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Evaluating the impact of place-based education: insights from a river environmental program in Taiwan

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Abstract

Purpose – The current education paradigm is often criticized for fostering human dependence and failing to reduce environmental impacts. This has led researchers to propose alternative approaches. One alternative approach, place-based education, integrates a specific location's natural and social context into learning experiences. By deepening students' connection to their surroundings, place-based environmental education aims to enhance students' sense of interdependence with a place and their place attachment in cognitive and affective dimensions. While widely practiced, its effectiveness remains largely unevaluated, particularly in the East Asian context. The gap hinders the development of impactful pedagogical approaches for educators.

Design/methodology/approach – The authors examine a river environmental education program located upstream of Taiwan's capital, offering a valuable case study within the East Asian context. The program's design is analyzed, and its impact on enhancing students' place attachment is assessed through a pre- and post-survey approach.

Findings – The results indicate a substantial increase in students' place attachment following program participation, particularly pronounced among children with limited prior experience with the river. Importantly, this increase is comparable to or exceeds those observed in similar studies from other regions.

Originality/value – The considerable increase in place attachment observed in this program demonstrates its effectiveness in fostering environmental connections, particularly among children with limited prior experience. The magnitude of the increase might be partially attributable to the interdependent orientation of Taiwanese culture. This suggests that place-based education might yield significant positive outcomes in other non-Western countries with strong interdependent cultural orientations.

Keywords Place-based environmental education, Place attachment, Sense of interdependence, Perspective taking, River education

Paper type Research paper

1. Introduction

As humans face dire environmental challenges like climate change, education emerges as a critical tool for fostering environmental sustainability (Komatsu, Rappleye, & Silova, 2020; Sumida, 2024). The dominant paradigm embodied in initiatives like the United Nations Millennium Development Goals and Sustainable Development Goals prioritizes increased

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access to modern schooling and improved literacy and numeracy. These cognitive proficiencies are posited to empower students by enabling them to critically analyze information, identify social issues—including environmental concerns—engage in independent and reasoned thinking, and subsequently deviate from established social norms to address problems and contribute to the creation of a more sustainable world (Komatsu, Silova, & Rappleye, 2023; Rappleye, Silova, Komatsu, & Takayama, 2024).

However, this paradigm has increasingly come under scrutiny. Critics argue that it exacerbates environmental issues by promoting human independence from others, including nature, and hindering recognition of our interdependence (Bowers, 1995, 2002; Orr, 2004, 2009; Silova, 2019, 2021). This argument, first voiced decades ago (White, 1967; Naess, 1973), now finds support in scientific research. Psychologists demonstrate that individuals with strong independence tend to engage in pro-environmental behaviors less frequently than those who value interdependence (Arnocky, Stroink, & DeCicco, 2007; Chuang, Xie, & Liu, 2016; Komatsu, Fu, Lin, Hsieh, Rappleye, & Silova, 2022). Additionally, studies suggest that countries emphasizing independence generally exhibit higher environmental impacts compared to societies prioritizing interdependence (Komatsu, Rappleye, & Silova, 2019; Komatsu, Rappleye, & Silova, 2021).

Recognizing the significance of interdependence, educational researchers have developed diverse approaches to cultivate this value, particularly in relation to the environment. One prominent approach is place-based education (Semken & Brandt, 2010; Horlings, 2015; Grenni, Soini, & Horlings, 2020), which aims to foster students' sense of interdependence with a specific environment, what is known as "place attachment." This attachment reflects an individual's deep connection with their surroundings, including cognitive and affective bonds. Affective bonds are often understood as emotional attachments to a place, and cognitive bonds are reflected in an individual's knowledge, thoughts, and beliefs related to a place (Kyle, Mowen, & Tarrant, 2004; Daryanto & Song, 2021). The development of people's sense of interdependence and attachment to a place can be proceeded sequentially from shaping cognitions of ecological knowledge and social context to cultivating place affects (Worster & Abrams, 2005).

Studies suggest that place attachment fosters people's engagement in local affairs, promoting neighborhood revitalization and improvement (Brown, Perkins, & Brown, 2003; Manzo & Perkins, 2006; Amundsen, 2015; Wu, Li, Liu, Huang, & Liu, 2019). Additionally, studies have found a positive correlation between higher levels of place attachment and more frequent pro-environmental behavior (Stedman, 2002; Vaske & Kobrin, 2001; Scannell & Gifford, 2010; Ramkissoon & Mavondo, 2017). Place-based education's potential extends beyond environmental awareness, reaching into the realm of decolonizing education. Modern education, by prioritizing decontextualized knowledge, often unintentionally perpetuates colonial power structures within its systems (Silova, 2021; Beech, 2023; Saito, Edwards, Sustarsic, & Taira, 2023). Place-based education, in contrast, emphasizes contextualized knowledge grounded in the specific environment and history of a community (Smith, 2007; Semken & Freeman, 2008; Ormond, 2013). This fundamental shift holds the power to challenge and ultimately dismantle the lingering legacies of colonialism within educational practices.

Although place-based environmental education is widely practiced (Smith, 2007; Semken, Ward, Moosavi, & Chinn, 2017; Ito & Igano, 2020), its effectiveness is only assessed in several cases (Semken & Freeman, 2008; Kudryavtsev, Stedman, & Krasny, 2012; Kuwahara, 2013; Cincera, Johnson, & Kovacikova, 2015; Lee & Chiang, 2016). This lack of evaluation poses a significant challenge to educators, hindering the development of successful pedagogical approaches (Komatsu *et al.*, 2023). While several assessments exist, they primarily focus on Western contexts, leaving a significant gap in our understanding of how place-based education operates in diverse settings.

This study aims to address this gap by investigating a case within an East Asian context. It assesses the effectiveness of an ongoing place-based education program implemented in Pinglin (坪林), a district in upstream protected area of Taipei, the capital of Taiwan R.O.C with a population of 2.6 million. Pinglin is recognized for its environmental conservation efforts

and was selected as one of the top 100 Sustainable Destinations in 2018 (Green Destinations ITB, 2018). In recent years, place-based environmental education for elementary school children has been implemented in Pinglin by a local team focused on revitalizing local culture. The program targets fourth graders and beyond in the local elementary school and comprises both in-class and field activities aimed at enhancing students' understanding of the environmental significance of their surroundings, and intensifying their positive affect towards the place. This study will detail the activities of the education program and assess changes in children's place attachment before and after its implementation.

2. Theory of place attachment

The concept of place attachment has been broadly discussed by scholars of different disciplines, including human geography, anthropology, sociology, psychology, planning and design, education, and resources management. Researchers from different fields have used inconsistent terms to describe the person-place relationship, such as topophilia (Tuan, 1974), rootedness (Relph, 1976; Tuan, 1980; McAndrew, 1998), sense of place (Worster & Abrams, 2005; Vanclay, 2008), and place identity (Proshansky, Fabian, & Kaminoff, 1983). These terms are often used interchangeably and their definitions tend to be operationalized according to the purposes of the studies, leading to inconsistency.

Diverse conceptions of place attachment are associated with divergent methods and research purposes, employing both qualitative and quantitative approaches. Human geographers and sociologists using qualitative approaches aim to discover meanings of places as perceived by people (Tuan, 1974; Mesch & Manor, 1998; Knaps, Gottwald, Albert, & Herrmann, 2022), the contents of people's attachment (Ngo & Brklacich, 2014; Shabak, Norouzi, Abdullah, & Khan, 2015), or to clarify the dynamic process of developing attachment (Worster & Abrams, 2005; Seamon, 2013). Quantitative approaches became prevalent when psychologists entered this field and provided operationalized definitions of place attachment to clarify its relationship with other variables (McAndrew, 1998; Jorgensen & Stedman, 2001; Lewicka, 2010). While some researchers took place attachment a general concept (Jorgensen & Stedman, 2001; Moore & Scott, 2003), others have developed multiple dimensions of place attachment, including place identity and place dependence (Williams & Roggenbuck, 1989; Williams & Vaske, 2003; Junot, Paquet, & Fenouillet, 2018), place affect (Jorgensen & Stedman, 2001; Ramkissoon, Smith, & Weiler, 2013), community and social bonding (Kyle *et al.*, 2004; Ramkissoon *et al.*, 2013; Huber & Arnberger, 2016), and environment and nature bonding (Raymond, Brown, & Weber, 2010).

Though definitions may vary, place attachment generally describes positive bonding between a person and a place (Giuliani, 2003; Scannell & Gifford, 2010), encompassing both affective and cognitive bonds (Scannell & Gifford, 2010; Lewicka, 2011; Daryanto & Song, 2021). Affective attachment refers to emotional connections or affect in person-place bonding, while cognitive attachment contains elements like memories, beliefs, meaning, and knowledge (Scannell & Gifford, 2010). Affect and cognition are regarded as important components of place attachment, alongside behavioral intentions (Shumaker & Taylor, 1983, p. 237; Jorgensen & Stedman, 2001; Scannell & Gifford, 2010). As described in an earlier model of place attachment, it involves "*expectations of stability, feelings of positive affect, greater knowledge of the locale, and behaviors that serve to maintain or enhance the location*" (Shumaker & Taylor, 1983, p. 237). Previous studies measured the strength of people's place attachment with items of self-reported cognition (questions like "I know this place very well") and emotional affect (questions like "This place is important to me") (McAndrew, 1998; Lewicka, 2010; Gao, Church, Peel, & Prokopy, 2018).

Based on this theoretical foundation, this study focuses on the cognitive and affective dimensions (i.e. students' self-reported level of knowledge about the river and their positive affect towards it) to analyze a river environmental education program in the Pinglin area (see the next section).

3. Design of the Pinglin-based environmental education program

This study explores a river education program designed for a class of fourth graders in a local school who participated in the place-based environmental education program for the first time in Autumn 2022. Named "Exploration and Understanding of Rivers," the program was conducted from October to November 2022, consisting of five weekly sessions. The main objective was to enhance students' cognitive understanding and affective affinity with the river flowing through their locality and to cultivate empathy towards other organisms inhabiting the river. To achieve this goal, the program not only provided basic knowledge about the stream organisms and river-community relations but also focused on developing students' observational skills, encouraged their active learning and exposure to rivers, and concluded with an empathic perspective-taking activity.

Two features of this program design were influenced by previous studies. Firstly, the incorporation of outdoor learning, commonly found in other place-based environmental education programs (Smith, 2000; Semken & Freeman, 2008; Cincera *et al.*, 2015). Research has indicated that outdoor exploration plays a significant role in fostering place attachment in children (Lim & Barton, 2010; Morgan, 2010). This aligns with Chawla's (2007) observation that environmentalists often reminisce about early childhood experiences where they were allowed to freely explore and engage with natural environments. Therefore, increasing students' exposure to the local stream is presumed to be crucial in fostering their attachment to the natural environment of the area.

The second feature is an empathic perspective-taking activity during the last session, encouraging students to consider the perspective of other beings for class discussions. Researchers argue that empathic perspective-taking activities help induce empathy (Batson, Chang, Orr, & Rowland, 2002), leading to improved environmental concern and awareness (Bragg, 1996; Schultz, 2000; Berenguer, 2007). Thus, it is expected that through this activity, students will develop more concern for other beings living in their locality. The study will examine whether students can effectively follow the instructions to advocate for other beings in this activity.

The five sessions included three indoor sessions and two outdoor sessions, each focused on a topic decided by the teacher (see Table 1). The first indoor lesson introduced basic knowledge about water organisms and basic observation skills. The teacher prompted students to consider organisms living near or in water, discussing their habitats, physical characteristics, and behaviors. Various observation tools were displayed, and students guessed their uses, including trapping tools (fish traps and nets, shrimp traps, brushes, and tweezers), containers (water dishes, jars, wet towels), observation tools (goggles, water scopes, magnifying glasses), and measurement tools (rulers, coins, cameras, pens, paper). The assigned homework was to choose one stream organism or object to draw and gather information on its appearance, characteristics, habitats, food sources, and its relationships with other organisms.

The second lesson was an outdoor activity focusing on water flow in the old street, followed by river organism observation. Students walked along the old street to the designated section of the stream. Along the way to the river, the teacher introduced the source of tap water from the river and guided them to the drainpipe flowing into the river. By explaining how their daily water usage comes from the river and returns to it, the teacher directed students to understand the interdependent relationship between the community and the river. Upon arriving at "Xia Kengzi Kou (下坑子口)," they reviewed the observation tools and practiced observing and recording organisms in five traps placed previously. Despite most students being local residents, many were surprised and curious to see stream organisms in observation boxes.

After outdoor observation, the third lesson in the classroom explained the relationship between trapped organisms and the stream. Each student introduced one stream organism from their homework. The teacher guided a review of the outdoor observations, noting impact of trap locations. For instance, traps in rapid flows yielded no findings, while slow-flow traps found different fish sizes at various depths. Other local stream fishes, organisms, and insects as water quality indicators were introduced. Students were then asked to draw one stream

Table 1. Contents of the Pinglin-based environmental education program: exploration and understanding of the river

Lesson topic	Date	Contents
Session 1 Who Lives with Water?	10/13	Introduction to water organisms, observation, and recording methods, and the tools required
Session 2 Walking Along the Water to Look for River Residents	10/20	Walked along the drainpipe system of the old street to the "Xia Kengzi Kou" section of the river, introducing water sources from the river and waste water flowing into the river. At the river, the teacher introduced different river environments. Students observed and recorded the water organisms and non-living things found in the area
Session 3 The River Water Community	10/27	Students shared their homework and introduced the characteristics of the water organisms they had selected, along with their preferred habitats. Together, they created a map of the water community. Recommended resources for further exploration were provided
Session 4 Stories That Flow into the Sea (Field Trip to the Downstream Area)	11/17	Visited Tamsui to view the completed cyanotype products made by the students. Also, visited "Chengshi Old House" and "Cloud Gate" to observe the different appearances of the river downstream, as well as how downstream residents utilize the water source
Session 5 Public Hearing in the River Water Community	11/24	Observed the water bodies in different areas and reviewed the Tamsui field trip from the previous week. Building on the 3rd session's homework, students assumed the roles of various organisms/non-living things in the "Xia Kengzi Kou" section of the river. They proposed ideas for different stream management plans from the perspectives of these different beings

Source(s): Table by authors

organism or non-living being on a sticky note and place it on an appropriate location on the stream map drawn on the whiteboard. Homework involved a simulated river community public hearing for the last lesson.

After three weeks centered on the upstream home place, the fourth-week lesson explored downstream river areas. They visited downstream Tamsui (淡水), a local old house, and nearby irrigation canals impacted by urbanization. They also visited the Tamsui Historical Museum to see the exhibition of their cyanotype artwork about upstream stories, created together in a previous education program. Seeing their artwork exhibited made students realize the importance of documenting home stories and contributing to public understanding of the upstream area. They brought back a bottle of downstream Tamsui River water for the next lesson.

In the last lesson, students first described the differences among three water bodies from the downstream Tamsui area: river water, well water, and canal water, using observations and smell. The second part, also the main activity, involved the simulated river community public hearing homework. Students were asked to temporarily take on the roles of other stream beings during the hearing for redesigning the stream landscape. The teacher encouraged all students to think and express their opinions from the perspectives of the roles they played. Four river redesigning plans were provided by the teacher, and students voted for their preferred one and explained their reasons. The teacher then explained how each redesigning plan could affect different types of river beings and encouraged students to provide new possible better plans and explained why. With the teacher's guidance and reminders, most students were able to describe the environment their roles preferred and gave opinions for modifying the chosen plans.

Overall, this program aimed to enhance students' understanding and affinity with the river's natural environment and nurture empathy towards river beings. Students are expected to acquire knowledge about this river, recognize its interdependency with the community, and form an affinity with river organisms. Knowledge teaching helped them understand the river ecosystem and river beings' needs; guidance on community water sources and drainpipes showed them how the community and river environment mutually affect each other; outdoor observations increased their exploration of the local stream and motivation to learn by themselves; and the empathic perspective-taking activity encouraged them to step out of their egocentric selves and speak for other beings.

4. Measurements

A questionnaire was designed to measure students' place attachment, pro-environmental behavioral intentions, and life experiences (see Table 2). Place attachment and life experiences were measured before and after the education program, while willingness to engage in pro-environmental behavior was measured only after the education program. The target group consisted of 20 fourth-grade students who participated in this education program, with all but one student residing in the Pinglin area. We were unable to have a larger sample size or a control group, as this class was the only one in the school, which was also the sole educational institution in the area.

To assess students' attachment to the river, we referred to a long-term survey of residents' attitudes and attachment to a river by Gao *et al.* (2018). From there, we selected six items representing different dimensions, i.e. two for cognitive dimension (item 5 and 6) and three for affective dimension (item 1, 2, and 4), as well as one for instrumentality (item 3). Considering the local conditions in the area, we developed six question items to evaluate students' pro-environmental behavioral intentions and four question items to measure their life experiences. The behavioral intention items are adapted from commonly used items in previous studies. Considering students' age and limitations, we selected commonly used items such as talking to

Table 2. Questionnaire design

Place attachment items
1. The Beishi river is important to me
2. The Beishi river is a symbol of the region
3. I like outdoor activities, but I don't recreate along the Beishi river
4. I like having a river in town
5. I don't know a whole lot about what the Beishi river provides to our community or myself
6. I don't know very much about the natural processes of the Beishi river
*All cited from Gao *et al.* (2018)
Behavior intention items
1. I talk with people around me on environmental matters
2. I talk with people around me on environmental matters about Beishi river
3. I participate in environmental protection activities such as beach cleaning, litter picking, removing invasive species, planting trees, and so on
4. If I see trash on the riverbank or in the river, I will pick it up
5. I search for knowledge related to the environment of the Beishi River on the internet or in books
*Items cited and adapted from Kaiser (1998), Kaiser and Wilson (2000), Vaske and Kobrin (2001), Scannell and Gifford (2010), Ugulu *et al.* (2013), Larson *et al.* (2015), Rees *et al.* (2015), Tonge *et al.* (2015), Musser and Malkus (1994), Walker and Chapman (2003), Stevenson *et al.* (2014)
Life experience items
1. I go dabble in the Beishi river with families
2. I go dabble in the Beishi river with friends
3. My parents teach me knowledge and history about the Beishi river
4. School teachers teach me knowledge and history about the Beishi river
Source(s): Table by authors

others about environmental issues (item 1 and 2) (Kaiser, 1998; Kaiser & Wilson, 2000; Vaske & Kobrin, 2001; Scannell & Gifford, 2010; Ugulu, Sahin, & Baslar, 2013; Larson, Stedman, Cooper, & Decker, 2015), picking up litters left by others (item 4) (Musser & Malkus, 1994; Walker & Chapman, 2003; Tonge, Ryan, Moore, & Beckley, 2015), active learning (item 5) (Stevenson *et al.*, 2014; Tonge *et al.*, 2015), and attending pro-environmental activities (item 3) (Rees, Klug, & Bamberg, 2015; Tonge *et al.*, 2015). In items that include a "place" statement, the term "place" refers to the Beishi River, the mainstream flowing through this area.

During both pre and post surveys, students were provided with instructions for responding to the questionnaire. All items were designed to be rated on a 7-point scale, where respondents could choose from point one (strongly disagree) to point seven (strongly agree). We calculated students' scores based on the points they chose for each item. However, for items with negative statements, such as items 3, 5, and 6 for place attachment, the original scores were reversed before calculation.

The questionnaire survey adhered to the Belmont principles and international ethical standards (U.S. Department of Health and Human Services, 1979). It did not target vulnerable or disadvantaged populations, and there were no financial affiliations or conflicts of interest between the participating students and the experimenters. In accordance with ethical principles, the experimenters provided clear and comprehensive explanations regarding the survey's objectives, procedures, and estimated duration. Participants were also explicitly informed of their right to withdraw or skip any question without prejudice. The survey was designed to avoid collecting personally identifiable information, such as names or video and audio data, and involved no deceptive interventions. All questions adhered to ordinary social discourse, ensuring participants encountered nothing beyond the scope of routine ethical interaction.

5. Analysis methods

First, we identified items of place attachment that explained students' pro-environmental behavioral intentions. We examined the Pearson correlation coefficients (r) between each place attachment item and the mean of all behavioral intention items. Because r values can be strongly affected by outliers, we calculated 90% bootstrapping confidence intervals of r to examine the stability of the correlation (Komatsu & Rappleye, 2017a, b). The decision to use a 90% confidence level was guided by the constraint of our limited sample size.

Next, we analyzed the change in place attachment before and after the education program, using only the place attachment items identified in the previous step. The change was assessed using Glass's delta, which is a measure of effect size proposed by Glass, McGaw, and Smith (1981). The effect size was calculated by subtracting the mean score of the pre survey from the mean of post survey, and then dividing it by the standard deviation of the pre survey. To understand the magnitude of the increase in place attachment, we compared Glass's delta for this study with those from previous similar studies (Semken & Freeman, 2008; Kudryavtsev *et al.*, 2012; Cincera *et al.*, 2015).

Additionally, we conducted supplementary analyses to examine the relationships between life experience and place attachment, aiming to discern patterns among those whose place attachment was more substantially enhanced. Our hypothesis posited a positive correlation between life experience and place attachment before the education program, aligning with findings from previous studies (Hinds & Sparks, 2008; Cudworth & Lumber, 2021). The focal point of our analysis was the examination of whether the education program effectively augmented place attachment for students with limited prior experience with the river, thereby mitigating disparities in place attachment among students.

It is essential to note that our analysis focused on relationships and differences without resorting to hypothesis testing. We recognize that statistical significance does not always translate to practical significance. In a context where sample sizes are sufficiently large, even a

very weak relationship or a minimal difference can attain statistical significance. This concern has been acknowledged by eminent statisticians (e.g. Berkson, 1938) and has regained attention in recent years (Thompson, 2002; Komatsu & Rappleye, 2017a, b; Edwards, 2018). Therefore, instead of emphasizing statistical significance, we advocate reporting effect sizes such as *r* and Glass's delta (Thompson, 2002; Komatsu & Rappleye, 2017a, b).

6. Results

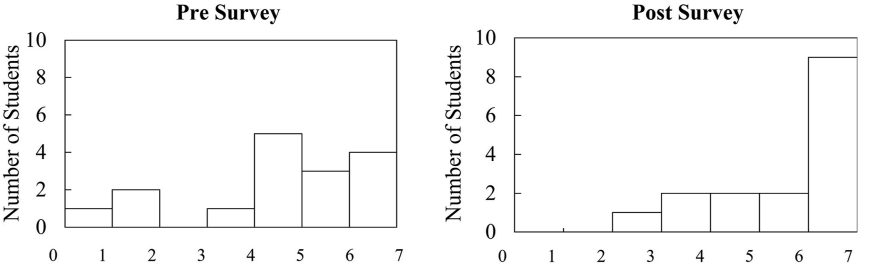
The first and second place attachment items representing the affective dimension (#1 and #2 in Table 2) were moderately correlated with the mean score of all behavioral intention items (see Table 3). The other items, especially those representing the cognitive dimension (#5 and #6 in Table 2), were poorly correlated with behavioral items. The correlation coefficients for the first and second items were comparable to those found in studies examining the relationships between place attachment and behavioral items (Junot *et al.*, 2018; Mullendore, Ulrich-Schad, & Prokopy, 2015; Ramkissoon *et al.*, 2013; Scannell & Gifford, 2010). The two items were moderately correlated ($r = 0.48$), indicating that these two items measured approximately the same phenomenon. We thus decided to use these two items for calculating place attachment in the following analyses.

Figure 1 shows the frequency distributions of students' place attachment before and after the education program. Students' place attachment scores were widely distributed before the

Table 3. Correlation coefficients between individual item of place attachment and items of behavioral intentions

Place attachment items	Correlation coefficients with behavior items	90% bootstrapping confidence intervals
1. The Beishi river is important to me	0.67	[0.930, 0.404]
2. The Beishi river is a symbol of the region	0.49	[0.972, 0.001]
3. I like outdoor activities, but I don't recreate along the Beishi river	0.30	[0.698, −0.092]
4. I like having a river in town	0.21	[0.861, −0.450]
5. I don't know a whole lot about what the Beishi river provides to our community or myself	−0.05	[0.370, −0.469]
6. I don't know very much about the natural processes of the Beishi river	0.19	[0.671, −0.284]

Source(s): Table by authors



Source(s): Figure by authors

Figure 1. Distribution of average score of item 1 and item 2 in both surveys

education program. After the education program, the number of students in the highest place attachment level increased, whereas those in the lowest place attachment level decreased. This suggests a large increase in place attachment for those with low place attachment before the survey (see the next paragraph). The mean (SD) place attachment score was 4.70 (1.95) before the education program and 5.78 (1.51) after the education program. The Glass's delta was calculated to be 0.56. This delta value was comparable to or greater than those from previous studies, indicating the effectiveness of the education program (Table 4).

Table 4. Different place-based environmental education program in previous studies and the glass' delta

	Pinglin, Taiwan (this study)	Arizona (Semken & Freeman, 2008)	Bronx (Kudryavtsev *et al.*, 2012)	Czech (Cincera *et al.*, 2015)
Place name	The Beishi River	Arizona	Bronx	Respondents' own community
Education program contents	Pinglin-based environmental education program: Exploration and Understanding of the River - Session: 3 indoor, 2 outdoor - Activities • Introduce river organisms and observation methods • Conduct outdoor river observations and explorations • Explain river organisms' needs and relationships • Field trip to a downstream town • Perspective-taking activities	Experimental Arizona-based geology course (Adapted from indigenous framework) - Modules: 12 covering geology, hydrology, climate, and environmental quality relevant to Arizona - Activities • Discuss the beauty and scientific significance of Arizona sites • Analyze local case studies and their importance • Three 2-h field trip to nearby parks	Urban environmental education program: Bronx River watershed - Activities • Environmental stewardship • Recreation • Environmental monitoring Trainings and workshop	"The Roots" environmental education program combines a community-based project and provides residential stay in an outdoor center in a natural area, including activities - Features: Community-based projects and residential stay at an outdoor center - Activities • 5–6 sensory sharpening activities • Campfire, theater show, and adventure-themed activities • Three interpretative walks (4–8 km) focused on regional features • Post-program community project interpreting their local area
Duration	5 weekly sessions (Oct-Nov 2022), 2 hours each	Fall semester 2005	5–6 weeks (Summer 2010), Monday-Friday, 24 hours/week	2.5-day residential stay
Survey respondents	16 fourth-grade students (ages 9–10)	27 of 31 enrolled university students	63 urban high school students (average age 15, most from Bronx	158 respondents (mean age 12.9)
Glass's delta	*0.54*	*0.40*	*0.14*	*0.23*

Source(s): Table by authors

We observed a positive correlation ($r = 0.65$ with the 90% confidence interval of [0.937, 0.360]) between students' life experiences and place attachment before the education program. However, this correlation disappeared after the education program ($r = 0.19$ with the 90% confidence interval of [0.582, −0.204]). This was primarily due to the relatively large increase in place attachment for students with low life experience scores (Figure 2). The education program seemed to act as a replacement for life experience in enhancing their affinity towards the place.

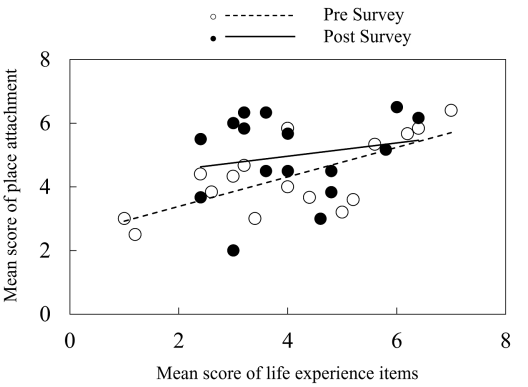
7. Discussion and conclusion

7.1 Effectiveness of the education program

This study demonstrates the effectiveness of the environmental education program in Pinglin in fostering students' place attachment. Despite comparable timeframes with other programs (Table 4), the observed increase in students' place attachment was comparable to or even greater than outcomes from other programs. The quantitative measures employed underscore the program's success, making it a noteworthy model for educators, particularly in the contexts of Taiwan and East Asia. It is arguably the sole program supported by quantitative measures in the region. While we caution against direct replication in different locales, as local context remains a cornerstone of place-based education, the other programs in Table 4 also serve as inspirational starting points for educators seeking to design their own programs.

A noteworthy finding was the substantial increase in place attachment among children with limited prior river-related life experiences, suggesting the program served as a substitute for such experiences in terms of enhancing their attachment to the place. Notably, the scarcity of nature exposure is considered a major obstacle to enhancing pro-environmental behaviors (Martin *et al.*, 2020; Soga & Gaston, 2024). Recognizing the well-established correlation between childhood experiences in nature and pro-environmental behavior in adulthood (Evans, Otto, & Kaiser, 2018; Rosa, Profice, & Collado, 2018; Collado & Evans, 2019), our results underscore the potential of place-based education to enhance place attachment among students with minimal exposure to nature. Nonetheless, the long-term durability of these effects needs further investigation (see Liefländer, Fröhlich, Bogner, & Schultz, 2013 for a related discussion).

Readers might be concerned about the robustness of our results due to the limited sample size. We acknowledge this concern; however, increasing the sample size was not feasible as



Note(s): The regression lines were determined using the least-squares method
Source(s): Figure by authors

Figure 2. Distribution of each student's mean score of place attachment and life experience in pre and post surveys

this study encompassed all available students in the only fourth-grade class. We recommend that future studies investigate whether similar results can be observed in other schools located in different rural areas of Taiwan. Comparing the results of such studies would facilitate the examination of the generalizability of our findings.

Despite its success in improving place attachment, this place-based river environmental education program has several limitations. First, this program mostly conveys river ecosystem knowledge, centering on the cognitive rather than the affective dimensions of place attachment. Only one session of an empathic perspective-taking activity specifically aimed to foster students' empathy towards river beings. However, the result of our analysis shows that items of affective dimension (#1 and #2 in Table 2) correlated more strongly with pro-environmental behavioral intentions than cognitive items (#5 and #6 in Table 2) (See Table 3). We thus suggest that future environmental education program designs should include more activities addressing the affective dimension of attachment.

Second, primarily due to time constraints, this education program did not provide activities to teach students social, historical, and cultural connections between the community and the river. The education program focused mainly on river ecological knowledge from a natural science perspective. Social, historical, and cultural connections between the community and the river were briefly mentioned sporadically. This limitation should be addressed in future education programs. Fortunately, the program designer has plans for education programs for the following semesters, in which students are expected to explore the history of the river and community from local elders' memories and to write folktales and stories of river gods by their creativity. The results of this study suggest this could potentially enhance educational outcomes.

7.2 Potential factors behind the increase in place attachment

Due to the limited number of previous studies, our comparative analysis does not allow us to identify the factors explaining the effectiveness of our education program. Previous studies have suggested many factors influencing place-based environmental education outcomes (e.g. scale and characteristics of places, curriculum, class size, instructor enthusiasm, pedagogical approach, participants' demographics, length of residency, and involvement in community-based projects) (Semken & Freeman, 2008; Kudryavtsev *et al.*, 2012; Cincera *et al.*, 2015). However, the relative importance of these different factors has not been examined primarily due to the limited number of studies.

Here, we discuss three factors potentially related to the effectiveness of our education program: (1) the scale of the place, (2) perspective-taking activities, and (3) an interdependent orientation of Taiwanese culture. First, this program focused on a small local stream, the Beishi River, unlike other programs addressing larger areas such as Arizona (Semken & Freeman, 2008), or the urban Bronx (Kudryavtsev *et al.*, 2012). The curriculum of our program focused on the nature of a local stream flowing through the community, and students' attachment was measured specifically to this stream. As Kudryavtsev *et al.* (2012) surmised, education programs highlighting a smaller scale may be more successful in strengthening place attachment, consistent with our findings.

Second, the course contents included perspective-taking activities absent in other education programs (Table 4). While studies have not specifically examined their impact on place attachment, research suggests that perspective-taking activities affect recipients' inner being by expanding their sense of self to include other beings (Bragg, 1996; Mayer & Frantz, 2004). The more people feel interconnected with other beings, the more they grow environmental concerns towards the biosphere (Schultz, 2000), and enhance empathy, leading to more positive attitudes and motivation for protective actions (Batson *et al.*, 2002; Berenguer, 2007). During the empathic perspective-taking activity, each student took the perspective of one river organism or non-organism, such as shrimp, fish, insects, and river stones, and explained how it relies on others for food and suitable habitats. Students chose to be spokespersons of shrimp,

fish, insects, and even river stones. This exercise highlighted the interdependency within the river ecosystem and encouraged students to consider the perspectives of river beings when designing river landscapes. After discussing the potential impacts of various plans, students proposed new designs, justifying their benefits for both humans and river life. This process fostered students' empathy towards river beings and prompted reflection on the influences of artificial river changes. The post survey indicates that students' enhanced attachment to the stream may result from their increased environmental concern developed through these empathic perspectives.

Third, culture and religion in Taiwan might have laid the foundation for nurturing students' sense of interdependence with nature and other beings. Those in East Asia tend to have an interdependent orientation, which contrasts with the independent orientation prevalent in Western countries (Komatsu *et al.*, 2019; Hofstede, Hofstede, & Minkov, 2010; Nisbett, 2003). Such an interdependent orientation may be partly due to Taiwan's Daoist tradition, which emphasizes interdependence with the spirits of lands, stones, and trees. Pinglin, our study site, has preserved Daoist tradition, which may partly explain the success of the education program in increasing place attachment. We recommend that future studies explore the impact of similar educational programs on place attachment in non-Western countries where an interdependent orientation is prevalent. If such studies observe considerable increases in place attachment, it would suggest that the interdependent orientation of these cultures plays a crucial role in the success of place attachment educational programs. Additionally, this would enable the development of place-based education programs specifically tailored for non-Western countries. This endeavor is vital, given that place-based education research has predominantly been conducted in Western country contexts.

To understand the relative importance of different factors, we propose that researchers accumulate more case studies on the impact of place-based environmental education programs on place attachment. Unfortunately, among numerous place-based environmental education programs, very few assess changes in place attachment before and after the programs (Semken & Freeman, 2008; Kudryavtsev *et al.*, 2012; Kuwahara, 2013; Cincera *et al.*, 2015; Lee & Chiang, 2016). Conducting such assessments will allow us to compare the effectiveness of different programs and eventually conduct a meta-analysis to understand the relative importance of different factors.

7.3 Methodological contribution of this study

To accumulate more cases, this study makes a significant methodological contribution by expanding the scope of place-attachment measurements to include fourth-graders. Previous research has posited age as a crucial factor influencing changes in place attachment resulting from educational programs (Chawla, 1992; Sobel, 1997; Jack, 2010; Shabak *et al.*, 2015). The conventional belief is that the impact of such programs on place attachment is more pronounced and enduring when introduced at an early age (see Liefländer *et al.*, 2013 for a related discussion). However, the majority of previous studies have predominantly focused on assessing place attachment among adults and teenagers, with limited exploration of its applicability to young children (Semken & Freeman, 2008; Kudryavtsev *et al.*, 2012; Severcan, 2015; Lee & Chiang, 2016).

In contrast, our study has demonstrated the applicability of place-attachment measurements to children at ages 9–10, a demographic underexplored in previous studies. The results of our investigation underscore the viability of utilizing place-attachment assessments in this age group, providing valuable insights into the developmental nuances of attachment to place during early stages of education. This novel application of place-attachment measurements not only enriches the current understanding of environmental education's impact but also encourages broader applications of place-attachment measurements, thereby contributing to the burgeoning body of case studies in this domain.

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