

From awareness to action: How knowledge, responsibility, and environmental attitudes shape ecological behavior among elementary school students

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Abstract. Persistent environmental issues in Indonesia, such as waste accumulation and excessive energy consumption, highlight the need for early environmental education. The Adiwiyata School Program represents the government's initiative to integrate environmental learning into educational settings. This study examined the influence of environmental knowledge, awareness, responsibility, and attitudes on the ecological behavior of school-age children. Data were collected through self-administered questionnaires from 207 elementary school students using a cross-sectional design and cluster-random sampling technique. Descriptive analysis was conducted using SPSS, while structural equation modeling (SEM) was performed using SmartPLS. The findings revealed that environmental responsibility significantly and positively affected environmental attitudes ($\beta = 0.442$; $t = 6.339$). Furthermore, environmental knowledge ($\beta = 0.208$; $t = 2.889$), responsibility ($\beta = 0.192$; $t = 2.380$), and attitudes ($\beta = 0.242$; $t = 2.910$) significantly influenced ecological behavior. The results suggest that fostering environmental awareness, responsibility, and affection for nature can effectively enhance ecological behavior among school-age children.

1 Introduction

Environmental issues are major international concerns. The high contribution to the waste problem is due to the persistently high level of littering and a persistently underdeveloped waste management system in the country. In addition to littering, Indonesians tend to be indifferent to excessive energy use, such as leaving lights or water running when not in use. Waste and excessive energy use is a clear example of the lack of public awareness and concern for the environment, driven by irresponsible, unsustainable consumption.

In Indonesia, the government has instilled knowledge of environmental sustainability through education for elementary school-aged children. Children's environmental knowledge

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is significantly related to their environmental attitudes [1]. Elementary school children, as consumers in educational institutions, are expected to become agents of cleanliness that impact the environment, both at school, at home, and in the community. A systematic review shows that elementary school children are capable of practicing real hygiene behaviors, acting as agents of change, and that school environmental education plays a crucial role in shaping these behaviors [2]. Behaviors taught and shaped from an early age are one way to instill better behaviors in a new generation, particularly regarding concern for the surrounding environment. The Indonesian government has established the Adiwiyata Program to implement environmental education in schools. Adiwiyata is a program initiated by the Ministry of Environment to cultivate knowledge and awareness of environmental conservation among schoolchildren. Students participate in various school activities that promote a healthy environment and help reduce negative environmental impacts [3]. The Adiwiyata program in elementary schools is the starting point for developing environmentally conscious children.

The Knowledge-Attitude-Behavior (KAB) model was used as the theoretical basis for this ecological behavior study. This model explains how knowledge influences attitudes and changes individual behavior [4]. Another theoretical framework employed in this study is the Norm Activation Model (NAM). The NAM suggests that a person's pro-environmental actions are driven by a sense of personal responsibility, which is embodied in personal norms that guide behavior [5]. In addition to responsibility, environmental awareness is also a factor that fosters sustainable environmental attitudes and practices.

Based on this theory, this study analyzed the ecological behavior of school-age children. Ecological behavior refers to actions that aim to minimize the negative environmental impact of each activity [6]. This behavior encompasses actions such as recycling and composting, conserving energy and water, engaging in political activism, practicing consumerism responsibly, and supporting environmental organizations [7]. Previous research has shown that ecological behavior is influenced by several factors.

In this case, environmental attitudes often mediate other factors, such as knowledge of pro-environmental behavior, and have a fairly strong influence. Attitude is also a crucial factor in motivating individuals to commit to practicing environmentally conscious behaviors [8]. Environmental knowledge is another factor that indirectly determines environmentally friendly consumer behavior [9]. Knowledge-based behaviors are more consistent and long-lasting than those that are not. Individuals who are aware of the importance of the environment will act to create and maintain a clean environment [1, 10, 11]. Individual behavior in preserving the environment is closely associated with high levels of environmental awareness. Furthermore, consumers' sense of responsibility for the environment shapes an environmentally conscious attitude, which ultimately leads to pro-environmental behaviors.

Previous research has demonstrated that ecological behavior is affected by a multitude of factors, including demographic characteristics, environmental values, behavioral intentions, environmental attitudes, environmental knowledge, lifestyle, environmental awareness, and a sense of responsibility. Nevertheless, most investigations have analyzed these factors in isolation or focused solely on specific variables. Consequently, there is a limited body of research that integrates environmental knowledge, awareness, responsibility, and attitudes into a comprehensive framework. Furthermore, most studies on ecological behavior have focused on adult populations, with relatively few focusing on school-age children. Consequently, this study seeks to address this gap by concurrently examining the impact of these four environmental psychological variables on the ecological behaviors of school-age children.

2 Materials and methods

2.1 Population and samples

This study used a quantitative approach with a population of 454 students in grades IV, V, and VI at SDIT AL-IZZAH Serang in the 2022/2023 academic year. The research site was selected purposively because the school implements the Adiwiyata program. The number of study groups in each class was four, six, and five for grades IV, V, and VI, respectively. The respondents were student representatives of the population. In this study, we used a probability sampling technique, specifically random cluster sampling. A total of 207 students were recruited from two class groups in Grade IV, three in Grade V, and two in Grade VI.

2.2 Research instrument

Quantitative measurement of environmental knowledge variables was performed using the Children's Environmental Attitude and Knowledge Scale (CHEAKS) questionnaire, modified and developed by Leeming *et al.* (2024) [2]. The questionnaire consisted of seven items with Guttman scale scoring and three answer choices (wrong, do not know, and correct). Environmental awareness variables were measured using a questionnaire modified and developed by Artvinli and Demir (2018) [10], which consisted of six questions and was measured using a five-point Likert scale (strongly disagree, disagree, somewhat agree, agree, and strongly agree). The measurement of environmental responsibility variables used a modified questionnaire developed by Alhassan *et al.* (2020) [8], consisting of seven statements with five options on a Likert scale. Environmental attitude variables were measured using a questionnaire modified and developed by Leeming *et al.* (2024) [2], which was measured using a five-point Likert scale. The environmental attitude questionnaire consists of three dimensions with 12 statements. Ecological behavior variables were measured using a modified questionnaire developed by Kaiser (2007) [12], consisting of four dimensions with 11 statements and using a five-point Likert scale for assessment.

2.3 Collection of data

Qualitative data were collected through content analysis of sustainable consumption-related exposures in elementary school theme books. The theme books were analyzed by identifying the results of discussions with the principal and teachers regarding exposure to sustainable consumption in several theme books. Quantitative data were collected through an offline survey using a self-administered questionnaire. The data in this study are primary and were collected through questionnaires completed by elementary school students. The primary data included characteristics (gender, age, class, father's highest education, mother's highest education, father's occupation, and mother's occupation), environmental knowledge, environmental awareness, environmental responsibility, environmental attitudes, and ecological behavior. Primary data were collected using measuring instruments adjusted to the variables used in the study.

2.4 Data analysis

Data processing and analysis in qualitative research were conducted using content analysis and data interpretation. Quantitative research was performed using Microsoft Excel and the Statistical Package for Social Science (SPSS) for descriptive analysis and Smart Partial Least

Squares (Smart PLS) for the SEM analysis. Quantitative data analysis and interpretation were conducted using descriptive, correlational, and SEM analyses.

3 Results

3.1 Descriptive analysis

The results indicated that the 207 participants were nearly evenly split between men (49.8%) and women (50.2%). Furthermore, the highest proportion of sample members were 11 years old (44.4%). Based on daily pocket money, more than half (61.8%) of the sample had pocket money exceeding Rp10,000 per day. Regarding the final educational level of the sample members' fathers, more than half (74.4%) had a bachelor's degree (S1/D4 degree). Similarly, the final educational level of the mothers was at the S1/D4 level (72.5%); and furthermore, the majority of fathers and mothers were employed, accounting for 42.0 percent and mothers accounting for 37.7%, respectively. The highest family income of the sample members in this study was found in families with an income between Rp5,000,000 and Rp20,000,000, or above the minimum wage in Serang City (61.4% of the sample).

Table 1 shows that more than half of the identified variables were categorized as moderate: environmental knowledge (59.4%), environmental awareness (66.2%), environmental responsibility (48.3%), and environmental attitudes (65.7%). Most ecological behaviors were at a low level (59.9%), and some were moderate (37.2%). Overall, four of the five variables were in the moderate category, except for ecological behavior, which had a higher percentage at a lower level.

Table 1. Measurement and assessment of variables (n=207)

Variable	Less Category (%)	Medium Category (%)	Good Category (%)
Environmental knowledge	14.5	59.4	26.1
Environmental awareness	28.0	66.2	5.8
Environmental responsibility	12.6	48.3	39.1
Environmental attitudes	8.7	65.7	25.6
Ecological behavior	59.9	37.2	2.9

3.2 Correlation analysis

In this study, a correlation analysis was conducted between sample characteristics and ecological behavior variables. The results of the correlation analysis are shown in Table 2. The results indicate that fathers' occupations and education and mothers' education are related to ecological behavior. Fathers' highest level of education and occupation were significantly and positively related to ecological behavior. Conversely, the highest level of education of the mother was significantly and negatively related to ecological behavior.

Table 2. The relationship between sample characteristics and ecological behavior

Characteristics	Ecological Behavior (p-value)
Gender (1=female; 2=male)	0.163
Age (years)	0.643
Father's highest level of education	0.024*
Father's occupation	0.001*
Mother's highest level of education	-0.012*
Mother's occupation	0.088
Family income (rupiah)	-0.084

Note: *significant at $p < 0.05$ (2-tailed)

Last education: (0) up to high school graduation (1) up to high school graduation

Parents' occupation: (0) not working (1) working

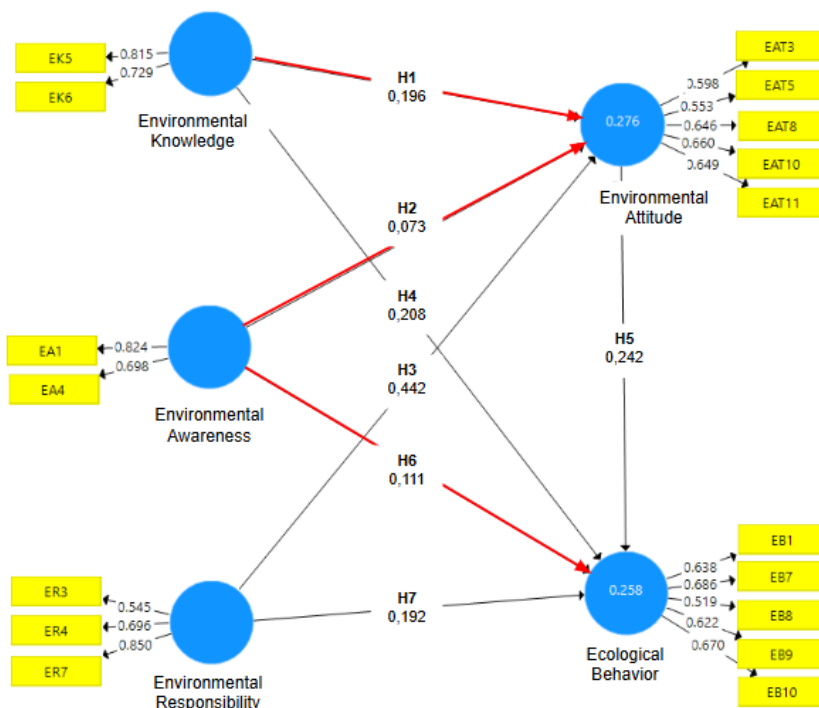


Fig. 1. Final model result

3.3 SEM Analysis

3.3.1 Measurement model analysis results (Outer Model)

The measurement results in Figure 1 show that each indicator has a factor value of more than 0.5, which means that it is valid and reliable. The next test examined the composite reliability value. A variable is deemed reliable if its composite reliability value exceeds 0.7. The composite reliability values for environmental knowledge (0.748), environmental awareness (0.735), environmental responsibility (0.745), environmental attitude (0.759), and ecological behavior (0.756) were greater than 0.7. Therefore, these variables satisfied the criteria and were considered reliable.

3.3.2 Structural model evaluation (Inner Model)

If the model has an R-square value of 0.02, it can be categorized as weak, 0.13 as moderate, and 0.26 as strong. The model indicates that the environmental attitude variable is classified as weak to moderate, with an R-squared value of 0.258. Conversely, the ecological behavior variable was classified as strong, with an R-squared value of 0.276.

3.3.3 Hypothesis testing

The results of the direct influence hypothesis test among the variables, as presented in Table 3, indicate that environmental responsibility ($\beta = 0.422$, $t = 6.394$) exerts a significant positive impact on environmental attitudes. Additionally, environmental knowledge ($\beta = 0.208$, $t = 2.889$), environmental attitudes ($\beta = 0.242$, $t = 2.910$), and environmental responsibility ($\beta = 0.192$, $t = 2.380$) demonstrate significant positive effects on ecological behavior. Consequently, four of the seven hypotheses—H3, H4, H5, and H7—have been supported. This suggests that an increased sense of responsibility towards the environment correlates with improved environmental attitudes. Furthermore, enhanced environmental knowledge correlates with greater environmental responsibility, which in turn influences environmental attitudes and subsequently enhances ecological behavior. Based on the supported hypotheses, it is noteworthy that environmental responsibility has the most substantial influence on environmental attitudes ($t = 6.394$), whereas its impact on ecological behavior is comparatively modest ($t = 2.380$). Conversely, three hypothesized relationships were found to be statistically insignificant, namely the effects of environmental knowledge ($\beta = 0.196$, $t = 1.892$) and environmental awareness ($\beta = 0.073$, $t = 1.239$) on environmental attitudes, as well as the influence of environmental awareness ($\beta = 0.111$, $t = 1.427$) on ecological behavior. As a result, hypotheses H1, H2, and H6 are rejected.

Table 3. Results of testing the direct influence hypothesis (n=207)

Pathway	Path coefficient	t-value	Conclusion	Hypothesis decision
Environmental knowledge → Environmental attitude	0.196	1.892	Not significant	Reject H1
Environmental awareness → Environmental attitude	0.073	1.239	Not significant	Reject H2
Environmental responsibility → Environmental attitude	0.442	6.394	Significant	Accept H3
Environmental knowledge → Ecological behavior	0.208	2.889	Significant	Accept H4
Environmental attitude → Ecological behavior	0.242	2.910	Significant	Accept H5
Environmental awareness → Ecological behavior	0.111	1.427	Not significant	Reject H6
Environmental responsibility → Ecological behavior	0.192	2.380	Significant	Accept H7

In addition to its direct influence, this study also had an indirect influence. The indirect influence in this study includes environmental knowledge (EK), which influences ecological behavior (EB) through environmental attitudes (EAT), and environmental awareness (EA), which influences ecological behavior (EB) through environmental attitudes (EAT), and environmental responsibility (ER), which influences ecological behavior (EB) through environmental attitudes (EAT). Based on the table above, the results of the indirect influence test indicate that one variable has a significant influence, as its t-value exceeds 1.96. The

indirect influence between these variables is the influence of environmental responsibility on ecological behavior through environmental attitudes, with a t-value of 2.576 or more than 1.96. The results of the indirect hypothesis tests are presented in Table 4.

Table 4. Results of indirect influence testing (n=207)

Pathway	Path coefficient	t-value	Conclusion
Environmental knowledge→Environmental attitudes→Ecological behavior	0.047	1.101	Not significant
Environmental awareness→Environmental attitudes→Ecological behavior	0.018	1.494	Not significant
Environmental responsibility→Environmental attitudes→Ecological behavior	0.017	2.576	Significant

4 Discussions

A strong and positive relationship exists between fathers' occupation, education level, and children's ecological behavior. Fathers who work in the environmental or natural resources sector are more likely to promote environmental awareness and model environmentally friendly behavior for their children. Fathers working in the environmental sector tend to be more concerned with and engage in environmentally friendly practices, thus positively contributing to ecological behavior. Furthermore, a father's higher education level tends to promote environmentally responsible behavior among children, as individuals with higher education are generally more cognizant of environmental issues and exhibit a greater willingness to engage in environmentally friendly practices. In contrast, a mother's highest educational attainment was strongly and negatively associated with children's ecological behavior. This may be because individuals with higher education levels tend to have greater career demands and professional responsibilities, resulting in diminished attention to environmental issues relative to economic or academic achievements. Prior research has also demonstrated that parental behavior and attention are significantly influenced by work-related demands, available resources, and family priorities [13].

Meanwhile, gender, age, maternal occupation, and family income did not show a significant relationship with children's ecological behavior. Age was not associated with children's ecological behavior; however, the findings indicate that environmental knowledge and attitudes increase with age [1]. This may be due to the homogeneity of respondents' ages; thus, variations in maturity are less likely to influence behavior. Maternal employment is unrelated because employment plays no role in shaping behavior; however, parental involvement plays a significant role [10]. Family income is also not significantly related and tends to be negative for children's ecological behavior because economic variables have a weak and inconsistent influence on pro-environmental behavior [9]. However, some studies indicate that people with higher incomes are generally more interested in and willing to participate in environmentally friendly activities [7]. Pro-environmental behavior is more influenced by cognitive and attitudinal factors than by demographic characteristics such as gender and age [5].

Individuals generally possess a good level of environmental knowledge; however, this does not significantly influence their attitudes toward the environment. Environmental knowledge and attitudes toward the environment are not interrelated [5, 9]. Other studies have shown that environmental knowledge greatly affects environmental attitudes and that awareness increases as the understanding of environmental issues deepens [14]. Environmental knowledge does not fully influence environmental attitudes and has only a limited influence on predicting a person's environmental attitudes.

Consumer awareness of the environment was relatively high, but consumers did not have a sufficiently positive attitude toward it. This finding suggests that environmental awareness does not always correlate with positive attitudes [15]. However, other studies have shown that environmental awareness significantly influences environmental attitudes [15]. Consumers' environmental awareness of environmental issues can foster their concern for environmental issues and directly influence their attitudes.

Consumers who feel environmentally responsible tend to have positive attitudes toward the environment. Environmental responsibility is an internal value that fosters positive attitudes toward the environment [10]. Other studies have also revealed a relationship between environmental responsibility and attitudes [14]. Consumers who perceive a sense of social responsibility towards the environment demonstrate more positive attitudes towards environmentally friendly practices and products [15].

Ultimately, consumers' worries about ecological problems often encourage environmentally friendly actions. Multiple studies have demonstrated that positive environmental attitudes significantly boost pro-environmental behavior [5, 6]. Attitude significantly influences the cultivation of environmentally conscious behaviors. Environmentally conscious attitudes serve as a link between awareness and concrete action, becoming a key factor in the shift from awareness to ecological behavior [14].

5 Conclusion

The study's respondents were almost equally divided by gender, with an average age of 11. Most fathers and mothers had a diploma or bachelor's degree, were employed, and earned family incomes above the minimum wage in Serang. The variables of environmental knowledge, awareness, responsibility, and attitude were rated as moderate or fairly good. In contrast, ecological behavior was categorized as low.

Correlation tests showed that sample characteristics, such as the father's occupation and both parents' highest education levels, were linked to ecological behavior. Specifically, higher levels of education in fathers correlated with increased ecological behavior in children. Conversely, a higher level of education in the mother led to lower levels of ecological behavior in the child. Furthermore, children with employed fathers tended to exhibit better ecological behavior than those with unemployed fathers.

SEM tests demonstrated that the stronger an individual's sense of responsibility for the environment, the more positive their environmental attitudes, which ultimately results in ecological behavior. Furthermore, individuals with positive environmental attitudes tend to exhibit more ecologically friendly behavior. Although environmental knowledge can encourage individuals to engage in ecological behavior, its ability to predict individual attitudes toward the environment remains limited. Furthermore, even if individuals have sufficient environmental awareness, this may not necessarily motivate them to develop environmental attitudes and behavior.

6 Research limitations and recommendations

This study has limitations. The analysis focused solely on the influence of variables in the KAB model without examining the relationships among independent variables in the NAM model. Furthermore, the measurement tools and questionnaire items need to be refined to be more easily understood by school-age children. Data collection was self-administered due to limited enumerators and time, particularly during the Ramadan period, and due to the lack of teacher and parent perspectives.

This study implies the need to strengthen the roles of families, schools, and the government in shaping the ecological behavior of school-age children. Parents must play an active role as primary socialization agents by providing role models and fostering environmentally friendly behavior in daily life. Schools are expected not only to maintain but also to consistently integrate environmental programs through supervision, rewards, adding environmental conservation activities, and ongoing guidance so that ecological behavior becomes part of the school culture. Further research is recommended to develop instruments that are more appropriate to children's characteristics, incorporate external factors such as social media and peer influence, and compare the effectiveness of environmental programs across different schools. Furthermore, these findings imply the importance of policy support from local governments through enhanced environmental education, training, and outreach programs involving students, teachers, parents, and the community to support the sustainability of ecological behavior from an early age.

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