National Park Society, the Society of Environmental Protection, and many other concerned individual subscribers of the *Quarterly Journal of Environmental Education*. The Q-Sort technique was used to collect research subjects' attitudes toward environmental concepts. A group of experts assisted in establishing the instrument's face and content validity. A Test-Retest method was used to decide the reliability of the Q-set. A Q-set including 44 concepts was established (mean of Pearson's r=.55). The research instrument was sent by mail to 280 systematically randomly selected samples. A total of 196 (70%) research subjects responded to the survey. R-factor analysis was used to analyze the Q-Sort data response. Six underlying essential elements were extracted and identified. They are: 1. Interaction and Interdependence, 2. Resource Conservation, 3. Environmental Ethics, 4. Environmental Management, 5. Ecological Principles, and 6. Carrying Capacity and Quality of Life. A graphic representation describing the interrelationships among the identified elements was also developed via two rounds of discussion involving an interdisciplinary panel of seven experts in science education, environmental protection, conservation, and environmental education.

Key Words: environmental education, concept, element, Q-Sort technique

I. Introduction

The development of appropriate and effective environmental education programs is one of the most important efforts being made by both the government and society in tackling environmental problems in Taiwan. To convey the entire picture of the status of the environment to the general public and students, the decision makers and planners of environmental education programs should have a clear idea of the major foci and directions for their programs before they formally launch extensive efforts. Similar efforts have been made by western environmental educators such as Entwistle (1981), Stapp (1982), & Roth (1989). Therefore, there is a necessity to provide a simple and vivid graphic representation that can reveal the interrelationship among the essential elements underlying basic concepts (Chou, 1994; Chou & Roth, 1992) used in environmental education in Taiwan. With a representation, environmental education programmers and decision makers can grasp the major directions and incorporate them into their education programs more easily. Moreover, this effort can help environmental education practitioners conduct and implement environmental education programs more efficiently and effectively.

To develop environmental education at either the formal or non-formal level has become a basic step for an integrated effort made by any country in tackling various environmental problems. It is also believed that the development of environmental education in different countries will "require the devel-

opment and teaching of the environmental philosophy and related concepts at every point in the formal and non-formal education process" (Schmieder, 1977). However, before meaningful approaches can be initiated to educate children and adults about environmental matters, questions such as "what should the main focus and major concerns of environmental programs be?" and "what should students know about the environment?" must be clearly answered (Chou, 1992; Townsend, 1982; Yang *et al.*, 1988).

Basically a concept is a way of grouping objects or events in terms of essential similarities. However, concepts are not evaluative (Entwistle, 1981), especially abstract concepts related to the environment which are very difficult to define clearly by simple concepts. Thus, learners have to "build up their own understanding, which thus acquire a personal meaning" (Entwistle, 1981) of those concepts relating to the total environment. Therefore, it is necessary to identify the most essential elements beyond those environmental concepts for appropriate use in environmental education. For example, tremendous progress has already been made in the U.S. in identifying the basic concepts that can be used in environmental education at different levels (Allman, 1972; Ballard, 1989; Brennan, 1986; Ronfeldt, 1969; Roth, 1969; Visher, 1960; White, 1967). Moreover, knowledge of the underlying structure beyond those concepts has also been accumulated (Bowman, 1972; Chou, 1992; Isabell, 1972; Townsend, 1982). However, when applying the research results in developing practical environmental education, the specific conditions in different countries, such as the economy, politics, culture, etc., should be carefully considered (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 1990).

The necessity of developing environmental education in Taiwan did not become an important issue until the late 1980s. Accompanied by the rapid development of the economy, environmental degradation gradually emerged and attracted the attention of the whole society. In addition to large scale pollution abatement measures launched by the government, a comprehensive research program on environmental education was launched by the National Science Council (NSC) of the Republic of China (R.O.C.) in July 1987 (Wang *et al.*, 1987). Many studies have been undertaken in Taiwan since then (NSC, 1989; 1990; 1992). However, very little effort except Chou's (1992) study has been directed toward determining the essential elements that are appropriate for the environment of Taiwan (Chou, 1989; NSC, 1990). It is also believed that with a simple and easily-understood representation, environmental educators should be able to get the whole picture of the concerns related to environmental education. Although some studies have attempted to identify basic concepts in environmental education (Chou, 1989; NSC, 1990; 1992), research specifically focusing upon identifying the essential elements of environmental education and its related graphic representation have been very rare in Taiwan. Such information is essential for environmental education related instruction, teacher training, curriculum development, program planning, and policy formulation in Taiwan.

1. Statement of the Problem

This study is focused on understanding the perceptions that are held by experts in and practitioners of environmental protection, conservation, science education, and environmental education in Taiwan regarding the basic concepts that are appropriate for environmental education. The question posed in this study was: What are the essential elements and their related graphic representation appropriate for environmental education (K-16) as perceived by randomly selected samples of concerned professionals in Taiwan?

2. Objectives of the Study

The objectives for this study were:

(1) To identify the essential elements underlying the important environmental concepts as perceived by experts in environmental protection, conservation, science education, and environmental education in Taiwan.

(2) To develop an easily-understood graphic representation describing the interrelationships among the identified essential elements.

II. Methods

1. Population and Sampling

The target population of this study was professionals who were concerned about the environment especially with regard to education. Owing to the great difficulty in identifying all such individuals in society, names listed on the directories of The Society of Environmental Protection, the National Park Society, the Society of Science Education , and individual subscribers of the *Environmental Education Quarterly* were used as the accessible population to form the sampling frame (n=1398). A systematic random

sampling method was adopted to select samples from the frame. Two hundred and eighty subjects were randomly selected for participation in this study.

2. Instrumentation

After extensive review of the related researches and considering the purpose of the study, it was decided that a structured type of Q-sort that used forced sorting (a normal distribution with a specified number of cards in each pile) and R factor analysis could appropriately meet the needs of this study. Several interdisciplinary panels of experts with expertise in environmental management, conservation, environmental education, and science education were consulted during the research instrumentation stage and assisted the researcher in developing the research instrument. At the beginning, six interdisciplinary review panels from the areas of environmental management, conservation, and environmental education were asked to help solidify the initial concept base which was originally developed by the researcher (containing 57 concepts). Through discussion, the panelists reached agreement on reducing the number of concepts in the pool from 57 to 50. Afterwards, a pilot test was conducted. At this stage, eleven experts from different fields but all concerned about the environment were asked to use the Q-sort technique to sort the cards twice (with a one week break in between). Six concepts which had low or negative values of the calculated Pearson's r were deleted from the original Q set. The final Q set containing 44 concepts was used in the formal research instrument during the following data collection stage. Experts also helped to review the content of the questionnaire and the sorting instructions. Through the field test and pilot test (test and retest method was used) mentioned above, the face validity, content validity, and reliability (mean of Pearson's r=.55) were established. The basic components of the research instrument used in the data collection stage included: 1. a complete Q set (44 different environment related concepts, each printed on a card), 2. clearly stated and easy to follow sorting instructions, and 3. a questionnaire inquiring about the background of each respondent.

3. Data Collection and Analysis

The data collection process of the survey was conducted following Dillman's (1978) suggested steps in the Total Design Methods (TDM). All the mailings were sent out by regular first class mail. Totally, three followups were sent to the subjects in order to increase the response. One week after the first mailing, the first followup was delivered. A two-week break was allowed between the later followups. Totally, 196 subjects (70% of the samples) responded to the survey and returned their research packet.

Research subjects were asked to follow the sorting instructions to sort the 44 small cards in the Q set. The easily followed sorting instructions were a very essential tool in order for obtaining data which could be analyzed and were necessary to meet the criteria and satisfy the purpose of the study. By consulting related researches (Chitwood, 1977; Chou, 1992; Townsend, 1982), the researcher of this study developed sorting instructions which were used in the data collection stage. The instructions directed the research subjects to manipulate and sort the 44 cards in the Q set. These cards were to be placed into seven different piles (labeled 0 to 6) in terms of their relative importance ("6" being the most important pile, "0" being the least important pile) for environmental education, with a specified number of cards in each pile. One key question they were to ask themselves when they sorted the cards was: "What should our students know about the environment?" The score for each statement was calculated according to the numeric label of the pile to which it belonged.

The major analytical instrument which was used in the data analysis stage was a statistical package program, used on a Macintosh computer, called SYSTAT (Version 5.2 SYSTAT, Inc.). R Factor analysis with a VARIMAX rotation on the data collected from the samples was used to obtain essential elements.

III. Results

1. Factor Analysis Results

The collected responses of the Q-sort results (the scores of each statement) were used as the basis for R factor analysis. In order to get a significant factor through the calculation process, several standards were considered and applied in selecting the significant factor (Chou, 1992). First, to be a significant item in a factor, its factor loading had to be equal to or greater than three times the standard error of a zero correlation, i.e., $3/\sqrt{n}$ where n is the number of items in the Q set (Schlinger, 1969). That is, for this study, the value of a significant factor loading had to be equal to or greater than $3/\sqrt{44}$. Thus, a decision was made to use .45 as the minimum standard for this study to determine whether a factor loading was significant. Second, a significant factor had to have at least two

or more statements. The third consideration was the proportion of the total variance explained by the last factor to be retained. Researchers have set one, five, or ten percent as the standard in different studies, and it was further stated that "...one may set the criterion at whatever level is considered substantively important" (Kim and Mueller, 1978). Four percent was established as the minimum for this standard. The fourth consideration was the criteria of interpretability, which is a crucial step (Kim and Mueller, 1978). Using factor analysis with an orthogonal (Varimax) rotation on data obtained from Q-sort responses of research subjects, six factors were identified and treated as essential elements met the first objective set forth for this study.

Overall, six factors were extracted from the factor analysis. These factors were then treated as essential elements underlying the 44 environmental concepts in the Q set. Altogether, they could explain 35.0 percent of the total variance (Table 1).

The six extracted factors and the corresponding concept statements with rotated factor loadings are shown in the following tables.

Table 2 provides information about the concept statements and corresponding rotated factor loadings of Factor I. Factor I could explain 9.4 percent of the total variance.

Table 3 provides information about the concept statements and corresponding rotated factor loadings of Factor II. Factor II could explain 7.07 percent of the total variance.

Table 4 provides information about the concept statements and corresponding rotated factor loadings of Factor III. Factor III could explain 5.60 percent of the total variance.

Table 5 provides information about the concept statements and corresponding rotated factor loadings of Factor IV. Factor IV could explain 4.83 percent of the total variance.

Table 6 provides information about the concept statements and corresponding rotated factor loadings of Factor V. Factor V could explain 4.09 percent of the total variance.

Table 7 provides information about the concept statements and corresponding rotated factor loadings of Factor VI. Factor VI could explain 4.01 percent of the total variance.

Table 1. Results of Factor Analysis of the Q-sort Results

Factor	Eigenvalue	Added (%) Variance	Coumulative Percent (%) of Total Variance
I	4.13	9.40	9.40
II	3.11	7.07	16.47
III	2.47	5.60	22.07
IV	2.13	4.83	26.90
V	1.80	4.09	30.99
VI	1.77	4.01	35.00

Table 2. Factor I and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
40. All living organisms have the right to live on earth and compete to survive. This right can not be denied, no matter whether they can be used by humans or not.	-.58
10. During different kinds of human settlement and development, human have the responsibility to maintain the living environment in order to upgrade the welfare of all people.	.54
9. Humans are also a part of the nature. We are not superior to other living organisms.	-.53
17. Responsibility for conservation should be shared by individuals, business and industries, special interest groups, and all levels of government and education.	.51
23. Living things are interdependent on each other and their environement.	-.49
41. Energy, its production, use, and conservation, are essential in the maintenance of our society.	.47

*Varimax rotation

Table 3. Factor II and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
39. Natural resources are limited and should never be wasted.	.59
33. Most natural resources are vulnerable to depletion in quantity, quality, or both.	.54
6. To manage environmental pollution, prevention beforehand is more effective than compensation and treatment afterwards.	.54
25. Natural resources affect and are affected by the material welfare of a culture and directly or indirectly by philosophy, religion, government, and the arts.	-.51
28. The natural environment is irreplaceable.	.47

*Varimax rotation

2. Naming the Essential Elements

Obtaining six essential elements which were extracted from the 44 environmental concepts in the

Table 4. Factor III and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
4. We are ethically responsible to other individuals and society, and to that larger community, the biosphere.	-.69
11. Humans have a moral responsibility for their environmentally related decisions.	-.65
35. Forests are an important part of the global ecosystem that supports us and of which we are a part. Deforestation (clearing an area of all trees) will cause an immediate loss of wildlife habitat and natural resources. Long-term effects may include desertification and climate change.	.55

*Varimax rotation

Table 5. Factor IV and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
30. The management of natural resources to meet the needs of successive generations demands long-range planning.	-.62
1. Humans should play a role in understanding nature and to cooperating with other constitutents of nature.	-.60

*Varimax rotation

Table 6. Factor V and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
3. In any environment, one component such as space, water, air or food may become a limiting factor.	-.63
13. The environment is the sum of all external conditions and influences affecting organisms. The environment may be divided into biotic (living) and abiotic (non-living) components.	-.56

*Varimax rotation

Q set was only half the work required to reach objective one set forth for this study. In order to make the results of factor analysis meaningful, the second step--a very crucial and essential step--was to give each identified essential element a name. With meaningful names given to the identified elements, researchers and environmental educators could then

Table 7. Factor VI and the Corresponding Concept Statements with Rotated* Factor Loadings

Concept	Rotated Factor Loading
37. There is a maximum human population corresponding to each resource base. The population cannot exceed this level if a satisfactory standard of living for all people is to be maintanined.	-.66
44. Increasing population and per capita use of resources have brought about changed land-to-people or resource-to-population ratios.	-.65
27. Family planning and the limiting of family size are important if overpopulation is to be avoided and a reasonable standard of living assured for future generations.	-.59
26. Humans should never do whatever they want. Everything we do will have an unexpected influence on other people and living organimsm either now or in the future. Therefore, humans should always use environmental ethics as a basis for making value judgments.	.48

*Varimax rotation

communicate effectively and efficiently with target audiences about the major concerns/directions of environmental education in terms of the content core. Five professionals from the areas of the environment, education, and conservation were asked to provide assistance during the factor-naming stage. Two rounds of written discussion among panelists were adopted at this stage. They carefully looked into the meanings and implications of the concepts of each element and expressed to each other their opinions about the appropriate names and their meanings. After two rounds of exchanging and sharing opinions, they finally reached a consensus on the names of the essential elements. They were named as follows:

(1) Interaction and Interdependence;
(2) Resource Conservation;
(3) Environmental Ethics;
(4) Environmental Management;
(5) Ecological Principles; and
(6) Carrying Capacity and Quality of Life.

Furthermore, the identified essential elements' implied meanings were listed and discussed as follows:

1. Interaction and Interdependence

Within the environment, living and non-living elements always interact and are interdependent with each other. Moreover, living organisms, humans, and even different segments of the human society are interacting and interdependent with each other. Therefore, we have to understand the unique char-

acteristics of interaction and interdependence existing in the environment.

2. Resource Conservation
   Human society and its cultural development are close tied to natural resources. Since the natural resources on earth are limited, humans have to use them carefully by considering the sustainability of natural resources.
3. Environmental Ethics
   Humans are also members of the whole ecosystem. Therefore, we have to have a positive attitude, proper behavior, and a sense of responsibility with respect to the earth and all other living organisms.
4. Environmental Management
   Human welfare depends upon the appropriate management and maintenance of the environment. We have to use the environment carefully in order to avoid damaging the earth and harming future generations.
5. Ecological Principles
   Understanding the nature and principles of ecology is essential to foster positive attitudes and actions among people to maintain the proper balance, stability, and integrity of the ecosystem.
6. Carrying Capacity and Quality of Life
   The size of the human population and human behavior have direct influence on natural resources, environmental quality, and the quality of life. Therefore, we have to adequately regulate the size of the human population and control human behavior's impact on the environment.

3. Developing the Graphic Representation

The second major focus of this study was to develop a simple and easily-understood graphic representation which could be used as a communication tool to help concerned educators understand the major concerns of environmental education and the interrelationships which exist among them. It was hoped that through the model's graphic representation of the interrelationships existing among the identified underlying essential elements, environmental education programmers and policy makers could then grasp the whole picture of the major concerns of environmental education easily. In order to reach this goal, the researcher invited seven experienced professors from the areas of environmental management, environmental education, conservation, and education to form an interdisciplinary panel to participate in a panel discussion on the model-development stage in this study. During this stage, each panelist fully expressed his or her ideas on the paper in and returned them to the researcher by mail without meeting the other panelists personally. The researcher was the one responsible for compiling all the ideas and feedback then sending to each panelist to serve as a basis for next round of discussion. Each expert was given all of the written information about the results of factor analysis for reference. Experts were asked to draw a diagram on paper to illustrate the interrelationships that existed among all the identified essential elements. They were also asked to write down their explanation of the meaning expressed by the representation and their reasons for drawing it the way they did. All the results were integrated and compiled by the researcher and provided to each expert in the panel. After two rounds of extensive written discussion, the panelists finally reached on agreement concerning the graphic representation. This is shown as follows (Fig. 1).

IV. Discussion

Apparently, the results of this research essentially reveal the need for a comprehensive and systematic understanding of the entire environment which emphasizes learning about all the facets of the environment and related issues, and does not only focus on teaching and learning compartmental and partial knowledge of the environment.

The meanings conveyed by the essential elements and graphic representation may be directed toward the development of a basic understanding of the earth's environment and related ecological concepts. The developed model emphasizes that understanding should be based upon the characteristics of interaction and interdependence existing among the living organisms, the environment, humans, and different sectors of society. Humans should also establish a new ideology that includes a positive attitude, value judgments and treatment of the earth and all

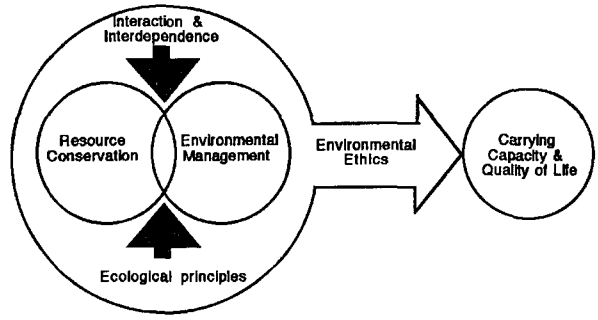

Fig. 1. Graphic representation of the essential elements of hte environmental education related concepts.

organisms with equality and respect. Only through the integration and incorporation of the knowledge, attitudes, and values mentioned above can we then efficiently use limited natural resources by considering the earth's sustainability, and manage and solve environmental problems in an effective manner. Only by solving environmental problems at their root causes and lessening humans' negative effects on the environment can the quality of the environment be maintained. In this way the end goal of achieving a better quality of life can be reached.

V. Implications and Recommendations

Corresponding to the processes, technique, and results of this study, several implications and recommendations for environmental education, future study, and other researchers are given as follows:

1. The six essential elements identified in this study are a very important means of clarifying the major focus of environmental education development. They imply that the major task of environmental education is to investigate all facets of the environment instead of being limited to one or two directions' narrow perspective.
2. The graphic representation developed here can be provided as valuable reference for the development of future environmental education curriculum and instructional materials for different age groups. The essential elements in the graphic representation can be used as a major axis leading toward the direction of developing different levels' environmental curriculum and instructional materials.
3. The findings of this study may be provided to the concerned governmental agencies and non-governmental organizations as a good reference for the determination of the major directions of environmental education efforts such as environmental education policy planning, program planning, teacher training (both pre- and in-service training), and curriculum development.
4. Because of the limited time and resources available, it is suggested that use more diverse groups of people as the population. Further study should consider different target groups such as:
   a. government officials in education and environmental conservation;
   b. school teachers (primary and secondary levels);
   c. representatives of non-governmental organizations;
   d. representatives of industry.
5. Further study may also use Q-factor analysis (treating the subjects as the independent variables) to analyze the data in order to understand any different types of attitude underlying the research subjects' views concerning the environment.
6. Further research can incorporate on investigation of the association between the attribute variables and the elements identified into the research design in order to provide more information on the field of environmental education.
7. Comparing the normal distribution method used in the forced-sorting Q-sort process of this study to the rectangular distribution Q-sort method used in an earlier similar study (Chou, 1992), the researcher discovered that there is no great difference between the two kinds of method when considering the survey's response rate. Similar future research can take either normal or rectangular distribution as the sorting method in the Q-sort process.

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Elements of Environmental Education Concepts

鑑別環境教育重要概念的最基本要素並發展其相關之圖形表徵

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摘　要

本研究的目的是爲了能夠找出符合我國現況的環境教育概念隱含的基本要素（essential elements），並將其以一容易理解的圖形表徵呈現出來。研究主要採用調查（survey）研究法。研究對象涵蓋層面頗爲廣泛，包括來自科學教育學會、國家公園學會、環境保護學會以及其他關心環境教育發展的學者專家。利用 Q-Sort Technique 來收集受訪者對於各環境概念的態度反應，也使用基本資料問卷來收集受訪者的基本背景資料。研究工具 Q set 經由專家參與評審訂定其表面效度（face validity）及內容效度（content validity），並經 pilot test 的前後兩次測試達到最終 44 個環境概念的整體信度測試（Pearson's 平均 =0.55）。研究工具組由郵遞送達經系統隨機抽樣所得之樣本共計 280 名，回收率達 70%。回收的資料使用 R 型因子分析法（R-factor Analysis），得到最後的六個基本要素，分別是 1. 互動與互賴（Interaction and Inerdependence），2. 自然資源的保育（Resources Conservation），3. 環境倫理（Environmental Ethics），4. 環境管理（Environmental Management），5. 生態原理（Ecological Principles），以及 6. 承載量與生活教育、環境保護、保育、環境教育等方面的專家經過了兩回合的討論，研擬出了一個簡易圖形，用來表示這六個環境教育內容的基本要素之間的相互關係。