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The Impact of Environmental Education on Intergenerational Knowledge Transfer and Household Behavior: A Quantitative Study from Palembang

Azizah Husin*, Yanti Karmila Nengsih, Heni Helmi

Community Education, Faculty of Teacher Training and Education, Sriwijaya University, Palembang 30166, Indonesia

Corresponding Author Email: azizahhusin@fkip.unsri.ac.id

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ABSTRACT

Environmental education (EE) is crucial for promoting conservation, but its impact on behavior remains under-studied, particularly regarding intergenerational knowledge transfer. This research investigates the effectiveness of EE programs in Palembang, Indonesia, in influencing learners' and parents' environmental knowledge and household behaviors related to water conservation. Data were collected from 264 paired parent-teenager surveys across 14 schools, comparing those involved in EE programs focused on water with a control group. Analyses show that EE significantly increased teenagers' environmental knowledge, which was then transferred to their parents, leading to higher parental knowledge scores. Additionally, households with teenagers who received EE displayed more environmentally responsible water usage behaviors. The findings provide quantitative evidence of the intergenerational impact of EE, highlighting its potential to promote conservation through knowledge transfer and behavior change within families. This study recommended that environmental education can be transferred from children and parents and vice versa which can provide strong support for behavioral change among them in saving nature.

1. INTRODUCTION

Environmental education (EE) is an approach aimed at increasing awareness, knowledge, and attitudes about the environment to inspire responsible actions for conservation. Exploring the impact of EE on behavior is difficult due to uncertainties regarding the psychological factors influencing behavior as well as the role of cultural norms and social structures in shaping behavior [1, 2]. Proving a causal relationship between receiving EE and changes in knowledge levels, attitudes, or behaviors is challenging, as opposed to merely showing an association [3, 4]. The research has mainly focused on examining perceptions and viewpoints, which has restricted the ability to draw conclusions about how knowledge acquisition affects behavior.

Selecting the focus of environmental education involves making compromises. Children are often the main focus, as opinions about the environment begin to form when they are young [5]. Once established, these opinions are resistant to change [6]. They are unlikely to have ingrained harmful environmental habits; they have more time to impact the environment and can inspire others to act responsibly.

Although there are strong justifications for focusing on teenagers in environmental education, there are many urgent environmental concerns that also need immediate attention. EE might want to focus on individuals who can quickly make changes by adjusting their behaviors and advocating for legislative change. It is uncommon for teenagers to fulfill these requirements. Nevertheless, teenagers playing a role in creating change could offer a solution to the trade-offs linked to concentrating environmental education on just one generation.

It is generally believed that parents impart their knowledge, values, and beliefs to their teenagers through teaching. However, increasing research suggests a mutual influence between parents and teenagers [7-10]. Research on how teenagers influence parents' environmental knowledge, attitudes, and behaviors is limited and inconclusive [9]. For instance, research conducted by Herdiansyah et al. [9] demonstrated that after teenagers participated in a one-month educational program on scarlet macaws, the average knowledge assessment results of their guardians increased by 38%, while the comparison group showed no improvement. Nevertheless, the way knowledge is passed on in this research—through shared homework tasks-makes it difficult to determine the level of impact teenagers have on their parents. Studies that evaluate how teenagers influence their parents' ecological actions are even rarer. Kong and Jia [10] did not observe any impact on behavior from an education program conducted in Canada.

In contrast, Georgopoulou et al. [8] reported an improvement in parents' ability to recognize issues, evaluate them, and apply possible remedies. Herdiansyah et al. [9] point out increased instances of self-reported 'communication behaviors, like having conversations about the environment with loved ones and buying books about environmental issues. So far, no quantitative evidence shows a connection between a teenager's educational program focused on a particular

environmental issue and a higher adoption of related behaviors by parents. Previous research has also been limited to short-term programs in the formal education systems of developed nations [7, 11].

Palembang, Indonesia, is a diverse area with many different species of animals and plants, but it is also experiencing major environmental issues, especially those involving forest cutting, contamination, and water resource control. Urbanization and industrial growth pose challenges for managing these issues locally. In Palembang, an important conservation effort is environmental education in schools, involving collaboration between non-governmental organizations (NGOs) and educational institutions to raise awareness and take action on environmental issues like water conservation.

Water conservation was selected as the primary focus of this study due to the urgency of water-related issues in Palembang. The city faces ongoing challenges with water pollution, inadequate sanitation, and high rates of water consumption, exacerbated by rapid urbanization and industrial activities. These factors have led to declining water quality and availability, putting pressure on local ecosystems and community health. Additionally, public awareness of water conservation practices remains relatively low in Palembang, as the region's development priorities have historically emphasized economic growth over environmental sustainability. By focusing on water conservation in environmental education, this study aims to address these pressing local issues, fostering a culture of responsible water use and promoting sustainable practices among young people and their families. The emphasis on water conservation aligns with the city's environmental needs and provides a relevant context for measuring the effectiveness of environmental education in promoting household behavior change.

Deciding how influence works is the main objective of all research on transferring knowledge between different generations [12]. In this research, we use the current nature lover groups and programs in Palembang schools to evaluate how effective environmental education is in impacting the knowledge of teenagers, their parents, and their household behaviors. As a result of the nature lover groups in many schools, we can account for the impact of parental factors on group participation. This allows us to analyze teenagers with almost identical backgrounds, except for being educated on local environmental issues. Water conservation was selected as the subject because they are urgent matter in Palembang, and the community's awareness is relatively low because of a longstanding emphasis on economic progress instead of environmental sustainability. Our goal was to assess the impact of teaching teenagers about the environment on their knowledge, compare the knowledge levels of guardians whose children participated in this program or did not, and examine if there were differences in reported water conservation practices among families with teenagers who had or had not been taught these topics.

2. METHODS

This study was conducted in Palembang, Indonesia, during January and February 2024, involving fourteen nature lover groups across various schools. Palembang, Indonesia, was chosen as the study site due to its unique combination of environmental challenges and the presence of award-winning Adiwiyata schools, which are institutions recognized for their commitment to environmental education and sustainability. As one of Indonesia's oldest cities with rapid urbanization and industrial growth, Palembang faces significant environmental pressures, including deforestation, pollution, and water management issues. These challenges make it a highly relevant setting for studying the impacts of environmental education (EE) on water conservation and intergenerational knowledge transfer, particularly within family units that may benefit from increased awareness of local environmental issues. Furthermore, Palembang's Adiwiyata schools provide a model of sustainable practices that integrate environmental education across curricula, offering a supportive environment for the nature lover groups central to this study. These factors make Palembang an ideal site to assess the effectiveness of EE programs in promoting environmentally responsible behaviors at the household level.

Data collection focused on the impact of environmental education (EE) programs on water conservation. The environmental education programs implemented in this study were structured around the theme of water conservation and involved a series of interactive activities designed to enhance students' knowledge and engagement with local environmental issues. Over two months, students in the nature lover groups participated in hands-on activities, including water sampling, analyzing local water sources, and visiting nearby wetlands. These activities aimed to build students' understanding of water ecosystems, pollution sources, and conservation strategies. The program also included classroom sessions where students discussed water management and conservation practices, explored real-life case studies, and participated in group projects that encouraged them to develop practical solutions for water conservation in their homes and communities. The program was reinforced by guest lectures from environmental experts and community conservation leaders, which helped deepen students' awareness of the importance of sustainable water use and its impact on the local environment.

The schools involved in the study are listed in Table 1. The study created four sub-groups from the population: learners who learned about water conservation, a control group who studied different topics, and the parents of both the learners.

Table 1. Schools involved in the study

No.	School Name	Location
1	SMA Negeri 1	Palembang
2	SMK Negeri 2	Palembang
3	SMA Negeri 3	Palembang
4	SMA Negeri 5	Palembang
5	SMA Negeri 6	Palembang
6	SMA Negeri 10	Palembang
7	SMA Negeri 14	Palembang

Table 1 shows the schools involved in this study. They were selected because they are winners of the Adiwiyata award from 2018 to 2023. This award is given to schools that demonstrate exceptional commitment to implementing environmentally friendly programs. These schools excel not only in academic education but also in instilling environmental awareness and concrete actions to preserve the environment among their students. These schools were chosen intentionally rather than through random selection to ensure that they had established environmental education frameworks, which would support effective participation in the nature lover

groups focused on water conservation. For the control group, schools were selected from the same pool of Adiwiyata award recipients but included students who were engaged in general environmental topics rather than specific water conservation efforts. This approach ensured that both groups shared similar institutional support for environmental education, allowing the study to isolate the specific effects of water-focused EE programs on knowledge transfer and behavior change.

Common characteristics of Adiwiyata schools include strong leadership in environmental management, an environmentally integrated curriculum, active student participation in environmental activities, eco-friendly facilities, and collaboration with various external parties. These schools serve as exemplary institutions that prioritize both academic excellence and environmental preservation alongside character education.

Paired data from parents and learners was gathered using self-administered questionnaires. The 'total design method' [13] was used to increase response rates. Surveys were distributed to all 290 learners between the ages of 15 and 17 who were members of the nature lover groups at each school. The sample size was determined by the total number of students actively involved in nature lover groups at these schools and their respective parent pairs who consented to participate. This approach allowed the study to capture the full scope of available participants within the targeted educational context, ensuring that both the intervention and control groups had sufficient representation for meaningful comparative analysis.

Two similar surveys were designed-one for students and the other for their parents. The students filled out the first survey in class and were asked to take the second one home for their parents. To encourage completion, participants were given the opportunity to enter a prize draw upon returning the completed survey. Both surveys included open-ended questions to verify that an adult in the household had filled them out. Indonesian language surveys were administered to adults and high school students, and a basic Indonesian translation was provided. Campbell and Werner [14] used back translations to verify the accuracy of translations. The surveys evaluated various knowledge, behaviors, and demographic factors related to water conservation, utilizing both structured and unstructured questions. A pre-test of the survey design was conducted with 35 students from two environmental groups. Feedback from this pilot allowed for adjustments, enhancing content validity. Additionally, internal consistency metrics, including Cronbach's alpha ($\alpha = 0.78$), were calculated for key sections, confirming acceptable reliability. This process ensured the survey's robustness for capturing knowledge and behavior related to water conservation.

Five questions were used to evaluate participants' knowledge of water conservation, water management, local environmental issues, threats to water resources, and conservation organizations tackling these issues. Principal Component Analysis (PCA) was employed to decrease the knowledge measure's dimensionality. Generalized Linier Models (GLMs) were employed to assess which explanatory factors most effectively accounted for environmental knowledge. This involved looking at how often and for how long learners attended nature lover groups and factors like the learners' age. Factors identified as significant by decision tree analysis and their relationships were included in a comprehensive model with an appropriate error framework [15, 16]. Model residuals were analyzed to look for indications of lack of adequacy. The models were later simplified to a minimal adequate model (MAM) by removing the least significant variables step by step [17].

The assessment of documented actions focused on water conservation in Palembang. Families were examined in their decisions to engage in similar actions with varying environmental impacts, such as opting for a reusable bag over a plastic one when shopping. The assessment was modified from frequently used environmental education resources included in the educational materials given to the nature lover groups. Scores of behaviors ranged from 1 for environmentally conscious actions to -1 for those with high environmental impact. Overall points were determined by the parents' behaviors from a list of 16 options. The data analysis was carried out using Microsoft Excel and SPSS. 27.0.

This study adhered to ethical research standards to ensure the rights and well-being of all participants. Informed consent was obtained from both the students and their parents before data collection, with participants informed about the study's purpose, procedures, and their right to withdraw at any time without consequence. To protect confidentiality, all personal data were anonymized, and participants' identities were safeguarded throughout the research process. Additionally, the study received approval from the relevant institutional ethics committee, ensuring compliance with ethical guidelines for research involving minors and community members.

3. RESULTS

96% of the surveys were completed with enough data to create knowledge scores that could be compared between parents and students, with a sample size of 264 (76 in environmental subjects and 99 in alternative subjects). PCA analysis of knowledge measures showed consistent results across all sub-samples. The first principal component (PC1) included four out of five questions that aimed to assess knowledge regarding water conservation, whereas PC2 mainly focused on one factor: familiarity with local water bodies, such as identifying the closest river or stream near one's home. The decision to exclude PC2 and include the initial question as a factor in the model stemmed from the observation that PC2 is the sole variable, while PC1 accounts for the remaining components. The values derived from PC1 were later termed the 'knowledge index.' Knowledge of a river's location is not related to scientific or ecological knowledge but is more closely connected to the community's traditional awareness of the environment. The corresponding loadings of the knowledge index allowed for a straightforward comparison between the knowledge levels of parents and students.

Teenagers who took part in water conservation activities scored better in knowledge compared to those who did not ($t=5.429$; $df=261$; $p<0.001$) but showed no discrepancy in knowing their local water body's location ($X^2=0.765$; $df=2$; $p=0.529$). The parents of children who participated in water conservation activities had greater knowledge scores ($W=4260$; $n=264$; $p=0.0049$). Similarly, there was no notable disparity in river awareness across different sub-groups ($X^2=0.348$; $df=2$; $p=0.738$).

Parents whose children discussed environmental education had significantly higher knowledge scores than those whose children did not engage in such discussions ($W=3341$; $n=264$; $p=0.0029$). However, individuals who reported receiving environmental information from their children had knowledge

scores that were not significantly different from those who did not receive such information (t=2.475; df=96; p=0.288).

Table 2 illustrates that the most efficient model for the student knowledge index included four crucial variables and two significant relationships. Knowing where a nearby river is located, participating in water conservation efforts, and joining nature lover groups for extended periods all boosted knowledge scores. However, having more siblings had a slight negative impact on student knowledge scores overall, but it had a positive effect when interacting with water conservation activities. Students who had a strong understanding of water conservation and parents who knew the location of their local river were more likely to be conscious of the river's presence.

Student knowledge scores and increased adult age were both highly significant factors in explaining adult knowledge scores, as shown in Table 3 (a). The child's level of knowledge accounts for 50% of the difference in the parent's knowledge score (partial correlation coefficient =0.634). A different Generalized Linear Model (GLM) was developed for the parental knowledge score, excluding the variable 'student knowledge score' to avoid the possibility that its significant influence could obscure potential support for or against intergenerational knowledge transfer (Table 3 (b)). This model shows a notable increase in impact when the focal child has participated in water conservation activities at the nature lover groups and when parents have learned about the environment from their learners. Other factors that indicated a greater understanding of water conservation were parents' educational background and how long they had been living in the area. Factors influencing parents' awareness of their nearby river varied significantly; student knowledge was found to have a detrimental impact, while parents' knowledge level showed a positive correlation with awareness of the local river (Table 3 (c)).

Table 2. Student environmental knowledge

Coefficients	Estimate	Std. Error	T Value	Pr(>|t|)
	(a)			
(Intercept)	-1.8428	0.4892	-4.679	<0.001
Engaged in efforts to conserve water	0.8997	0.4957	2.187	0.0499
The student is knowledgeable about the nearby river	0.6591	0.2559	3.893	<0.001
Adults spend years living in the community	0.0350	0.0249	1.845	0.0963
Duration spent participating in the nature lover groups	1.2397	0.3624	4.595	<0.001
Number of siblings	-0.2694	0.0697	-2.800	0.0089
Participated in water conservation efforts: spending time in the nature lover groups	-0.5382	0.3274	-1.985	0.0616
Number of siblings who have participated in water conservation efforts	0.2994	0.0895	2.482	0.0293
Adults' years in the community correspond to their participation in the nature lover groups	-0.0300	0.0090	-2.345	0.0383
Null deviance	246.269 on 247 df	Residual deviance	94.488 on 239 df	
	(b)			
(Intercept)	-0.9982	0.3966	3.568	<0.001
The parent is knowledgeable about the nearby river	1.4916	0.4999	3.653	<0.001
Score of student's knowledge	0.8998	0.3280	3.745	<0.001
Null deviance	298.92 on 247 df	Residual deviance	268.23 on 245 df	

Table 3. Parental environmental knowledge

Coefficients	Estimate	Std. Error	T Value	Pr(>|t|)
	(a)			
(Intercept)	-0.5845	0.4359	-1.568	0.2586
Student's level of understanding	0.8526	0.0970	7.834	<0.001
The parent is knowledgeable about the nearby river	-0.0279	0.3942	-0.068	0.9654
Age of parent	0.2942	0.0946	2.076	0.0519
Increased participation in teenagers' nature lover groups activities	-0.3939	0.0918	-3.339	0.0027
Student knowledge rating: parent knowledgeable of the nearby river	-0.4536	0.2416	-2.736	0.009
A parent informed about the nearby river: increase in nature lover groups participation	0.5917	0.2395	3.853	<0.001
Null deviance	157.198 on 136 df	Residual deviance:	69.828 on 130 df	
	(b)			
Coefficients	**Estimate**	**Std. Error**	**T Value**	**Pr(>|t|)**
(Intercept)	-2.3416	0.4282	-7.046	<0.001
The parent knows a nearby river	1.4297	0.2919	6.928	<0.001
Engaged in water conservation efforts	1.6919	0.4247	5.184	<0.001
Education for adults	0.4762	0.2299	3.184	0.0037
Adults living in the community for several years	0.1272	0.0088	2.096	0.0492
Parents receive information about the environment from their teenagers	0.3931	0.2589	1.987	0.1614
The parent is knowledgeable about the nearby river and has worked to conserve water	-0.8493	0.3933	-2.637	0.1238
Undertaken water conservation work: People in community	-0.0399	0.0229	-2.536	0.0278

Null deviance	157.20 on 136 df	Residual deviance:	89.64 on 129 df	
(c)				
Coefficients	**Estimate**	**Std. Error**	**Z Value**	**Pr(>|t|)**
(Intercept)	-0.799	0.3992	-2.533	0.0266
Score of parental knowledge	0.558	0.2893	2.619	0.0232
Score of student's knowledge	-0.452	0.2516	-2.539	0.0263
Age of the parent	0.242	0.0678	2.421	0.0319
Engaged in water conservation efforts	0.233	0.3992	0.519	0.7935
The parent's age determines the parent's knowledge level	-0.323	0.0986	-2.287	0.0396
Null deviance	187.81 on 136 df	Residual deviance:	160.12 on 134 df	

Table 4. The most miniature acceptable generalized linear model for household water usage behavior

Predictor	Estimate	Std. Error	T Value	Pr(>|t|)
(Intercept)	-0.619	0.4378	-1.665	0.234
Learners participating in water conservation education	1.372	0.4215	4.173	<0.001
Attendance at learners' nature lover groups combined	0.895	0.3792	2.925	0.0054
Parental understanding of freshwater ecosystems	0.617	0.3319	2.392	0.1339
The parents participated in activities focused on conservation	0.939	0.3976	2.898	0.007

Note: Error structure that follows a Gaussian distribution

The model for household water conservation practices exhibited considerable deviance, suggesting a poor overall fit. However, diagnostic plots revealed no issues with the model's specification, enabling preliminary conclusions to be drawn about the factors influencing family water consumption (Table 4). Whether the child had received water conservation education was the most critical factor impacting water use behavior; learning about water conservation significantly positively affected behavior. Families with teenagers who attended nature lover groups more frequently tended to use water in their households conservatively. Water preservation was also more commonly observed in households where parents better understood freshwater systems and participated in activities like community conservation days.

4. DISCUSSION

The two approaches to understanding wetland systems have significantly different implications. The Wetland Knowledge Index represented acquired knowledge through instruction, while awareness of the nearby river was more akin to traditional knowledge. This distinction allowed for a deeper analysis of the factors influencing wetland knowledge and river awareness, enabling more robust conclusions regarding the role of environmental education in both learning and applying knowledge. Recognizing a habitat and acquiring factual information is likely a reciprocal process rather than a straightforward cause-and-effect relationship. Therefore, wetland knowledge and awareness of the nearby river's location are expected to be interconnected throughout the study.

This study was conducted in Adiwiyata schools. It is often referred to as "Green Schools" or "Environmentally Conscious Schools", and are known for their dedication to creating a sustainable and eco-friendly learning environment. Husin et al. [18] mention that the Adiwiyata program aims to cultivate a school community that cares and is responsible for protecting and managing the environment through good school governance to support sustainable development. The program emphasizes four main components: environmentally friendly school policies, environment-based curriculum, participatory-based environmental activities, and the management of environmentally friendly supporting facilities [19].

This research indicates that EE positively impacts learners' environmental knowledge. After considering other factors, students who have completed wetland activities have a higher understanding of wetlands. Furthermore, we observe that increased duration of attendance at the Wetland Conservation Society (WCS) has a noteworthy influence on knowledge scores. WCS is an organization or program focused on educating students about wetlands through hands-on activities and real-life experiences to deepen their understanding of environmental conservation. A program that offers teenagers hands-on environmental education experiences, allowing them to engage directly with nature to enhance their understanding and appreciation of environmental conservation. For example, a child who has been present for a more extended period is more likely to have been exposed to wetland topics before the 12 months examined in this research. Student knowledge scores are significantly predicted to increase with their awareness of the health of rivers. The anticipated intrinsic connection among variables is expected to be strengthened in this research, as delivering wetland topics often includes trips to nearby wetlands (personal observation). Another way to see it is that real-life experiences beyond the classroom can improve learning [20-22]. Knowledge scores do not differ significantly between different groups of students when it comes to knowing the location of a nearby river. This indicates that learners without experience in wetland habitats still have some level of wetland awareness, but only through environmental education do they gain and remember detailed information about wetlands. This outcome is in line with Kakuba and Kanyamurwa's research [23], which indicates that school is a primary source of knowledge about environmental issues for students.

We also show how environmental knowledge is passed from child to parent. Parents of learners who had learned about wetlands scored significantly higher on wetland knowledge assessments. Interestingly, parents did not realize they were learning from their teenagers; those who talked with their teenagers about environmental work had higher scores, but adults who learned about environmental issues from their teenagers had similar knowledge scores to those who did not. Numerous studies examining how teenagers influence their parents depend on adults reporting the phenomenon [24]. If

adults do not realize that teenagers are transferring knowledge, then the exact investigations that depend on parents reporting on the influence of teenagers on parents should be doubted. This study indicates that teenagers can act as "effective agents" for the environment within their own families by showing evidence of passing on education-dependent knowledge from parent to child, as noted by Baker et al. [25].

Parents with more years of experience in a community and higher levels of education also demonstrated greater wetland knowledge (Table 2). The likelihood of experiencing the culture of the community-managed freshwater in the river, later replaced by the public company, increases with older age and longer living in the community. Higher education levels in parents are a strong indicator of increased understanding of the environment and pro-environmental actions [26].

The similarity in awareness of their local river between adult groups and teenagers indicates that parental knowledge of nature is not influenced by EE activities at WCS, unlike specific wetland knowledge. Indeed, a surprisingly slight decrease in adult awareness of their local river's location is noted as a result of increased child knowledge. This could be because adults are becoming more unsure about which river is nearest to them as their teenagers participate in WCS activities and explore more of Palembang's numerous small wetland areas. The parental knowledge score, which is greatly affected by the child's knowledge (shown in Table 2 (a)), shows a favorable effect on parents' knowledge level of the local river location; therefore, it is challenging to ascertain the actual impact of factual education on parental traditional knowledge. Additional research on the elements that lead to increased levels of informally gained understanding of the environment is necessary to ascertain the actual impact. Knowledge of the surrounding area is probably mutual, as parents and teenagers engage in activities and talk together [27].

In addition, two unforeseen negative responses were observed. In the model of students' understanding of wetlands, involvement in wetland activities at WCS and spending more time at WCS together slightly reduced the impact (Table 2 (a)). Parents familiar with their nearby river and having a child involved in wetland projects contribute to decreased parental understanding of wetlands (Table 2 (b)). In both of these interactions, it is noted that the individual variables have a beneficial effect in the same model. Therefore, it is challenging to understand these interactions. The presence of these variables should not draw attention away from the main results in the models but could suggest that additional research is needed to explore more detailed aspects of how EE affects the acquisition of factual information by teenagers and parents.

The idea that students engaged in wetland projects can predict their family's water consumption aligns with the theory proposed by Baierl et al. [28] that teenagers could impact the actions of individuals not directly involved in environmental education. Furthermore, an increased number of people attending WCS can lead to at least one child being exposed to freshwater education, contributing to positive changes in family water consumption habits. This evidence contradicts the research of [29-33], which all argue that having an independent environmental understanding independently is not enough to promote positive nature actions within families. It contradicts the findings of Liu et al. [32] which found that intergenerational knowledge transfer did not lead to an increase in ecological behaviors among the parents of the recipients. Households focusing on the environment use water to benefit freshwater systems and participate in community activities related to freshwater conservation. Teenagers' participation in freshwater lessons at WCS influences adult knowledge, indicating successful reinforcement of intergenerational influences.

This research indicates that the environmental education program in Palembang is effective. Children are gaining knowledge about their surroundings and sharing it with their parents, impacting household practices. Engaging in environmental activities outside the classroom can improve students' learning and foster a deeper appreciation for nature. Nature lover groups that offer teenagers the chance to engage with nature directly are key components of WCS programs and are a significant attraction for teenagers who want to join WCS. Chawla [29] demonstrates that being exposed to natural environments firsthand during childhood plays a crucial role in influencing one's future beliefs and feelings toward the natural world. In this research, the amount of time students spend in school (represented by their age) does not impact their understanding of wetlands. Only by participating in the livelier WCS can one gain this understanding. Parents' understanding could improve when children engage in interactive tasks, as they are more inclined to share interesting environmental education topics with their parents compared to written assignments.

Increased participation in the WCS, whether over some time or by numerous teenagers, could be influenced by inherent interest, which makes determining causality more difficult. The inference of causality is weaker in self-reported water use behavior, as individuals with more knowledge may be influenced to provide responses expected by the researchers. An ideal experimental design would, therefore, replicate the work of Fu et al. [34], where they gathered data from both teenagers and adults at three different time points. It is important to assess knowledge, attitudes, and behavior before implementing an education program to determine causality [32]. Conducting a longitudinal study like this necessitates a prolonged period of data collection as well as a commitment to assessing the effectiveness of environmental education before the program begins.

This research stands out in the field of EE literature because it utilizes quantitative data to show a direct connection between EE-induced learning in teenagers and a targeted behavioral change related to conservation within households. This analysis demonstrates that educating teenagers on EE can change parental knowledge and behavior, showing that educating teenagers and adults is not mutually exclusive. However, a key limitation of this study is the reliance on a specific sample from Palembang's Adiwiyata schools, which may limit generalizability to other regions or educational contexts. Participation in the nature lover groups was voluntary, likely attracting students and families already inclined toward environmental issues, potentially introducing a selection bias. Additionally, the use of self-reported questionnaires may have led to response biases, as participants could have overreported knowledge or positive behaviors to align with perceived social expectations. Although measures like prize incentives and verification questions were employed to encourage accuracy, self-reporting remains a potential source of bias. Given the study's unique cultural and geographical context, further research in varied cultural and educational settings is recommended to validate the generalizability of these findings. Additional research should continue to investigate the possibility of EE and analyze how it is being implemented based on the results of this study.

5. CONCLUSION

This research demonstrates the effectiveness of environmental education (EE) programs in Palembang, Indonesia, in enhancing teenagers' environmental knowledge and facilitating knowledge transfer to their parents, ultimately influencing household behaviors related to water conservation. The quantitative analyses provide evidence that teenagers who participated in EE programs focused on water exhibited significantly higher environmental knowledge levels than the control group. Notably, this knowledge was successfully transferred to their parents, as indicated by higher parental knowledge scores in households where teenagers received EE. Furthermore, the study revealed a positive association between teenagers' participation in EE programs and more environmentally responsible water usage behaviors within their households. Families with teenagers engaged in EE were found to adopt water conservation practices and participate in community-based freshwater conservation activities to a greater extent. Based on the findings, policymakers should fund and expand environmental education (EE) in schools to foster sustainable behaviors across generations. Including EE in core curricula can promote long-term impact, while partnerships with community organizations can enhance real-life learning and engagement. Educators are encouraged to use hands-on activities, like water conservation projects, and promote family discussions on environmental practices to strengthen knowledge transfer and influence household behaviors. These findings challenge previous research suggesting that having environmental knowledge on its own is insufficient to promote pro-environmental behaviors within families. Instead, this study highlights the potential of EE to foster intergenerational knowledge transfer and subsequent behavior change, emphasizing the crucial role teenagers can play as "effective agents" for environmental conservation. Overall, this research provides quantitative evidence of the intergenerational impact of EE, underscoring its value in promoting conservation efforts through knowledge dissemination and behavior modification within families. The results encourage further investigation into the implementation and effectiveness of EE programs, as they hold promise for facilitating environmental stewardship across generations. Future research could examine the long-term effects of environmental education (EE) on sustained behavior change, explore digital tools for enhancing EE, and compare EE impacts in urban vs. rural settings. Additionally, methods to reduce self-report bias would improve accuracy in measuring EE's effectiveness.

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