Effects of a One-day Environmental Education Program on Sixth-Graders’ Environmental Literacy at a Nature Center in Eastern Taiwan

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Received: 23 April 2020; Accepted: 18 June 2020; Published: 20 June 2020

Abstract: This study assessed the effects of a one-day environmental education program on sixth-graders’ environmental literacy at a nature center in eastern Taiwan. In this program, the use of role play and games for teaching about Formosan black bear and forest conservation was adopted. A nonequivalent control group design was used to collect data. The experimental group (N = 100) received the one-day environmental education program and the control group (N = 73) did not receive any environmental instruction. The ANCOVA results indicated that students’ environmental knowledge and locus of control were effectively improved by the end of the program. Besides, students in the experimental group showed a lower utilization preference than students in the control group. One month after the end of the program, the present study discovered retained effects on students’ environmental knowledge, environmental responsibility, locus of control, and environmental action. Moreover, students in the experimental group showed a higher preservation and a lower utilization preference than those in the control group in the follow-up test. Based on this study, implications for program development and instructional practice were presented.

Keywords: environmental literacy; games; nature center; program evaluation; role play

1. Introduction

The loss of biodiversity has become a major concern and promoting people’s commitment to protecting local biodiversity is vital for conservation in Taiwan. Hwang et al. [1] pointed out that the Formosan black bear, an endemic subspecies residing in Taiwan’s remote forests, is listed as an endangered species because of habitat loss and poaching. Although environmental education in Taiwan has received considerable policy support from the government in recent decades, few conservation programs have focused on Formosan black bears.

Eastern Taiwan is a hotspot for Formosan black bears. Our research site is a nature center of the Taiwan Forestry Bureau in eastern Taiwan and this nonformal education center provides a variety of environmental education programs for local students. Each year, over 6000 secondary and elementary school students visit the nature center for a one-day environmental education program [2]. Therefore, the nature center designed a one-day Formosan black bear and forest conservation program (i.e., Black Bear Detectives) specifically targeting sixth–eighth graders in eastern Taiwan.

Traditionally, environmental education in Taiwan has emphasized the acquisition of environmental knowledge much more than the promotion of affective objectives [3,4]. However, the ultimate goal of environmental education is to enable students to make informed decisions concerning the environment and take action for it [5]. On the basis of the competence model for environmental education, attitude towards nature predicts behavior better than environmental knowledge [6]. Furthermore,
According to the study of Fielding and Head [7], it is observed that environmental knowledge and multiple affective factors (e.g., locus of control, environmental concerns) are all associated with environmental action. Considering that taking environmental action requires more than an increase in environmental knowledge, affective domains must simultaneously be achieved in order to promote environmental action [3,8–10]. Consequently, the nature center’s one-day program (Black Bear Detectives) has learning objectives that encompass not only environmental knowledge but also environmental attitudes, locus of control, environmental responsibility, and environmental action, its aim being to improve the environmental literacy of citizens and generate support for the conservation of Formosan black bears and the forest. However, the effectiveness of this program is still unknown because no evaluation has ever been done.

Both appropriate program content and suitable teaching strategies are required to achieve educational goals. Many studies on environmental education [11,12] have indicated that role play, games, and dramas can improve the environmental knowledge, attitudes, and behavior of elementary and secondary students. Generally, role play and games can help learners adopt a holistic view of environmental problems, and learners can actively ponder how their values and behaviors affect the environment [13]. For this reason, the nature center’s one-day program (Black Bear Detectives) adopts a versatile teaching method by combining role play and games to promote students’ cognition, affect, and behavior toward Formosan black bears and forest conservation.

The duration of a teaching session is also a factor that affects the effects of environmental education. Sellmann and Bogner [14] argued that a longer intervention duration might have led to a higher knowledge gain. This is supported by Stern et al. [15], who compared the effects of three- and five-day educational interventions conducted in a national park and found a better cognitive outcome in the longer one. Furthermore, researchers found a four-day program focusing on water issues increased students’ system knowledge, action-related knowledge and effectiveness knowledge in the retention test after a month-long delay [16]. Aside from knowledge building, environmental education also concerns about the development of students’ environmental attitudes. Bogner and Wiseman [17] conducted a study on the influence of a weeklong outdoor program within a national park on students’ environmental knowledge and attitudes. The research found out that the weeklong course led to both a significant positive effect on students’ environmental knowledge and attitudes and provided evidence of the long-term effect over a period of one month. Although research indicates that multiday programs achieve superior results in terms of student learning compared with one-day programs [18,19], DeWitt and Storksdieck [20] pointed out that the most influential factors affecting the effects of programs are often the teaching method and the course structure. For the nature center, one-day programs continue to be the most commonly used service among students in Eastern Taiwan [2]. Therefore, the assessment of its learning outcomes remains necessary.

If an environmental education program is an essential means of advancing conservational goals, then understanding the effectiveness of the program is particularly important [21]. Engleson and Yockers [22] also believe that careful assessment of course plans can help with understanding the variables influencing learning outcomes (e.g., cognition, feeling, skill, and behavior) and can serve as improvement guidelines for environmental education programs. So far, little research has been done at nature centers on evaluating how role play and games teaching methods influence the effectiveness of the program concerning endangered species and forest conservation. This study may contribute empirical insights for future research regarding the evaluation of program effectiveness in a natural setting. Furthermore, this study could serve as a guide for improving environmental education programs at nature centers in Taiwan so as to promote learners’ environmental literacy.

The objectives of this study are as follows:

1. To assess the immediate effects of the one-day Black Bear Detectives program on sixth-graders’ environmental knowledge, attitudes, responsibility, and locus of control.
(2) To perform an assessment one month after the end of the program for determining the continuous effects of the program on students’ environmental knowledge, attitudes, responsibility, locus of control, and environmental action.

1.1. Characteristics of Games and Role Play in Environmental Education

Taylor [13] identified games and role play as suitable approaches for enhancing the effectiveness of environmental education because they simulate reality and provide learners with a clear and easily comprehensible path for learning and achieving a holistic perspective of the concerns addressed. However, separating games from role play is not easy. As Wood and Attfield [23] explained, games are continually evolving and thus they are difficult to categorize. In a certain sense, role play can be considered a type of game.

With respect to game content, Hays [24] argued that the educational effect exists in games because players reflect on their behaviors and decision-making in specific situations, thereby extending the consequences of learning to the real world. To improve the teaching effectiveness of the games approach, Garris et al. [25] proposed the input–process–outcome game model. The model introduces games into a curriculum as the input, leading to a process consisting of the learners’ voluntary participation in the game, which in turn generates an expected learning outcome. To provide learners with a conduit for applying their learned knowledge in the real world, Garris et al. [25] further suggested that teachers should share information, guide learning, and provide student feedback during the teaching process because these actions are essential to creating knowledge-based and emotional connections between students and the real world.

Similar to the game approach, the role play approach can also create an immersive learning environment for students to acquire first-person experience of certain problems. Role play can improve learning outcomes because of its playful style of learning, which is congruent with the playful nature of children [26]. McSharry and Jones [26] argued that in addition to the learning generated by theatrical performances, methods for evoking emotional responses in students are more effective if instructors conduct postperformance sessions that can guide students toward achieving the target learning outcome. Therefore, instructors adopting this method must possess group leadership skills and undertake ample preparation for the event in order to achieve the expected outcome of learning through role play. In sum, role play and games are two approaches that require the creation of a certain scenario and time for reflection as well as sufficient activities and action plans that provide real-world immersive experiences in order to attain educational goals.

1.2. Effectiveness Evaluation of Games and Role Play Teaching Approaches

Because games and role play are two teaching approaches focused on in this study, this chapter provides a literature review concerning the effectiveness of games and role play as teaching approaches.

Ouariachi et al. [27] focused on evaluating the effectiveness of games as a teaching method. Their experiment used a 30- to 45-min online gaming experience as an intervention and tested whether this intervention changed students’ self-efficacy and behavioral intentions toward climate change. The result was that game intervention had no significant effect. Ouariachi et al. [27] argued that the short duration of the game might be the primary reason for the teaching to be ineffective. Soekarjo and Oostendorp [28] also adopted a game approach to teaching in their study and observed that gameplay was not significantly different from a PowerPoint presentation in terms of participants’ attitude and knowledge attainment regarding energy conservation. Soekarjo and Oostendorp [28] argued that overtly complex and uninteresting games are the main causes of ineffectiveness. Targeting sixth-graders, Turan et al. [29] used the game teaching approach to conduct a four-week, 16-h gaming session on the topic of matter and heat subjects. The results indicated that the game teaching approach could increase students’ environmental knowledge by making abstract objects more concrete. Games could stimulate the different modes of sensory perception in learners and improve their learning outcomes.
In addition to games, role play is another focus in the program of this study. McNaughton [30] found that during the role play process designed for educating students on environmental issues, drama was a useful format for guiding children toward developing positive environmental attitudes and expressing their personal views. Curtis et al. [12] also discovered that integrating drama as a teaching tool was an effective means of positively influencing students’ environmental knowledge, attitudes, and intention to act. Curtis et al. [12] argued that this effectiveness could be attributed to the integrative nature of theater because teachers can integrate the targeted knowledge for acquisition into the theatrical activity and perform simple environmental actions during the theatrical process, such as the demonstration of turning off the lights. Krain and Shadles [31] studied the differences between the approaches of role play teaching and a traditional lecture with discussion. They observed that students who received instruction through the role play approach acquired more environmental knowledge than did those who were educated through traditional lecture with discussion. These students were also more capable of extending beyond their personal experiences to understand the perspectives of others. These research results indicate that immersing learners in a certain learning atmosphere is the common element required for the success of both the games approach and role play approach. However, insufficient duration of an activity or lack of aspects that captivate student interest are factors that may inhibit the creation of an appropriate atmosphere.

1.3. Pedagogical Factors Affecting Effectiveness in Environmental Education

Many pedagogical factors may affect the effectiveness of promoting learners’ environmental literacy. Ardoin et al. [32] reviewed 119 studies concerning the effectiveness of environmental education and determined that environmental knowledge is the most modifiable variable following teaching intervention. By contrast, affective learning objectives and environmental action are less modifiable through curriculum intervention. Moreover, environmental knowledge acquisition may affect attitudes and behaviors to varying degrees [33].

With respect to knowledge acquisition, Cox-Petersen et al. [34] discussed the learning outcome of environmental knowledge and discovered that the lack of a learner-oriented focus in teaching approaches leads to apparently inferior learning outcomes in terms of student cognition. Tung, Huang, and Kawata [35] determined that students’ environmental knowledge attainment cannot be improved without a structured teaching concept, even when students engage in lively and diverse school activities and field trips. Sellmann and Bogner [14] agreed with the aforementioned perspectives and raised an additional point that peer interaction is another primary factor that contributes to the attainment of environmental knowledge. Additionally, Nadelson and Jordan [36] observed that, although hands-on activities can leave learners with a lasting impression, they may not contribute to the increase in attainment of knowledge. Therefore, Nadelson and Jordan [36] argued that in addition to the coherence of teaching plans and learning materials, teachers must apply a range of teaching approaches to keep repeating the target concepts to be learned in order to enhance environmental knowledge.

However, some studies [37,38] have found that particular complex and abstract environmental concepts such as sustainability, greenhouse effect, and global warming hinder the achievement of teaching effectiveness. Therefore, many scholars [39–41] have proposed that complex knowledge such as global warming may require the use of an amalgamation of teaching approaches, including role play, field trips, and group discussions, in order to achieve teaching goals.

In addition to environmental knowledge, environmental action is also a primary objective of environmental education [5], and affective learning objectives such as environmental responsibility and locus of control are key variables that contribute to prompting environmental action [8,9,42]. Chawla and Cushing [42] argued that to increase environmental action, personal responsibility, and empowerment, concepts such as citizen identity and the pursuit of public benefit must be fostered. Furthermore, parents and teachers should serve as role models and encourage students to reject social injustices and environmentally harmful behaviors. Chawla and Cushing [42] also emphasized
that parents and teachers should also encourage children to participate in community projects and experience the sense of achievement that group action brings when working toward a common goal.

Besides, many scholars [43–45] have recommended that environmental education should simultaneously employ storytelling, issue analysis, role play, and simulation games to connect students’ everyday experiences and interests with environmental issues. Such a dynamic approach would enable students to become more immersed in the learning atmosphere and achieve favorable learning outcomes, thereby improving the effectiveness of affective learning objectives and prompting environmental action.

2. Materials and Methods

2.1. Design and Participants

A nonequivalent control group was used. The experimental group, composed of four classes (100 students in total), participated in the one-day program at the nature center. The control group, consisting of three classes (73 students in total), did not receive any environmental education program. All students were sixth-graders from the same school in the Hualien area of eastern Taiwan. The results of independent t-tests revealed no significant differences in the pretest scores for each environmental literacy variable assessed in the study. This could significantly decrease the internal validity threat resulting from differential selection.

A pretest was administered to both groups one week before the start of the program. At the end of the program, a posttest was conducted on the two groups to evaluate the immediate effects. One month after the completion of the program, a follow-up test was conducted on both groups to evaluate the continuous effects.

2.2. Instrument

The instrument consisted of a questionnaire with five subscales designed to measure the dependent variables of the study.

The first subscale measured environmental knowledge (25 items) on bear/forest ecology and existing protection measures, and global warming. Thirty-two multiple-choice questions were originally developed with reference to The Conservation Action Plan for Formosan Black Bears [46]. Since the knowledge items were developed to evaluate the program, they are program-specific. A total of 374 sixth-graders recruited from eastern Taiwan participated in the pilot test. Nine items with low corrected item-total correlation were excluded. A panel consisting of ecologists and environmental education researchers reviewed the subscale in order to establish content and face validity. A group of primary teachers were asked to make comments about the clarity, ease of use, and bias of the subscale. Then the subscale was modified according to their suggestions. The Cronbach’s α reliability (posttest) of the environmental knowledge subscale is 0.77.

As for the development of affective and action subscales, we followed the same procedures applied in the knowledge subscale in order to select the items with high corrected item-total correlation and establish content and face validity.

Environmental attitudes were measured with a two-dimensional construct that mainly retrieved from the 2-MEV [47–49]. We adapted the questionnaire to the cognitive ability of our students in grade 6. In the end, we embedded five preservation and eight utilization items into the questionnaire. Two examples of preservation were ‘Formosan black bears are well-protected, for there are many national parks and nature reserves in Taiwan’ and ‘If a lot of species are extinct, our survival will be threatened in the end’. Two examples of utilization were ‘We should construct more roads in the high mountains in order to make people enjoy Taiwan’s beautiful forest easier’ and ‘Taiwanese worry too much about the environmental problems’. We used a five-point Likert-scale ranging from 1 to 5, with 5 being a very positive preservation attitude and 1 being a very positive utilization attitude. The Cronbach’s α reliability is 0.72 for preservation and 0.85 for utilization.
The environmental responsibility subscale (five items, $\alpha = 0.79$) assessed students’ perceived responsibility for Formosan black bear and forest conservation. The locus of control subscale (five items, $\alpha = 0.66$) assessed students’ perceived ability to influence the solution of various environmental problems concerning Formosan black bear and forest conservation. The development of these two subscales was based on similar environmental literacy instruments [3,10,50]. We used a five-point Likert-scale ranging from 1 to 5, with 5 being a very high level of responsibility or locus of control, and 1 being a very low level of responsibility or locus of control.

The environmental action subscale (12 items, $\alpha = 0.82$) assessed the environmental action taken by the students under three action categories (ecomanagement, consumer action, and persuasion). The students were asked to identify the frequency with which they recalled engaging in each behavior during the past month. The items used a five-point Likert-scale ranging from 1 to 5. For each item of the environmental action subscale, the score was ‘1’ on ‘never’, ‘2’ on ‘rarely’, ‘3’ on ‘sometimes’, ‘4’ on ‘often’ and ‘5’ on ‘always’.

### 2.3. Treatments

This program focuses on the Formosan black bear, an endangered species, and also presents information on deforestation and poaching to strengthen students’ emotional ties with conservation issues concerning forests and Formosan black bears. Furthermore, this program aims to connect civil society operations, environmental problem solving, and students’ environmental behaviors. The program’s teaching strategy uses process drama as the main framework [51] and purposefully framed play [52] as the auxiliary strategy. Bowell and Heap [51] demonstrated that process drama is a useful approach in educational theater that places students in a purposely designed atmosphere to reflect on their self-worth and decisions. Teachers not only control the learning schedule but also play roles that challenge, drive, and conclude the narrative of the story. Additionally, with the aid of supportive materials, teachers in the purposefully framed play will give students appropriate time to explore and connect the game experience with the educational goals [52]. In sum, this program uses games and role play to achieve cognitive, emotional, and action-based educational goals. To reduce the influence of external factors, all teaching in the experiment group was conducted by the same experienced environmental educators from the nature center. The following information includes the educational goals, teaching content, methods, time, and place of each unit in the one-day Black Bear Detectives program (Table 1).

### Table 1. Teaching content of the one-Day Black Bear Detectives Program.

| Unit Name             | Session Duration | Location       |
|-----------------------|------------------|----------------|
| 1. Forest Rangers     | 60 Minutes       | Forest         |
| **Primary objectives**: Environmental knowledge, environmental attitudes |  |  |
| **Teaching content**: Provide students with an introduction to Taiwanese endemic species, the behaviors of Formosan black bears, problems concerning invasive species, and the function of forests (such as the reduction of flooding, droughts, and global warming) in order to impress upon them the importance of forests to wildlife and humans. |  |  |
| **Teaching method**: The teacher first instructs students to play the role of forest rangers and assigns group tasks for them to complete, such as species recognition and news report error identification, before providing explanations. The teacher uses local stories, outdoor observation, mudslide simulation experiment, and interpretative board to interpret the function of the forest. |  |  |
| 2. Formosan Black Bear Threats | 60 Minutes | Audio-Visual Room and Performance Stage |
| **Primary objectives**: Environmental knowledge, environmental attitudes |  |  |
| **Teaching content**: Broadcast the 15-min film by the Taiwan Black Bear Conservation Association titled “Formosan Black Bear Conservation Documentary” to strengthen students’ understanding of the behaviors of Formosan black bears, and then discuss the threats that poaching and habitat destruction pose to the survival of Formosan black bears. |  |  |
Table 1. Cont.

| Unit Name                          | Session Duration | Location               |
|-----------------------------------|------------------|------------------------|
| Teaching method: This unit first highlights students' awareness of the survival crisis of Formosan black bears and then invites students to play the roles of Formosan black bears, illegal merchants, law enforcement officers, and poachers in a role play session designed to strengthen students’ positive impressions of conservation work for Formosan black bears. |
| 3. Guardians of Black Bears        | 60 Minutes       | Outdoor Patio, Forest  |
| Primary objectives: Locus of control, environmental responsibility |
| Teaching content: Observe distribution patterns of Formosan black bears and discuss the importance of habitat integrity in black bear conservation. Students are able to understand that the efforts of a few cannot achieve black bear conservation and that instead, the full participation of an environmentally literate general public is necessary. |
| Teaching method: Each group is a sovereign country in the game session. Students can play the roles of presidents, scholars, students, and legislators and must work together in using bamboo sticks (representing habitats) to escort Formosan black bears (represented by a ball) to a safe zone. |
| 4. Black Bears and Forests         | 60 Minutes       | Grassland              |
| Primary objectives: Environmental attitudes |
| Teaching content: Study the behaviors of Formosan black bears and their contributions to the ecosystem, thereby promoting students’ conservation awareness and attitudes regarding Taiwan’s forests and Formosan black bears. |
| Teaching method: The teacher is a narrator and recites a passage to participants detailing the Formosan black bears’ behaviors. Students playing as Formosan black bears respond to the narration by performing gestures and actions. Upon conclusion, the teacher plays the role of a biologist specializing in Formosan black bears and gives a presentation on threats to the Formosan black bear’s survival and how Formosan black bears contribute to forest renewal. Finally, the teacher holds an arts and crafts workshop for students to make bear-themed keychain accessories. Students are then invited to become advocates of Formosan black bears and forest conservation. |
| 5. Black Bear Cub Going Home       | 60 Minutes       | Aerobics Classroom     |
| Primary objectives: Environmental responsibility, environmental action |
| Teaching content: Form connections between students’ everyday behaviors and Formosan black bears and forest conservation in order to enhance students’ pro-environmental behavior. |
| Teaching method: Students first use picture cards to learn about improper behaviors that harm forests and black bears. These behaviors form picture cards for the follow-up activity. The teacher randomly inserts cards representing improper behaviors into the base map laid out on the classroom floor. Students must work in teams to avoid the cards (representing threats) and escort the black bear cub back to safety in their forest habitat. After the game is finished, the teacher tells stories and uses role play to connect students’ improper behaviors with forest and black bear conservation. |

3. Results

3.1. Assessing the Immediate Effects of the Program

Because the students in the study were not randomly assigned to each group, each score for the pretest variables was used as a covariate, and the respective posttest variable was used as a dependent variable. Table 2 lists the average scores of each variable for the two groups before and after the intervention program. The ANCOVA results indicated that students in the experimental group showed a lower utilization preference than students in the control group. Furthermore, students’ locus of control and environmental knowledge were effectively improved by the end of the program.

3.2. Assessing the Continuous Effects of the Program

Table 3 lists the average scores on the pretest and follow-up test. Each score for pretest variables was used as a covariate, and the respective follow-up test variable was used as a dependent variable. The ANCOVA results indicated that students in the experimental group showed a higher preservation and a lower utilization preference than those in the control group in the follow-up test. Furthermore, students’ environmental responsibility, locus of control, environmental knowledge, and environmental action were promoted one month after the end of the program. Environmental knowledge is the variable with the most significant improvement. The posttest score of the experimental group increased
by 30% compared with the pretest score. The results of the delayed follow-up test conducted a month later indicated a slight decrease in the score but was overall 21% higher than the pretest score.

Table 2. ANCOVA scores on the immediate effects (pretest = covariate).

| Variables                        | Pretest | Posttest | F Ratio | p-Value |
|----------------------------------|---------|----------|---------|---------|
|                                  | Mean    | SD       | Mean    | SD      |         |
| Preservation attitudes           |         |          |         |         |         |
| Experimental group               | 3.59    | 0.93     | 3.95    | 0.87    | 2.132   | 0.146   |
| Control group                    | 3.69    | 0.87     | 3.87    | 0.76    |         |         |
| Utilization attitudes            |         |          |         |         |         |         |
| Experimental group               | 4.02    | 0.57     | 4.37    | 0.63    | 16.960  | 0.000 **|
| Control group                    | 4.12    | 0.53     | 4.17    | 0.55    |         |         |
| Environmental responsibility     |         |          |         |         |         |         |
| Experimental group               | 4.13    | 0.58     | 4.25    | 0.68    | 2.357   | 0.127   |
| Control group                    | 4.25    | 0.56     | 4.23    | 0.59    |         |         |
| Locus of control                 |         |          |         |         |         |         |
| Experimental group               | 4.04    | 0.56     | 4.24    | 0.66    | 7.226   | 0.008 **|
| Control group                    | 4.05    | 0.59     | 4.05    | 0.60    |         |         |
| Environmental knowledge          |         |          |         |         |         |         |
| Experimental group               | 62.48   | 15.08    | 81.28   | 13.92   | 87.279  | 0.000 **|
| Control group                    | 63.56   | 15.80    | 65.36   | 14.52   |         |         |

* p < 0.05; ** p < 0.01.

Table 3. ANCOVA scores on the continuous effects (pretest = covariate).

| Variables                        | Pretest | Follow-Up Test | F Ratio | p Value |
|----------------------------------|---------|----------------|---------|---------|
|                                  | Mean    | SD             | Mean    | SD      |         |
| Preservation attitudes           |         |                |         |         |         |
| Experimental group               | 3.59    | 0.93           | 3.97    | 0.84    | 4.130   | 0.044 * |
| Control group                    | 3.69    | 0.87           | 3.82    | 0.79    |         |         |
| Utilization attitudes            |         |                |         |         |         |         |
| Experimental group               | 4.02    | 0.57           | 4.28    | 0.60    | 14.580  | 0.000 **|
| Control group                    | 4.12    | 0.53           | 4.07    | 0.60    |         |         |
| Environmental responsibility     |         |                |         |         |         |         |
| Experimental group               | 4.13    | 0.58           | 4.24    | 0.67    | 13.270  | 0.000 **|
| Control group                    | 4.25    | 0.56           | 4.03    | 0.62    |         |         |
| Locus of control                 |         |                |         |         |         |         |
| Experimental group               | 4.04    | 0.56           | 4.23    | 0.66    | 20.479  | 0.000 **|
| Control group                    | 4.05    | 0.59           | 3.86    | 0.65    |         |         |
| Environmental knowledge          |         |                |         |         |         |         |
| Experimental group               | 62.48   | 15.08          | 75.76   | 16.00   | 64.106  | 0.000 **|
| Control group                    | 63.56   | 15.80          | 61.48   | 15.32   |         |         |
| Environmental action             |         |                |         |         |         |         |
| Experimental group               | 3.46    | 0.64           | 3.71    | 0.75    | 13.156  | 0.000 **|
| Control group                    | 3.64    | 0.69           | 3.56    | 0.67    |         |         |

* p < 0.05; ** p < 0.01.

4. Discussion

4.1. Effects on Affective Learning Outcomes and Environmental Action

Ardoin et al. [32] reviewed more than 100 studies and determined that affective learning outcomes and environmental action are more difficult to promote than environmental knowledge. However, the present study discovered a retained effect one month after the end of the program in terms of students’ environmental attitudes, environmental responsibility, locus of control, and environmental
action. This indicates that the one-day program (Black Bear Detectives) developed by the nature center on the basis of role play and game teaching methods could effectively promote students’ environmental literacy. The nature center does provide students an enjoyable and effective learning environment in eastern Taiwan.

The scores for the 2-MEV scale showed that even one month after participation, a long-term attitudinal change still remained in utilization and preservation. This shift is in line with previous findings in a week-long outdoor education program [17]. However, the result is inconsistent with previous studies [48,53]. Liefländer and Bogner [48] used the 2-MEV model to assess a four-day program. They found out that the preservation dimension of the sixth-graders only increased on the posttest and the utilization dimension was not influenced at all due to course participation. Liefländer and Bogner [48] suggested that environmental education programs aiming to enhance environmental attitudes may be more effective for younger children than for older children. From the discussion above, the present study suggests that even a short-term program could promote long-term retention of attitudes and age might be one of the factors that affect teaching effectiveness.

In the program of this study, role play and games were adopted to analyze environmental issues from ecological, social, and cultural perspectives and provide students a holistic perspective to understand how to solve environmental problems. The findings of the study indicated that this program could enhance students’ affective learning outcomes and environmental action. These results are in agreement with those reported by Curtis et al. [12], who have also shown that drama was an effective means of positively influencing students’ environmental attitudes and intention to act. The reason for the effectiveness of this program is probably that, as suggested in previous research [44,54], instruction through role play and games can provide a holistic perspective by teaching students to debate, analyze, and assess each other’s attitudes, values, and behaviors regarding the problems as if they were doing so in real life.

Locus of control and environmental responsibility are two important affective learning objectives in this study because they could promote the development of environmental action [8,42,50]. The program of this study uses local conservation issues in eastern Taiwan to help students understand that the efforts of a few cannot achieve black bear conservation and that instead, the full participation of an environmental citizenry is necessary for the success of conservation. The results of this study revealed that students’ locus of control, environmental responsibility, and environmental action were promoted one month after the end of the program. Consequently, as Jensen and Schnack [55] have emphasized, environmental education and participatory democracy should be closely linked. It is suggested that environmental educators in Taiwan should help students understand how to solve environmental problems through collective citizen-participation efforts in civic society. Moreover, more opportunities should be provided for students to learn from role model teachers and peers in order to enhance students’ locus of control, environmental responsibility, and environmental action.

It must be considered, however, that the use of games as a teaching method does not necessarily generate positive learning outcomes [27,28]. Soekarjo and Oostendorp [28] discovered that games that are too complicated or uninteresting cause interference and have a negative influence on learning outcomes, leading to results that are even worse than those obtained from traditional slideshow presentations. Furthermore, the games teaching approach requires that students be immersed in the atmosphere created by the instructor [24]. In the present study, students were not only fully involved in games and role play but also made exaggerated movements, facial expressions and sound effects actively. Most importantly, this achievement indicated that teachers were successful in building the learning atmosphere and guiding their thinking. Based on the aforementioned literature and the present study, it can be seen that the joy which games offer is an essential factor of its efficacy for improving learning outcomes because it matches well with the innate playful nature that children possess. Consequently, it is suggested that the games developed by environmental educators should be joyful, interesting, relevant to teaching content, and easy to comprehend and play, in order to increase the effectiveness of environmental education.
4.2. Effects on Environmental Knowledge

Environmental knowledge serves as the basis for citizens making decisions regarding whether to take appropriate environmental action [6], so it has received much attention in environmental education research. The present study showed that the participating students’ environmental knowledge was improved by the end of the one-day program in a nature center setting. It is also encouraging to find that the posttest mean score of the experimental group on knowledge increased by 30% compared with the pretest score. The results coincide with other studies [14,41], which showed a short-term knowledge gain after participating in a half- or one-day program in a natural setting.

With regard to the persistence of knowledge gain, the present study showed that students’ environmental knowledge was promoted one month after the end of the program. Although the participating students forgot some of the newly acquired knowledge, the knowledge mean score in the follow-up test was 21% higher than the pretest score. The results support the studies [14,18,41] which showed the short-term educational interventions conducted in natural settings, such as national parks, zoos, and botanical gardens, could facilitate students’ long-term knowledge retention after four to six weeks. Considering the importance of teaching methods, Sellmann and Bogner [14] suggested that the methodological design (e.g., student-centered approach) of the teaching unit presumably had a long-term positive influence on cognitive achievement, and pre- and post-visit educational activities in the classroom could enhance learning outcomes. Besides, Krain and Shadles [31] compared role play and lecturing methods and found that students who were subjected to role play attained more environmental knowledge and were better able to adopt a holistic view beyond their personal experiences to analyze environmental problems.

Environmental knowledge has been the most commonly examined variable and perhaps the most achievable goal in the evaluations of environmental education programs [32]. However, Tung et al. [35] found that students’ environmental knowledge cannot be promoted in the absence of structured programs and teaching strategies, even when students engage in lively and diverse school activities and field trips. Therefore, based on the previous discussion and the results of this study, it is suggested that the environmental educators’ ability to adopt role play and games teaching approaches with a well-structured lesson plan could be a contributing factor to knowledge retention.

5. Limitations

The subjects of this study consisted of sixth-graders in eastern Taiwan, so the research outcomes may not reflect the cognitive, affective, and behavioral development of sixth-grade children from other areas of Taiwan if they attend the same program. The generalizability of this research is only applicable to population samples with comparable attributes. Moreover, limitations include those resulting from the use of non-randomized sampling in the study. The generalizability of these findings is decreased by the sampling method. Furthermore, the schoolteachers, weather, and previous educational experiences of students may independently or collectively influence the effect of the one-day environmental education program in the study. Therefore, those confounding factors may damage the internal validity of the study results.

This study adopted a quantitative research method to assess students’ learning outcomes. However, the range of efficacy for individual students is still unknown. Moreover, this study did not examine the influences of learning styles or individual student’s nature experiences [4] on learning outcomes. Sattler and Bogner [41] suggested that factors like students’ fears and concerns that influenced students’ cognitive achievement individually in out-of-school settings should be assessed. Without employing qualitative methods like interviews or participant observations, the study could not determine the efficacy of individual students and we could not confirm which parts of the program as perceived by individual students shape their environmental knowledge, attitudes, and behavior change.

The issue of intervention length also needs to be addressed as it is related to the effects of educational programs. Sellmann and Bogner [14] proposed that a longer environmental education program might have led to a higher knowledge gain. Researchers found a better cognitive outcome [15]
or stronger nature connectedness [19] in the longer intervention. Since most of the primary students in eastern Taiwan came to visit nature centers within the framework of annual one-day field trips, the intervention of the study was designed as a one-day environmental education program. This is another limitation of the study. Furthermore, due to the limitations of research expenditure and time element, data collecting after a one-month period for the follow-up study may be insufficient to reflect long-term effects on students’ learning although the findings of the study showed that positive changes in knowledge, attitudes, and locus of control have been retained for one month following removal of the intervention.

In terms of instruments, the measure of students’ environmental action was limited to students’ self-reported perceptions rather than direct observations. This may decrease the test reliability because students’ self-reported behaviors is possibly influenced by their emotions or memory during administration. Another problem with self-reported environmental behavior is over-reporting as a result of social desirability. Besides, the ad-hoc knowledge questionnaire was developed in the light of the specific cultural, political, social, and ecological conditions of Taiwan. Therefore, the environmental knowledge contained in the study is limited to that revealed by the questionnaire.

Finally, the present study did not analyze the interaction effects among students’ environmental knowledge, affective variables like environmental attitudes or responsibility, and environmental action during the learning process. Although research designed to assess changes in environmental knowledge or environmental attitudes is important, changes in behaviors should receive more attention because behaviors will help maintain environmental quality. This study could neither determine the cause-effect relationships among environmental action, knowledge, and attitudes nor consider students’ emotional response [56] or life experiences [4] related to environmental knowledge, attitudes, and behavior in a nature center setting.

6. Conclusions

To conclude, the purpose of the present study is to evaluate the effectiveness of games and role play as teaching approaches. A major finding is that the one-day environmental education program indeed has positive long-term effects on environmental attitudes, knowledge, and actions. The results indicate that teaching through role play and games can provide a holistic view by guiding students to discuss and assess each other’s attitudes, values, and behaviors regarding the environmental issues as if they were doing so in real life. It is worth noting that enjoyable activities and local stories related to students’ everyday experiences and interests would enable students to become more immersed in the learning atmosphere and achieve favorable learning outcomes. Besides, the present study also suggests that a well-structured lesson plan could be another contributing factor to teaching effectiveness. In the end, we assume that the one-day environmental education program at the nature center may supplement formal education in regard to Formosan black bear and forest conservation.

Author Contributions: Conceptualization, C.-T.P.; data curation, C.-T.P.; formal analysis, C.-T.P.; funding acquisition, S.-J.H.; project administration, S.-J.H.; writing—original draft, C.-T.P.; writing—review and editing, S.-J.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Ministry of Science and Technology, Taiwan, grant numbers 107-2511-H-259-003-MY3.

Acknowledgments: The work was sponsored by the Ministry of Science and Technology, Taiwan. The authors would like to express their gratitude to Dr. Mei-Hsiu Hwang and environmental educators at Chihnan Nature Center of Taiwan Forestry Bureau for their kind help.

Conflicts of Interest: The authors declare no conflict of interest.
References

1. Hwang, M.-H.; Garshelis, D.L.; Wu, Y.-H.; Wang, Y. Home ranges of Asiatic black bears in the Central Mountains of Taiwan: Gauging whether a reserve is big enough. *Ursus* 2010, 21, 81–96. [CrossRef]
2. Hsu, S.-J. *Implementation of Environmental Education at Chihnan Nature Center* (Report No. 100-14); Taiwan Forestry Bureau: Taipei, Taiwan, 2018. (In Chinese)
3. Hsu, S.-J. The effects of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students. *J. Environ. Educ.* 2004, 35, 37–48. [CrossRef]
4. Hsu, S.-J. Significant life experiences affect environmental action: A confirmation study in eastern Taiwan. *Environ. Educ. Res.* 2009, 15, 497–517. [CrossRef]
5. UNESCO. *Environmental Education in the Light of the Tbilisi Conference*; UNESCO: Paris, France, 1980.
6. Roczen, N.; Kaiser, F.G.; Bogner, F.X.; Wilson, M. A competence model for environmental education. *Environ. Behav.* 2014, 46, 972–992. [CrossRef]
7. Fielding, K.S.; Head, B. Determinants of young Australians’ environmental actions: The role of responsibility attributions, locus of control, knowledge and attitudes. *Environ. Educ. Res.* 2011, 18, 171–186. [CrossRef]
8. Hungerford, H.R.; Volk, T.L. Changing learner behavior through environmental education. *J. Environ. Educ.* 1990, 21, 8–21. [CrossRef]
9. Kollmuss, A.; Agyeman, J. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res.* 2002, 8, 239–260. [CrossRef]
10. Liang, S.-W.; Fang, W.-T.; Yeh, S.-C.; Liu, S.-Y.; Tsai, J.-Y.; Chou, J.-Y.; Ng, E. A Nationwide Survey Evaluating the Environmental Literacy of Undergraduate Students in Taiwan. *Sustainability* 2018, 10, 1730. [CrossRef]
11. Monroe, M.C.; Plate, R.R.; Oxarart, A.; Bowers, A.; Chaves, W.A. Identifying effective climate change education strategies: A systematic review of the research. *Environ. Educ. Res.* 2017, 1–22. [CrossRef]
12. Curtis, D.J.; Howden, M.; Curtis, F.; McCollom, I.; Scrine, J.; Blomfield, T.; Reeve, I.; Ryan, T. Drama and Environment: Joining Forces to Engage Children and Young People in Environmental Education. *Aust. J. Environ. Educ.* 2013, 29, 182–201. [CrossRef]
13. Taylor, J.L. *Guide on Simulation and Gaming for Environmental Education*; UNESCO: Paris, France, 1983.
14. Sellmann, D.; Bogner, F.X. Climate change education: Quantitatively assessing the impact of a botanical garden as an informal learning environment. *Environ. Educ. Res.* 2013, 19, 415–429. [CrossRef]
15. Stern, M.J.; Powell, R.B.; Ardoi, N.M. What Difference Does It Make? Assessing Outcomes From Participation in a Residential Environmental Education Program. *J. Environ. Educ.* 2008, 39, 31–43. [CrossRef]
16. Liefünder, A.; Bogner, F.X.; Kibbe, A.; Kaiser, F.G. Evaluating Environmental Knowledge Dimension Convergence to Assess Educational Programme Effectiveness. *Int. J. Sci. Educ.* 2015, 37, 684–702. [CrossRef]
17. Bogner, F.X.; Wiseman, M. Outdoor Ecology Education and Pupils’ Environmental Perception in Preservation and Utilization. *Sci. Educ. Int.* 2004, 15, 27–48.
18. Bogner, F.X. The Influence of Short-Term Outdoor Ecology Education on Long-Term Variables of Environmental Perspective. *J. Environ. Educ.* 1998, 29, 17–29. [CrossRef]
19. Braun, T.; Dierkes, P.W. Connecting students to nature—How intensity of nature experience and student age influence the success of outdoor education programs. *Environ. Educ. Res.* 2017, 23, 937–949. [CrossRef]
20. DeWitt, J.; Storksdieck, M. A short review of school field tips: Key findings from the past and implications for the future. *Vistor Stud.* 2008, 11, 181–197. [CrossRef]
21. Gore, M.L.; Knuth, B.A.; Curtis, P.D.; Shanahan, J.E. Education programs for reducing American black bear–human conflict: Indicators of success? *Ursus* 2006, 17, 75–80. [CrossRef]
22. Engleson, D.C.; Yockers, D.H. *A Guide to Curriculum Planning in Environmental Education*, 2nd ed.; Wisconsin Department of Public Instruction: Madison, WI, USA, 1994.
23. Wood, E.; Attfield, J. *Play, Learning and the Early Childhood Curriculum*, 2nd ed.; Paul Chapman: London, UK, 2005.
24. Hays, R.T. *The Effectiveness of Instructional Games: A Literature Review and Discussion*; Naval Air Warfare Center Training Systems Division: Orlando, FL, USA, 2005.
25. Garris, R.; Ahlers, R.; Driskell, J.E. Games, Motivation, and Learning: A Research and Practice Model. *Simul. Gaming* 2002, 33, 441–467. [CrossRef]
26. McSharry, G.; Jones, S. Role-play in science teaching and learning. *School Sci. Rev.* 2000, 82, 73–82.
27. Ouariachi, T.; Gutiérrez-Pérez, J.; Olvera-Lobo, M.-D. Can serious games help to mitigate climate change? Exploring their influence on Spanish and American teenagers’ attitudes. *Psycology* 2018, 9, 365–395. [CrossRef]

28. Soekarjo, M.; Van Oostendorp, H. Measuring Effectiveness of Persuasive Games Using an Informative Control Condition. *Int. J. Serious Games* 2015, 2, 37–56. [CrossRef]

29. Turan, G.Y.; Köklükaya, A.N.; Yıldırım, E.G. Improving Matter and Heat Subjects Learning Through Genuine Designed Educational Games. *Int. J. Sci. Math. Educ.* 2020, 18, 19–42. [CrossRef]

30. McNaughton, M.J. Educational drama in education for sustainable development: Ecopedagogy in action. *Pedagog. Cult. Soc.* 2010, 18, 289–308. [CrossRef]

31. Krain, M.; Shadle, C.J. Starving for knowledge: An active learning approach to teaching about world hunger. *Int. Stud. Perspect.* 2006, 7, 51–66. [CrossRef]

32. Ardoin, N.M.; Bowers, A.W.; Roth, N.W.; Holthuis, N. Environmental education and K-12 student outcomes: A review and analysis of research. *J. Environ. Educ.* 2017, 49, 1–17. [CrossRef]

33. Cornelisse, T.M.; Sagasta, J. The Effect of Conservation Knowledge on Attitudes and Stated Behaviors toward Arthropods of Urban and Suburban Elementary School Students. *Anthrozoös* 2018, 31, 283–296. [CrossRef]

34. Cox-Petersen, A.M.; Marsh, D.D.; Kisiel, J.; Melber, L.M. Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. *J. Res. Sci. Teach.* 2003, 40, 200–218. [CrossRef]

35. Tung, C.Y.; Huang, C.C.; Kawata, C. The effects of different environmental education programs on the environmental behavior of seventh-grade students and related factors. *J. Environ. Health* 2002, 64, 24–29. [CrossRef]

36. Nadelson, L.; Jordan, J. Student attitudes toward and recall of outside day: An environmental science field trip. *J. Environ. Educ.* 2012, 105, 220–231. [CrossRef]

37. Porter, D.; Weaver, A.J.; Raptis, H. Assessing students’ learning about fundamental concepts of climate change under two different conditions. *Environ. Educ. Res.* 2012, 18, 665–686. [CrossRef]

38. Ruiz-Mallén, I.; Barraza, L.; Bodenhorn, B.; Reyes-Garcia, V. Evaluating the impact of an environmental education programme: An empirical study in Mexico. *Environ. Educ. Res.* 2009, 15, 371–387. [CrossRef]

39. Karpudewan, M.; Roth, W-M.; Chandrakesan, K. Remediating misconception on climate change among secondary school students in Malaysia. *Environ. Educ. Res.* 2015, 21, 631–648. [CrossRef]

40. Kinder, T.; Mesner, N.O.; Larese-Casanova, M.; Lott, K.H.; Cachelin, A.; Lalonde, K. Changes in Knowledge and Attitude from a Short-Term Aquatic Education Program. *Nat. Sci. Educ.* 2015, 44, 18–25. [CrossRef]

41. Sattler, S.; Bogner, F.X. Short- and long-term outreach at the zoo: Cognitive learning about marine ecological and conservational issues. *Environ. Educ. Res.* 2016, 23, 252–268. [CrossRef]

42. Chawla, L.; Cushing, D.F. Education for strategic environmental behavior. *Environ. Educ. Res.* 2007, 13, 437–452. [CrossRef]

43. Dickinson, J.L.; Crain, R.; Yalowitz, S.; Cherry, T.M. How Framing Climate Change Influences Citizen Scientists’ Intentions to Do Something About It. *J. Environ. Educ.* 2013, 44, 145–158. [CrossRef]

44. Joyce, B.; Weil, M.; Calhoun, E. Model of Teaching, 6th ed.; Allyn and Bacon: Boston, MA, USA, 2000.

45. Krain, M.; Lantis, J.S. Building Knowledge? Evaluating the Effectiveness of the Global Problems Summit Simulation. *Int. Stud. Perspect.* 2006, 7, 395–407. [CrossRef]

46. Hwang, M.H.; Pan, Y.J.; Lin, R.A. The Distribution Model and Conservation Action Plan for Formosan Black Bears (II); Taiwan Forestry Bureau: Taipei, Taiwan, 2012. (In Chinese)

47. Bogner, F.X.; Wiseman, M. Adolescents’ attitudes towards nature and environment: Quantifying the 2-MEV model. *Environmentalist* 2006, 26, 247–254. [CrossRef]

48. Liefänder, A.K.; Bogner, F.X. The effects of children’s age and sex on acquiring pro-environmental attitudes through environmental education. *J. Environ. Educ.* 2014, 45, 105–117. [CrossRef]

49. Johnson, B.; Manoli, C.C. A Measure of Children’s Environmental Attitudes Based on the Theory of Ecological Attitude. *J. Environ. Educ.* 2011, 42, 84–97. [CrossRef]
50. Marcinkowski, T.; Rehrig, L. The secondary school report: A final report on the development, pilot testing, validation, and field testing of The Secondary School Environmental Literacy Assessment Instrument. In Environmental Education Literacy/Needs Assessment Project: Assessing Environmental Literacy of Students and Environmental Education Needs of Teachers. Final Report for 1993–1995; Wilke, R., Ed.; University of Wisconsin-Stevens Point: Stevens Point, WI, USA, 1995; pp. 30–76.

51. Bowell, P.; Heap, B. Putting Process Drama into Action: The Dynamics of Practice; Routledge: London, UK, 2017.

52. Edwards, S.; Cutter-Mackenzie, A.; Hunt, E. Framing Play for Learning: Professional Reflections on the Role of Open-ended Play in Early Childhood Education. In Engaging Play; Brooker, L., Edwards, S., Eds.; Open University Press: Berkshire, UK, 2010; pp. 136–151.

53. Glaab, S.; Heyne, T. Green classroom vs. classroom—Influence of teaching approaches, learning settings, and state emotions on environmental values of primary school children. Appl. Environ. Educ. Commun. 2019, 18, 179–190. [CrossRef]

54. Gordon, S.; Thomas, I. The learning sticks’: Reflections on a case study of role-playing for sustainability. Environ. Educ. Res. 2016, 24, 172–190. [CrossRef]

55. Jensen, B.B.; Schnack, K. The Action Competence Approach in Environmental Education. Environ. Educ. Res. 1997, 3, 163–178. [CrossRef]

56. Fröhlich, G.; Sellmann, D.; Bogner, F.X. The influence of situational emotions on the intention for sustainable consumer behaviour in a student-centred intervention. Environ. Educ. Res. 2013, 19, 747–764. [CrossRef]