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# Assessment System for Junior High Schools in Taiwan to Select Environmental Education Facilities and Sites

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**ABSTRACT**
Environmental education is essential for people to pursue sustainable development. In Taiwan, environmental education is taught to students until they graduate from junior high school. This study was conducted to establish an assessment system for junior high schools to select appropriate environmental education facilities and sites. A mix of quantitative and qualitative methods, involving a literature review and expert in-depth interviews, was employed to establish an assessment hierarchy and indicators. Next, the fuzzy hierarchy process was adopted to formulate various assessment criteria and indicator weights, which were then verified. The results of this study can serve as a reference for junior high schools in selecting environmental education facilities and sites, thus achieving the expected outcomes of environmental education.
**Keywords:** environmental education, fuzzy analytic hierarchy process, assessment

## INTRODUCTION

In Agenda 21 (UNCED, 1998), the United Nations (UN) states that education plays a central role in any sustainable development for the future. The concept of education for sustainable development (ESD) was established. Since then, this concept has been under constant debate with respect to its objectives, terminology, and implications (Eilks, 2015; Sjöström, Rauch, & Eilks, 2015). To implement ESD thoroughly in formal education, the UN formally announced the Decade of Education for Sustainable Development (DESD) for 2005-2014 (UNESCO, 2005). The Environmental Protection Administration (EPA) of the Executive Yuan, Taiwan implemented the Environmental Education Act in 2010. This act is formulated to promote environmental education; to advance citizens' understanding of the interdependent relationships among individuals, society, and the environment; and to raise the nation's environmental ethics and responsibility. Thus, the following goals can be achieved:

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**State of the literature**

- Resource systems for student outdoor education must integrate various environmental education sites and multifaceted teaching activities.
- To achieve satisfactory environmental teaching effects, educators must select appropriate environmental education venues according to the education level of junior high school students.

**Contribution of this paper to the literature**

- Environmental education is promoted to teach citizens about the mutual dependence among individuals, society, and the environment, thereby fostering in them an awareness to sustain the ecological balance in the environment and respect other species. Environmentally aware citizens and environmental study communities are also cultivated and established to facilitate the achievement of sustainable development.
- Regarding the selection of environmental education sites for junior high school students, a quantitative assessment system and related indicators were developed in this study to serve as future references for teachers and students in choosing outdoor education sites.

maintaining the ecological balance of the environment, respecting life, fostering social justice, cultivating environmentally aware citizens and environmental study communities, and achieving sustainable development. This act requires junior high schools and lower to organize school outings at environmental education facilities and sites for environmental education.

In 2010, the Environmental Education Act was passed in Taiwan's Legislative Yuan, defining environmental education facilities and sites as professional entities that can provide school teachers and students with meaningful environmentally related learning experiences and leisure activities. Professional environmental education activity projects planned by environmental education facilities and sites not only meet school objectives but also relieve school teachers of the pressure of designing professional environmental education teaching activities (Chou, 2002; Liou, 2008). In 2011, when Taiwan first implemented the Grade 1–9 Curriculum, environmental education was listed as one of the six major topics in the curriculum guidelines, and it was comprehensively integrated into seven major learning areas. This curriculum outline substantially facilitated the promotion of environmental education in Taiwan (Chang, 2000). Developing an assessment system for enabling junior high schools to select environmental education facilities and sites is imperative. Therefore, the objectives of the present study are outlined as follows:

(1) Investigate the contents of environmental education facilities and sites as well as the connotations of outdoor education at the junior high school level.

(2) Establish assessment indicators for enabling junior high schools to select environmental education facilities and sites.

(3) Select empirical sites suitable for application in junior high school environmental education programs.

(4) Present research results and related suggestions to junior high schools as references for selecting environmental education facilities and sites.

A wide range of factors are associated with the selection of environmental education facilities and sites for junior high schools. Consequently, this study compiled and arranged such factors through a literature review, in-depth interviews, expert questionnaires, and the analytic hierarchy process (AHP). Opinions from official authorities and experts in the academic and education sectors were compiled. Subsequently, this study adopted the concept of membership functions in fuzzy logic to replace the conventional crisp value concept, generating feedback according to the fuzzy ranking of an expert group. Finally, the feedback structure of the experts and scholars was employed to assess the quantitative fuzzy hierarchical decision assessment system. In summary, this study aimed to (1) review the definitions of environmental education facilities and sites and the importance of junior high outdoor education, (2) develop assessment indicators for environmental education facilities and sites that serve junior high students, (3) identify sites that are empirically applicable for implementing junior high environmental education, and (4) provide references for selecting environmental education facilities and sites for junior high environmental education.

## LITERATURE REVIEW

In 2014, the Ministry of Education, Taiwan, proposed the Outdoor Education Declaration, which states that the outdoor education resource systems of junior high schools and elementary schools should involve integrating environmental sites managed by the central and local governmental departments as well as incorporating various teaching activities. Thus, teachers and students can engage in learning at professional environmental education facilities, thereby assisting students in engaging in environmentally experiential learning and enhancing environmental education quality. Accordingly, the goal of environmental education can be achieved.

The integration of environmental education into school curricula is a key feature of the curriculum reform. From the teaching content perspective, environmental protection has become a domestic and international focal point warranting adequate responses from school curricula and teaching practices. Maintaining flexibility in integrating environmental education into school curricula demonstrates the global perspective and progressiveness of the Grade 1–9 Curriculum. Regarding students' cognitive learning, environmental education provides a unique conceptual framework as well as an interdisciplinary knowledge system, featuring comprehensive and rich contents. For students' affective learning, environmental education cultivates student concerns about the environment; this motivates students to care for disadvantaged groups in society, other species in the natural environment, and the environment and ecological balance of the entire earth, thereby enabling them to foster a noble character. Concerning students' behavioral learning, environmental education emphasizes the development of students' topic investigation and problem solving abilities for addressing concrete phenomena or problems observed in daily life, thus enabling them to practice life skills. Finally, from the perspective of schools and teachers, because environmental education is an emerging field involving continually developing contents and concepts, active teacher and school participation and collaborative learning are necessary to realize educational goals. Interdisciplinary integration and teaching autonomy practices involved in the process can enhance the vitality of the educational system.

## Environmental Education

Proper educational strategies can promote the urban development of cultural and creative industries. The perceived benefits to urban habitants are imperative for successful sustainable urban development (Kuo & Perng, 2016). In the Environmental Education Act passed in 2010, the EPA of the Executive Yuan specifies that enabling citizens to learn about environmental ethics necessitates adopting education to enhance the citizens' environmental-protection-related knowledge, skills, attitudes, and values; thus, the citizens can be encouraged to pay attention to the environment and take necessary actions to achieve sustainable development (EPA, 2010). Environmental education is implemented in a dynamic process, through which the public can acquire knowledge about and identify problems in the environment, and find solutions to the problems. After becoming familiar with the natural environment, the public can develop the virtues of loving, protecting, and cherishing the environment (Tsai, 2014). **Table 1** presents a compilation of various definitions of environmental education.

Other areas for further consideration are: building on the initial professional development support some schools have received in environmental education; further consideration of the role of curriculum integration with respect to environmental education; identification of specific areas where schools need resourcing for environmental education; coordination in the development and delivery of programmes and resources to support environmental education in schools; and consideration of the visibility and status of environmental education (Bolstad et al., 2004).

In summary, the objective of environmental education is to enable all citizens to acquire environmentally related knowledge and attitudes, encouraging them to transform the knowledge into actions such as solving environmental problems that occur in their immediate surroundings. This can eventually empower all citizens to become environmentally aware and exhibit environmental literacy. Hence, environmental education is a type of life education and continuing education for all citizens.

**Table 1.** Definitions of environmental education

| Organization or researcher(s) | Definitions of environmental education |
|---|---|
| Mayor | Environmental education is a process in which individuals and society learn about the environment and its organisms as well as the interactions between the physical world and social culture, thereby gaining related knowledge, skills, and values and becoming capable of solving current and future environmental problems individually or collectively (Mayor, 1997). |
| Hsin Wang | Environmental education is an educational process aimed at improving the environment, clarifying ideas, and formulating values (Wang, 1987). |
| Chou-En Huang | On the basis of cognition, environmental education aims at facilitating people in gaining a deep understanding of nature, thus enabling them to have clear and accurate perceptions (Huang, 1999). |
| Tien-Cheng Lee | Environmental education focuses on environmental topics, educating students about appropriate environmental values and lifestyles, particularly environment-improving actions (Lee, 2008). |
| Environmental Protection Administration, Taiwan | Environmental education means the application of educational methods to cultivate citizens' understanding of their ethical relationship with the environment; to improve citizens' knowledge, skills, attitudes, and values with regard to protecting the environment; and to encourage citizens to treasure the environment and to take action in a public education process that aims to achieve sustainable development (Administration, 2010). |
| Hui-Chen Hsu | Environmental education is a process aimed at improving environmental awareness (2012). |
| Yang-Guan Zheng | Environmental education develops environmentally related values in students, providing them with the appropriate knowledge, skills, attitudes, and motivation to take actions to solve environmental problems and prevent new problems, thereby becoming environmentally literate citizens (Zheng, 2013). |

## Environmental Education Facilities and Sites

Article 14 of the Environmental Education Act of Taiwan stipulates that administrative authorities at all levels and central industry competent authorities must integrate and propose plans for typical environmental education facilities and resources. Priority choices for such facilities and resources comprise unused spaces and buildings as well as privately established facilities and resources that have received government funding. The goal is to create and provide comprehensive and professional services, information, and resources for environmental education (Administration, 2010). Article 2 of the Certification and Administration Regulations of Environmental Education Facilities and Sites defines the aforementioned environmental education facilities and resources as spaces, venues, devices, or equipment that are based on professional human resources, satisfactory course projects, and favorable management, for providing professional environmental education services that feature rich ecological or cultural and natural characteristics (Chou, 2011). **Table 2** presents a compilation of the definitions of environmental education facilities and sites in recent studies.

In summary, environmental education facilities and sites must incorporate in their planning comprehensive environmental (e.g., natural and cultural) learning resources, meaningful course projects, and professional interpreters and managing organizations, to facilitate public environmental learning and school outdoor education. Moreover, such facilities can achieve their goals of environmental education by organizing experiential nature activities for the public. In related regulations, the certification of environmental education facilities and sites involves the following execution stages and key points (listed in chronological order): certification (project launch), site visit and investigation (current status of project execution), assessment (result evaluation), and extension (qualification review).

**Table 2.** Definitions of environmental education facilities and sites

| Researcher(s) | Definitions of environmental education facilities and sites |
|---|---|
| Stapp & Tocher | All environmental education facilities and sites are established outdoors. The facilities include related educational equipment and administrative units. Such equipment and units provide young people and other community residents with the opportunity to enjoy the natural environment, in addition to enabling them to learn about the relationship between organisms and inorganic material as well as the role of human beings in the ecological system (Stapp & Tocher, 1971). |
| Evans Chipman-Evans | Environmental education facilities and sites enable people to experience nature under the guidance of professionals and to establish a relationship with nature and the environment. Specifically, environmental education facilities and sites are natural sites or buildings established for educational purposes. They are administrative entities derived from specific units and have contracted professionals and established educational activities (Evans & Chipman-Evans, 1998). |
| Erickson, E. & Erickson, J. | Environmental education facilities and sites require professional human resources, favorable facilities, meaningful course projects, and managerial organizations (Erickson & Erickson, 2006). |
| Hsin Wang | An environmental education facility or site is an area that possesses outdoor environmental education teaching resources; undergoes planning to serve as a teaching site for outdoor environmental education; has appropriate administrative agencies, necessary teaching materials, teaching aids, and full-time staff; and regularly holds teaching activities (Wang, 1995). |
| Environmental Protection Administration, Taiwan | Competent authorities at all levels and competent authorities of central industry shall integrate and plan distinctive environmental education facilities and resources, and assign priority to utilizing idle spaces or buildings, or assist the private sector in instituting environmental education facilities and venues to establish and provide comprehensive environmental education services, information, and resources (Administration, 2010). |
| Pin-Hui Fang | Environmental education facilities and sites combine professional personnel, excellent environmental education courses, managing organizations, and suitable facilities and sites (Fang, 2015). |

## Outdoor Education Activities for Junior High School Students

The Taiwan Outdoor Education Reference Manual for Schools of Various Levels states that the goals of outdoor education involve conducting effective learning, establishing students' fundamental concepts, eliciting awareness about the environment, providing recreational experiences, and cultivating a healthy attitude toward recreation (Shen, 1997). In Article 19 of the Environmental Education Act, the EPA of the Executive Yuan stipulates that all teaching and administrative staff and students in senior high schools and below should participate in environmental education programs for at least 4 hours annually. Specifically, environmental education facilities and sites must organize outdoor education programs. Moreover, to implement the spirit of multifaceted and adaptive learning proclaimed in the 12-year compulsory education policy, in addition to promoting high-quality outdoor education programs, the Ministry of Education has started developing related policies on outdoor education (i.e., learning activities conducted outside classrooms). A single short intervention (1-day workshop) can be effective both in the short and long term, but only if the provided information is simple and already adequately familiar to students (Nates, Campos, & Lindemann-Matthies, 2012).

At various outdoor venues transformed into learning sites, teachers and students can use diverse learning methods, such as experiential activities through the five senses and learning by doing, to expand the life experiences of students. Learning activities outside the classroom (and even at real-life sites outside the school) enhance students' experience and vision, enable them to apply the knowledge they have gained indoors to the outside world, and enable integrating the courses of all learning areas with emerging topics and school-based learning. This thus fulfills the goals of "designing curriculum according to student abilities; creating a balanced learning style that develops personal virtue, intellectual ability, physical ability, interpersonal relationship, and artistic appreciation; and enabling lifelong learning." In summary, the implementation of environmental education must start from basic school education. That the Ministry of Education incorporated environmental education into key issues in the Grade 1–9 Curriculum in 2001 highlights the importance of environmental education in school curricula. According to the Grade 1–9 Curriculum Guidelines, environmental education at the junior high school level requires students to participate in environmental-protection-related activities, in addition to paying attention to and investigating environmental matters. Currently, Taiwanese and international scholars have indicated that outdoor education is the optimal method for implementing environmental education. The goal of environmental education (i.e., enabling students to learn to respect and protect nature) can be achieved only when students have experienced and understood it.

Various factors affect how junior high schools select facilities and sites for conducting environmental education. Therefore, this study employed a literature review method, in-depth interview method, and expert questionnaire to compile such factors. Collecting suggestions from governmental, academic, and educational experts, we adopted the concept of membership function to replace the conventional exact-value concept. According to the perceived fuzzy ranking of the expert group, the feedback structure of the experts was employed in using a quantitative fuzzy hierarchical decision assessment system. A pairwise comparison method was applied to determine the weight of each hierarchical indicator; the center of gravity law of fuzzy theory and the maximum mean were then employed to quantify and assess the indicator weights. The hierarchy of the assessment system was categorized into three constructs: resources, recreation, and education. The most common model of sustainable development is still the aforementioned three-pillar model, which encompasses ecological, economic, and social sustainability (Eilks, 2015).

## ESTABLISHMENT OF EVALUATION MODEL

Wurdinger asserted that outdoor experiential learning enables maximizing the effectiveness of education, allowing students to achieve the goals of outdoor education (Wurdinger, 2005). The Taiwan Outdoor Education Reference Manual for Schools of Various Levels states that the goals of outdoor education involve conducting effective learning, establishing students' fundamental concepts, knowing about the environment, providing recreational experiences, and cultivating a healthy attitude toward recreation. An environmental education facility or site should be managed to provide comprehensive learning resources (including natural science or humanities) and meaningful curriculum options. Moreover, commentaries and explanations conducted by a professional staff and managerial organization enable such a facility or site to serve as an outdoor learning location for schools and the public. An environmental education facility or site allows the public to accomplish the goals of environmental education through experiencing nature. Selecting an appropriate environmental education site involves the process of multicriteria decision making (MCDM). During the decision-making process, the human preference model typically involves uncertainty and renders expressing the strengths of their preferences extremely difficult for decision makers (Min-Hua, Hsuan-Shih, & Ching-Wu, 2010). Based on expert interviews, case studies, and questionnaire surveys, an evaluation model was constructed, the process of which is detailed in the following subsections.

### Indicator and Weight Determination

Nine experts from the education field, academic field, and governmental departments were invited. According to literature data and the in-depth interview content of the experts, an assessment system was established for selecting outdoor environmental education facilities or sites for junior high school students. The system was divided into three constructs—resources, recreation, and education—and involved nine assessment indicators. Furthermore, three domestic environmental education sites approved by the EPA were selected to validate the proposed system. **Table 3** describes the details of the assessment indicators. **Figure 1** presents the hierarchy of the assessment constructs.

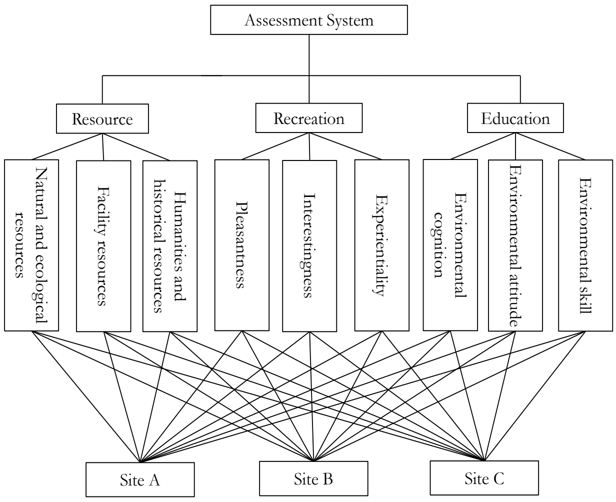


**Figure 1.** The hierarchy of the assessment constructs.

**Table 3.** Descriptions and features of the assessment indicators

| Assessment constructs | Indicators | Explanations and descriptions |
|---|---|---|
| Resources | Natural and ecological resources | Natural science education centers, field study centers, natural parks, ecological farms, national parks, ecological centers, artificial habitats, soil and water conservation, unique geological features, water resources, wetlands |
| | Humanities and historical resources | Museums, green buildings, natural disaster memorials, community development, buildings with historical or cultural significance |
| | Facility resources | Building facilities, education facilities, explanation facilities, living facilities, environmental facilities |
| Recreation | Pleasantness | Pleasant experiences in environmentally experiential activities, spiritual refinement, needs for physical and mental well-being |
| | Interestingness | Interesting activity participation and experiences, elicited curiosity, increasing interest in learning |
| | Experientiality | Experiencing nature, close contact between students and outdoor environments, experiential activities, comprehensive learning through situational experiences |
| Education | Environmental cognition | Knowing about the environment and clarifying concepts, possessing adequate knowledge, understanding environmental problems and knowledge, experiencing the process of conceptual cognition and value clarification, groups and individuals demonstrating cognition and sensitivity toward environmental problems, groups and individuals understanding environmental issues and related problems, perceiving various environmental damage and pollution, cultivating a sense of appreciation and sensitivity toward the aesthetics of natural and artificial environments |
| | Environmental attitude | Groups and individuals cultivating a sense of empathy toward the environment, learning to love and care about the environment, engaging in the process of situational education, showing an affectionate attitude toward the environment |
| | Environmental skill | Turning knowledge into concretized actions, engaging in skill education, demonstrating skills in solving environmental problems, being capable of adequately managing environmental problems, engaging in actions for improving the environment, being capable of alleviating environmental problems, possessing skills for solving environmental problems |

The fuzzy multiple criteria decision-making model was employed in this study. The fuzzy triangular function was substituted into paired comparison matrices to solve the ambiguity problem in measuring the criteria and to identify the importance of proportion in each project. According to Saaty (Saaty, 1980), the scale of comparison between 1 and 9 is recommended, as shown in **Table 4**. The fuzzy linguistic variables are shown in **Figure 2**. When the triangular fuzzy numbers are obtained after all questionnaire responses are compared, the numbers are further used to establish the fuzzy positive reciprocal matrix $\tilde{A} = [\tilde{a}_{ij}]$ for each participant. Buckley (Buckley, 1985) indicated that in integrating group opinions, integrating each fuzzy positive reciprocal matrix by using a weighted geometric mean method is effective.

**Table 4.** Fuzzy linguistic variables

| Fuzzy numbers | Semantic value | Fuzzy number endpoint |
|---|---|---|
| $\tilde{1}$ | Equally important | (1,1,3) |
| $\tilde{2}$ | Between equally important and weakly important | (1,2,4) |
| $\tilde{3}$ | Weakly important | (1,3,5) |
| $\tilde{4}$ | Between weakly important and essentially important | (2,4,6) |
| $\tilde{5}$ | Essentially important | (3,5,7) |
| $\tilde{6}$ | Between essentially important and very strongly important | (4,6,8) |
| $\tilde{7}$ | Very strongly important | (5,7,9) |
| $\tilde{8}$ | Between strongly important and absolutely important | (6,8,9) |
| $\tilde{9}$ | Absolutely important | (7,9,9) |

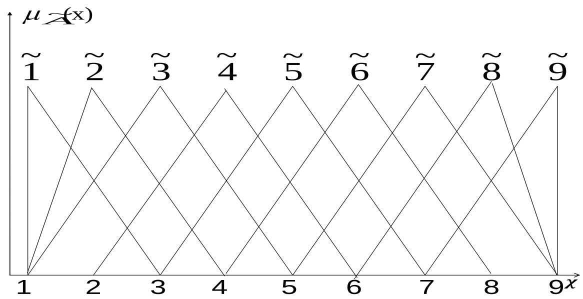


**Figure 2.** Membership function table of Linguistic Variables

## Fuzzy Set and Defuzzification

A pairwise comparison matrix $A$ is established by comparing factors in pairs. When n factors must be compared, $n(n-1)/2$ pairwise comparisons are required. If the ratio between factor $i$ and factor $j$ is $\tilde{a}_{ij}$, because of the reciprocal property of pairwise comparison, the ratio between factor $j$ and factor $i$ is the reciprocal of the original value, $1/\tilde{a}_{ij}$. Similarly, the lower triangular part of $A$, the pairwise comparison matrix, represents the reciprocal values of the upper triangle:

$$A = [\tilde{a}_{ij}] = \begin{bmatrix} 1 & \tilde{a}_{12} & \dots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \dots & \tilde{a}_{2n} \\ . & . & & . \\ . & . & & . \\ . & . & & . \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \dots & 1 \end{bmatrix} \quad (1)$$

After defuzzification, the fuzzy positive reciprocal matrix was converted into a positive reciprocal matrix, which was then used to calculate the eigenvector. Based on the eigenvector, the weight of each item was calculated for a specific evaluation project and its corresponding consistency index (CI) was assessed. According to Buckley (Buckley, 1985), $\alpha_{ij}$ in the AHP is equal to that of $\alpha_{ij}$ in the fuzzy AHP (FAHP). Therefore, when the *CI* value in the AHP meets the criterion established by Saaty, namely *CI* < *0.1,* it can be concluded that during the FAHP, the *CI* assessment applies. In this study, based on the normalization of the geometric mean of the row method proposed by Buckley (Buckley, 1985), the weight of the triangular fuzzy to positive reciprocal matrix was calculated. The process is expressed as follows:

$$\tilde{a}_{ij} = (\tilde{a}^1{}_{ij} \otimes \tilde{a}^2{}_{ij} \otimes \dots \otimes \tilde{a}^n{}_{ij})^{1/n} \quad (2)$$

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \dots \otimes \tilde{a}_{in})^{1/n} \quad (3)$$

$$\tilde{w}_1 = \tilde{r}_1 \otimes (\tilde{r}_1 \otimes \tilde{r}_2 \otimes \tilde{r}_3 \dots . \otimes \tilde{r}_n)^{-1} \quad (4)$$

where $\tilde{a}_{ij}$ is the fuzzy number in column *i* and row *j* in the fuzzy matrix, $\tilde{r}_i$ is the mean of the fuzzy numbers, and $\tilde{w}_i$ is the fuzzy weight of factor number *i*.

This study used the center-of-gravity method to obtain the defuzzified weight. The best nonfuzzy performance (BNP) value of the fuzzy number $\tilde{w}_i$ can be expressed as follows:

$$BNP_{wi} = [(U_{wi} - L_{wi}) + (M_{wi} - L_{wi})]/3 + L_{wi} \quad (5)$$

where $L_{Wi}$, $M_{Wi}$, and $U_{Wi}$ are the lower, middle, and upper synthetic performance values of factor number *i*.

The weight values obtained according to distinct assessment criteria, *W*, and the assessment value of the programs were integrated to calculate the overall assessment value, *R*, of the evaluated programs. The criterion weights and program assessment values were calculated as follows:

$$R = E \times W \quad (6)$$

By ranking fuzzy weights and fuzzy synthetic utility values, the relative importance of criteria and optimal strategies can be determined (Don Jyh-Fu, 2012).

## METHODOLOGY VALIDATION

The results of the literature review were summarized into three assessment constructs and nine assessment indicators serving as the items of a fuzzy AHP expert questionnaire. The expert questionnaire was developed and distributed to establish an assessment system for enabling junior high schools to select environmental education facilities and sites. Nine experts and scholars were invited to evaluate the main decision assessment constructs and indicators. Among the experts and scholars, one was from the public sector, serving as an engineer in the EPA; four were from the academic sector, having expertise in sightseeing and leisure activities, environmental planning, and education; and four were from the education sector, with three of them possessing an environmental education certification. In addition, among the experts and scholars, four (approximately 45%) held a doctoral degree, four (approximately 45%) held a master's degree, and one held a college degree and was a graduate student during the study period. All the invited experts and scholars had satisfactory knowledge about the area in which the empirical test was conducted.

The AHP expert questionnaire was designed as follows: Part 1 summarizes the research project; Part 2 requires the respondents to fill in demographic information such as gender, age, and areas of expertise; and Part 3 explains the assessment constructs and indicator scales adopted in the questionnaire framework, using five semantic expressions to represent the relevance of various assessment principles. Regarding the scoring, the definition of importance varies by person; therefore, the experts scored the semantic expression of the principles according to their subjective opinions. The 9-point scale was divided into score levels— low (*LRi*), medium (*MRi*), and high (*URi*)—demonstrating the fuzzy membership functions. The scores assigned to different semantic expressions could have similar values. For example, the *LRi, MRi,* and *URi* of the *extremely important* semantic expressions corresponded to 8, 9, and 9 points, respectively, whereas those for the *unimportant* semantic expressions section were 2, 3, and 4 points, respectively. The respondents defined the 9-point scale, thereby increasing the authenticity of the research results.

The expert questionnaires completed by the nine experts were analyzed using the AHP. A *CI* value of less than 0.1 indicated consistency in the questionnaire. Next, the center-of-gravity method was employed to defuzzify the data. **Table 5** lists the data analysis results.

This study mainly investigated an assessment system for junior high schools to select environmental education facilities or sites. According to the approved environmental education facilities and sites in Taiwan and the characteristics of outdoor education, an assessment hierarchy framework was established. This framework incorporates the content of the Environmental Education Act, Grade 1–9 Curriculum, and the 12-year Compulsory Education regarding outdoor education. Consequently, this framework is comprehensive and practical. The results of the fuzzy hierarchy process are described as follows:

Of the three major constructs for junior high schools to select environmental education facilities or sites, education attained the highest weight (0.437), followed by resources (0.310) and recreation (0.253). Of the indicators for junior high schools to select environmental education facilities or sites, natural and ecological resources attained the highest weight (0.219), followed by environmental cognition (0.200) and experientiality (0.147). Regarding the three sites for validating the proposed assessment system, Site A (Daping Village Regeneration Community Bitangwo Ecological Park) attained the highest PI value (0.411), followed by Site B (Zhudong Touqian River Water Quality Ecological Reserve; PI = 0.388) and Site C (Nanpu Golden Water Ecological Village; PI = 0.201).

**Table 5.** Defuzzification of the assessment constructs and indicators

| Construct | Construct weight | Construct ranking | Assessment indicators | Combined weight | Indicator Ranking | Site A | Site B | Site C |
|---|---|---|---|---|---|---|---|---|
| Resources | 0.310 | 2 | C1-1 Natural and ecological resources | 0.219 | 1 | 0.070 | 0.118 | 0.031 |
| | | | C1-2 Humanities and historical resources | 0.050 | 7 | 0.023 | 0.005 | 0.022 |
| | | | C1-3 Facility resources | 0.041 | 9 | 0.027 | 0.007 | 0.007 |
| Recreation | 0.253 | 3 | C2-1 Pleasantness | 0.061 | 6 | 0.031 | 0.020 | 0.010 |
| | | | C2-2 Interestingness | 0.046 | 8 | 0.032 | 0.008 | 0.006 |
| | | | C2-3 Experientiality | 0.147 | 3 | 0.073 | 0.041 | 0.032 |
| Education | 0.437 | 1 | C3-1 Environmental cognition | 0.200 | 2 | 0.054 | 0.099 | 0.047 |
| | | | C3-2 Environmental attitude | 0.098 | 5 | 0.024 | 0.052 | 0.022 |
| | | | C3-3 Environmental skill | 0.139 | 4 | 0.077 | 0.039 | 0.024 |
| | | | PI (Prioritized indicator) | | | 0.411 | 0.388 | 0.201 |

## CONCLUSION

This study mainly investigated the development of an assessment system for enabling junior high schools to select environmental education facilities and sites. On the basis of the certification requirements for environmental education facilities and sites as well as the characteristics of outdoor education, an assessment hierarchical framework was established, encompassing the contents of the Environmental Education Act, the Grade 1–9 Curriculum, and the outdoor education requirements for a 12-year compulsory education policy. This hierarchical framework can serve as a reference for future practical applications.

The hierarchy of the assessment system was categorized into three constructs: resources, recreation, and education. The constructs further involved nine secondary indicators. The research results reveal that when the junior high schools selected an environmental education facility or site, the education construct was the most essential aspect. Of the nine indicators, natural ecological resources was most crucial, followed by environmental cognition and experientiality.

School teachers can use the assessment indicators and the principles and weighting method thereof to assess environmental education sites systematically, identify age-specific sites, and develop their teaching materials accordingly to enhance education quality.

The results of this study can serve as a reference for junior high schools in selecting environmental education facilities and sites, thus achieving the expected outcomes of environmental education. Moreover, future studies can analyze the weight of assessment indicators for the selection of environmental education sites designed for specific age groups (e.g., elementary school or adult students).

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